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Dear Esteemed Readers, Authors, and Colleagues,

I hope this letter finds you in good health and high spirits. It is my distinct pleasure to address you as the Editor-in-Chief of Integrative Omics and Applied Biotechnology (IIOAB) Journal, a multidisciplinary scientific journal that has always placed a profound emphasis on nurturing the involvement of young scientists and championing the significance of an interdisciplinary approach.

At Integrative Omics and Applied Biotechnology (IIOAB) Journal, we firmly believe in the transformative power of science and innovation, and we recognize that it is the vigor and enthusiasm of young minds that often drive the most groundbreaking discoveries. We actively encourage students, early-career researchers, and scientists to submit their work and engage in meaningful discourse within the pages of our journal. We take pride in providing a platform for these emerging researchers to share their novel ideas and findings with the broader scientific community.

In today's rapidly evolving scientific landscape, it is increasingly evident that the challenges we face require a collaborative and interdisciplinary approach. The most complex problems demand a diverse set of perspectives and expertise. Integrative Omics and Applied Biotechnology (IIOAB) Journal has consistently promoted and celebrated this multidisciplinary ethos. We believe that by crossing traditional disciplinary boundaries, we can unlock new avenues for discovery, innovation, and progress. This philosophy has been at the heart of our journal's mission, and we remain dedicated to publishing research that exemplifies the power of interdisciplinary collaboration.

Our journal continues to serve as a hub for knowledge exchange, providing a platform for researchers from various fields to come together and share their insights, experiences, and research outcomes. The collaborative spirit within our community is truly inspiring, and I am immensely proud of the role that IIOAB journal plays in fostering such partnerships.

As we move forward, I encourage each and every one of you to continue supporting our mission. Whether you are a seasoned researcher, a young scientist embarking on your career, or a reader with a thirst for knowledge, your involvement in our journal is invaluable. By working together and embracing interdisciplinary perspectives, we can address the most pressing challenges facing humanity, from climate change and public health to technological advancements and social issues.

I would like to extend my gratitude to our authors, reviewers, editorial board members, and readers for their unwavering support. Your dedication is what makes IIOAB Journal the thriving scientific community it is today. Together, we will continue to explore the frontiers of knowledge and pioneer new approaches to solving the world's most complex problems.

Thank you for being a part of our journey, and for your commitment to advancing science through the pages of IIOAB Journal.

Yours sincerely,

Vasco Azevedo

Vasco Azevedo, Editor-in-Chief
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REVIEW

STUDY ON APPLICATIONS OF LAPLACE TRANSFORMATION: A REVIEW

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ABSTRACT

Background: *Role of mathematics is impeccable in day-to-day life. To justify and in validating their research findings, researchers from life sciences to computer technology uses various Mathematical technique or tool or model. Laplace transform is one of the tool used by scientist and researchers in finding the solution to their problems. In this paper we study the wide range of "Applications of Laplace transformations" in various fields. In this paper 25 research papers were studied and how Laplace transform has been used to solve their research problem is discussed. The current paper gives theory, problem worked on and application of Laplace transform in the research paper. To present a methodical review on applications of Laplace transformation is the objective of this paper. As a significant tool this technique have been used to respond diverse research problem modeled as differential or integral equation. The literature review provides a survey on Laplace transformation technique. The results of numerous studies, allow us to recommend the use of this technique to model their research problem mathematically and to find the solution to the same.*

KEY WORDS
Integral Transform, Laplace transformation, Applications, Analysis

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INTRODUCTION

The significance of transformation technique is it converts the system into an easier form so that solution can be derived from there. For numerous scientific foundations transform theory and techniques are helpful to experts. There are numerous classes of problems that are hard to solve or else algebraically very awkward in their unique portrayals. In applied mathematics, Laplace transformation has key role in concluding the solution guided by complex integral function. Comparing with the variation method of constant and undetermined coefficient this integral transform is simpler in application. In particular the Laplace transformation method is applied in solving the IVP (initial value problem) of nth order linear differential equations with constant coefficients [1].

Pierre-Simon Laplace, a French Mathematician introduced a special type of integral transform in his research later on it was called as Laplace transformation. Oliver Heaviside, a British physicist, developed Laplace transformation systematically. Among the various integral transform it is used mostly. The easiness in understanding and simple in applying is the inspiration behind this transformation technique. In numerous problems Laplace transformation is applied to derive the general solution.

As a significant tool the principal task of Laplace transform is, in establishing the suitable mathematical model for the solution of equations. Laplace transform converts the function f(t) from its time domain to frequency domain F(s). Then inverse Laplace transformation transfers the converted frequency domain F(s) in to time domain. In brief Laplace transform converts differential or integral equations into an algebraic equation. The extensive choice of application makes Laplace transform as a powerful tool in studying the characteristics of engineering problems [1].

Laplace transform is widely used method to solve higher order differential equations. It has many applications in Mathematics, Applied sciences and Engineering. It is also used for calibrating integral, differential, circuit systems, mechanical systems, avionics systems, image processing to say a few. Next section describes the application of Laplace transform in various fields.

STUDY ON APPLICATIONS OF LAPLACE TRANSFORMS

In this section the study about the applications of Laplace transform is discussed. The study is on how this technique is applied in various research problems. Research articles are studied, the theory behind, problem worked on and applications are portrayed. Methodical study is performed to portrait the functionality and the application of Laplace transformation technique.

Simulation of impulse response of electric machines

Electrical machines are often exposed to variety of wave forms which cause some faults in them. The work is done to replicate these impulse responses and know about them. Metwally, 1999 [2] had discussed three methods for deriving transient response of electrical machines are discussed, they are: (i) state space approach (ii) Realization of equivalent circuit (ii) Laplace transformation technique. Laplace transformation is applied to analyze voltage transient.

General non linear modal representation of large scale power system

Hasan Modirshanechi and Naserpari, 2003 [3] introduced and developed a new method called modal series method, which represents non linear system response for even zero input in form of differential equations. It derives and represents the behavior of non linear dynamic systems using non linear modal representation.
In this Laplace transformation is used to solve non linear differential equations.

Three level back to back high voltage direct current converters based on H bridge converters

Modeling of high voltage direct current converters based on H bridge voltage source converters are demonstrated by Siriya Skolthanarat, 2007 [4]. It has more features compared to two level converters. It corrects power system phenomenon like power quality, voltage and first swing stability. Designs of PI type compensators are derived by Laplace transformation.

Analytical techniques for broadband multi electro chemical piezo electric bimorph beams with multi frequency power harvesting

Peter Lloyd woodfield, 2015 [5] derived the multi frequency responses of multi electro chemical piezo electric bimorph beams based on closed form boundary value method from strong form of Hamiltonians principle. Also discussed the Conversion of unused mechanical energy to electrical energy by designing suitable electro mechanical system. Laplace transform is used to design new formulae for power harvesting multi frequency responses for multiple bimorph beams of different types of connections.

Generalized variational principles for heat conduction models based on Laplace transforms

For parabolic and hyperbolic heat conduction equations, Classical variational principle doesn't exist P. Szymczyk, M. Szymczyk, 2015 [6] explained and discussed the principles of those equations. In this classical variational principle is characterized to models like cattaneo-vernotte model, Jeffrey model, two temperature models to say a few. Laplace transformations are used to derive classical variational principles.

Transient analytical solution for the motion of a vibrating cylinder in the stokes regime using Laplace transforms

A stationary Newtonian fluid, a solution for transient decay of moment of vibrational cylinder is studied by Shu-NanLi, Bing-Yang Cao, 2016 [7]. Moment of elastic cylinder is also discussed. In this full expressions for transient terms are specified. It also have applications in viscosity measurements. Laplace transformation is used to derive analytical solutions for moment of elastic cylinder in Newtonian fluid.

Classification of geological structure using ground penetration radar and Laplace transform artificial neural networks

Mikail. F. Lumentat, 2012 [8] described a new type of artificial neurons and neural networks. By using these neural networks and on basis of different types of geological structures, the structure of geological substance is classified. Laplace transform is used instead of artificial weights and in linear activation function of artificial neuron.

SAR image Despeckling based on combination of Laplace mixture distribution with local parameters and Multiscale edge detection in lapped transform domain

The effect of speckle noise on tasks of automatic information extraction and SAR images is studied by D. Hazarika et al., 2016 [9]. And this effect is rectified using Laplace Transform Technique. A new and effective method is developed to SAR image Despeckling. A new type of Laplace orthogonal transform (LOT) is proposed to despeckle SAR images.

Wave propagation and transient response of a fluid filled FGM cylinder with rigid core using the inverse Laplace transform

A study on wave propagation and transient response of fluid filled Functionally Graded Material (FGM) is discussed by K. Daneshjou et al., 2017 [10]. Analytical methodology for deriving transient response of

fluid filled FGM cylindrical shell with a co-axial rigid core. Inverse Laplace transform is used for the study. Derivation of wave propagation, transient response of fluid filled FGM cylinder with rigid core using transform technique carried out.

Analytical solution of Abel integral equation arising in astrophysics via Laplace transforms

Sunil Kumar et al., 2015 [11] discussed an algorithm for Abel integral equation, called as Homotopy Perturbation Transform technique (HPTM). Comparatively it found very simple than other calculation methods. The HPTM is employed to get quick and accurate solutions of singular integral equations of Abel type, linear and non-linear type problems in science and technology. Here the new method HPTM is formed by some modification of Laplace transformation.

Analysis for pressure transient of coalbed methane reservoir based on Laplace transform finite differential method

Lei Wang et al., 2015 [12] have emphasized the mathematical model of coalbed methane based on fractal geometry. Fractal medium are derived from Langmuir isotherm, Adsorption formula, and Fick's diffusion law. Wellbore storage effect and skin effect is considered and mathematical equation is derived. Laplace transform is used as a finite difference method for solving mathematical equations.

Medical application for the flow of carbon-nanotube suspended nanofluids in the presence of convective condition using Laplace transform

Hodasaleh et al., 2013 [13] studied the use of CNT's in Medical sciences; they are used for cancer treatment by sending them to tumor sites by action of waves propagated by walls of artery. The equations for heat flow in CNT's are derived. Laplace transform is used for solving heat transfer equations of CNT's.

A Swiss army knife for finite rate of innovation sampling theory

Ayush Bhanar and Yanina C. Elar, 2016 [14] discussed the General description of a recipe to a wide class of mathematical operations for extension of FRI sampling theory. Development of a broad FRI framework which is applicable to class of transformation such as Laplace, Fourier, Fresnel and few other Transformations is done in this paper. For exact recovery of Dirac impulses from linear measurements in the form of orthogonal projections of streams of Dirac impulses, finite-rate-of-innovation (FRI) sampling theory is use onto the subspace of Fourier-band limited functions. The orthogonal projection of a signal onto the subspace of SAFT- Band limited functions is equivalent to low pass filtering followed by sampling. The representation of FRI signals in the SAFT domain is based this equivalence. Many interesting extensions are done via FRI principles.

Convexly constrained linear inverse problems: iterative least squares and regularization

Ashutosh Sabharwal and Lee C. Potter, 1998 [15] have intensely analyzed the Linear Inverse Problems which are accompanied by convex and closed constraints. Presentation of Conditions for convexly constrained inversion is done. The present analysis proves that this approach extends good to convexly constrained as well as other popular approaches such as L-curve and cross Validation. To regularize constrained inversion, a stopping rule is shown. Also an iteration that converges to the minimum norm least squares solution is presented. To illustrate the proposed algorithm, a constrained Laplace inversion is computed. Extension of Discrepancy principle is done for regularization of ill-posed inverse problems to include convex constraints. Stopping rule uses the knowledge of noise power bound effectively.

New Mathematical nonlinear modular model for switch-mode pulse width modulated converter circuits

Andres Nogueiras et al., 2013 [16] developed a new mathematical model of pulse width modulation (PWM) process to attain behavioral non linear simulation of switch mode power converters. This technique is employed to facilitate the simulations of dc to dc converters and VSI to obtain different PWM techniques. The modeling techniques are very efficient. The obtained data from the simulations are contrasted against data from other authors in previous works with other mathematical simulation models and proved to be valid. To achieve a nonlinear Mathematical Model of PWM pulses, Laplace Transform and Heaviside unitary pulse function is applied.

Reducing torque ripple of brushless dc motor by varying input voltage

Ki-Yong Nam et al., 2006 [17] presented a Method to reduce the torque ripple of brushless direct current motor. In the BLDC motor, the torque ripple is decided by back EMF which is constant in the conduction region of current, torque ripple depends on current ripple. By varying input voltage, torque ripple can be reduced to reduce current ripple. Torque ripple is reduced by ten percent, in the simulation confirmed by the experiment. The torque ripple is not reduced conspicuously. The current ripple is the one which is reduced conspicuously. The produced torque ripple wave form is similar to the back EMF wave form. The period of freewheeling reason in the conduction region is acquired by using Laplace Transformation via circuit analysis.

Electromechanical piezoelectric power harvester frequency response modeling using closed form boundary value methods

Two theoretical studies, CEDRTL and CEDRT have been discussed and compared by Lumentut and Ian M. Howard, 2014 [18]. CEDRTL and CEDRT tend to overlap when the load resistance approaches short circuit. To predict the electromechanical power harvester frequency response, a novel analytical model of a piezoelectric bimorph is presented. Using Laplace Transformation the electromechanical frequency response function with variable load resistance is given. To demonstrate the shifting frequency and amplitude changes due to variable resistance, using NYQUIST plot experimental and CEDRTL model results were very close to each other.

Electrochemical disturbance propagation and oscillation in power systems

A study on electromechanical disturbance propagation and oscillation based on a multi segment uniform change power system is discussed by Delin wang and Xiaoru Wang, 2012 [19]. Same as that of electrochemical wave propagation in a continuum model, the reflection and transmission formulae of electrochemical disturbance is presented. Also, power oscillation and frequency is derived from the view point of electromechanical disturbance propagation. The analytical expressions of Bessel functions reveal that the electromechanical disturbance propagates along the chain power systems. A power system, electromechanical power oscillations is induced by electromechanical disturbance propagation and the oscillation frequency modes could be obtained by a grid structures and parameters. The Machine rotors angle and power increments at all bases are derive using Laplace Transformation under a unit step function disturbance.

Interconnect reliability modeling and analysis for multi-branch interconnect trees

For electro migration reliability analysis in multi branch interconnect trees Hai-Bao Chen et al., 2015 [20] proposed a new modeling and analysis technique with continuous metallization which reflects more practical interconnect structures and writing techniques. Analytical solutions are obtained for each type of the interconnect trees by using Laplace transformation. The exact analytic solutions to stress evolution equations for different terminal wires (3,4 & 5) have been developed. An excellent agreement is shown by the new physics based EM model, for multi branch interconnect trees with the detailed numerical analysis. By De-coupling the individual segments through the proper boundary conditions the new approach solves the stress evolution in a multi branch tree accounting the interactions between different branches.

Neuro computing, supervised learning Laplace transform artificial neural networks an using it for automatic classification of geological structures

A method of learning novel Laplace transform artificial neural network (LTANN) is presented by P. Szymczyk and M. Szymczyk, 2014 [21]. The concept of Laplace transformation is utilized in neural networks. Description of the usage of (LTANN) for searching anomalies in geological structures is explained. This method is based on well known method of supervised learning and it was adopted into a new type of networks (LTANN).

Fast-varying and transient non-linear equations for micro structure fibers

Jing Huang et al., 2017 [22] discussed the fast varying field in micro structure fibers (photonic crystal fibers) is described by the transient non-linear equation. The transient non-linear equation in which the frequency and wave number are functions of time describes the quick evolution of the field in micro structure fibers. By non-linear effect, new frequencies are induced and amplified. The second order differential of the field to transmission distance can't be deleted, which will induce an oscillation along Z in the resonance condition to interpret the principle of photonic crystal fiber metamaterials, this property can

be utilized. Volterra series integration and Laplace transformation are the two methods used to solve the transient non-linear equations.

Novel unilateral NMR sensor for assessing the aging status of silicone rubber insulator

Xu Zheng et al., 2016 [23] proposed a novel unilateral nuclear magnetic resonance (NMR) method to quantify insulator degradation attribute to aging. Aging results in decrease in NMR transverse relaxation time and more serious aging results in a more severe decrease. Values of all SRIs with different service times tend to be nearly the same for sufficiently large depth. Sensor static field and step motor system are employed to obtain respective operation measurements. The Safety of the power grid is threatened by the aging of a silicone rubber insulator. So for taking Precautions against insulation failure, accurate estimation of the insulator aging status is necessary which is found by using the proposed method. By Applying Inverse Laplace Transformation on the filtered transverse relaxation, a decay curves 1-D T2 attribution of each layer is obtained.

A fast algorithm for parabolic PDE-based inverse problems based on Laplace transforms and flexible krylov solvers

Tania Bakhos et al., 2015 [24] proposed a new method to solve parabolic partial differential equations effectively and fast. In their work parameters are estimated for large scale weakly non linear inverse problems for which the governing equations are linear time dependent, parabolic partial differential equations (PDE). Laplace Transformation is applied to solve parabolic partial differential equations. Which improve the storage and computational cost.

Solutions for fractional order electrical circuits in Laplace transform an non standard finite difference method

WK Zahra et al., 2017 [25] studied Fractional linear electrical systems also Introduced new parameters for generalization of RL and RC circuits. The classical electrical system and fractional electrical system are compared. Fractional linear electrical systems are solved by fractional Calculus. This Fractional modeling introduces more accurate representation of real inductor and real Capacitor. Solution for fractional models of RL and RC circuits are derived by Laplace Transform.

Analytical solutions of convection-diffusion problems by combining Laplace transform method and homotopy perturbation

Sumit Gupta et al., 2015 [26] established a method to solve linear and non linear convection diffusion problems arising in physical phenomenon in which energy is transferred due to diffusion and convection. Homotopy perturbation transformation method is introduced which makes solving convection diffusion equations easily. Here HPTM is combination of Laplace transform and Homotopy perturbation.

CONCLUSION

The main purpose of this paper is to give a brief idea about applications of Laplace transforms in various areas and how it is used to solve various types of equations and problems in science, Engineering. In this paper some of the applications of Laplace transforms in various fields are reviewed and explained. This study on Laplace Transformation technique not only offers an insights and exhaustively comprehensive review. It also summarizes the various applications of Laplace transformation technique in various fields, making a general perception of the research progresses, leaning to assist the development and solution to various research problems.

CONFLICT OF INTEREST

There is no conflict of interest.

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ARTICLE

CROSS TALK AVOIDANCE AND ERRORCORRECTION CODES THROUGH RELIABLE NETWORKS ON CHIP USING HYBRID RECONFIGURABLE ARCHITECTURE

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ABSTRACT

In Traditional techniques, Messages in the NoC are exchanged with a wormhole slice through exchanging strategy; whereas various messages can be interleaved at bounce level in a similar correspondence interface without utilizing virtual channels. Advance in 3D NoCs basically utilize a deterministic directing calculation to convey bundles from a source to a goal hub. In any case, deterministic strategies can't disperse the activity stack over the system, which brings about debasing the execution. In this paper, with a specific end goal to increment in the unwavering quality of Network-on-chip by keeping away from blunders and crosstalk between the switches presents the outline of a NoC switch in view of turn model. A Turn Model directing calculation is utilized to maintain a strategic distance from deadlock clashes. Additionally the switch coordinates a dynamic authority to build the Quality of Service of system. Promote Crosstalk Avoiding Double Error Correction Scheme Encoder is a basic mix of Hamming coding took after by The Duplicate Add Parity (DAP) or Boundary Shift Coding (BSC) encoding to give insurance against cross talk, here in this paper we have joined two calculations and made configurable building outline. Additionally hamming codec is utilized for identification and mistake revision other than crosstalk evasion CODEC for staying away from the crosstalk in the middle of the switches of the NoC. In our work, 2D/3D switch configuration is broke down utilizing Xilinx 13.2 whereas results examination accomplished for delay and frequency in satisfied manner. The significance of 3D model is to expand the layers in the topology, which in increment the rate of availability that makes the NoC minimal in size.

KEY WORDS
3D network, fully adaptive routing, Duplicate Add Parity, Boundary Shift Coding (BSC)

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INTRODUCTION

The customary high clock rate single center frameworks have been supplanted by conveyed many-center frameworks on a solitary bite the dust because of vitality utilization and execution limits. Information transmission through a chip is viewed as more difficult since worldwide interconnects are turning into the foremost execution bottle-neck for superior systems. System-on-Chip (SoC) does not bolster future innovations as the quantity of centers on single kicks the bucket increments. Network on-Chip (NoC) has been proposed as another interconnection design to sup-port better particularity, versatility and higher transmission capacity highlights. Control scattering is getting to be distinctly basic constraints of framework plan because of battery lifetime, cooling, and warm spending plans concerns. It has been accounted for that system control for a many-center pass on later on can be as high as 150W, assuming current system scale usage. Reducing vitality devoured in NoC is of extraordinary significance for superior and vitality efficient designs. Routing is a basic piece of NoC, and has a significant effect on the correspondence efficiency, particularly if there should arise an occurrence of single-flit packets Various disseminated directing calculations have been proposed for NoC/SoC platforms. An versatile dispersed steering calculation for 2D work SoC/NoC is exhibited, which depends on Dynamic XY (DyXY) [1]. A conveyed directing calculation is displayed with no steering. In [2] an appropriated defeating calculation for a 3D NoC is introduced. As per the Technology Roadmap for Semiconductors (ITRS),There-Dimensional (3D) mix is viewed as a promising advancement to keep up the execution change past 65nm [3]. In 3D blend development, various element silicon layers are stacked together using Through-Silicon-Vias (TSVs).[4] The genuine favored angle of 3D ICs is the noteworthy diminishment in the impression and overall inter connect length, resulting in extended execution [5]. 3D Networks-on-Chip (3D NoCs), of course, are creating as a response for the inter connect multifaceted design in 3D SoCs [6].Routing estimations are used to thruway a package from a source to an objective. Controlling figurings can be gathered by where coordinating decisions are taken [7]. In a source coordinating [8], the way can be developed at the source center before the package implantation while in a circled directing, the way is settled dispersedly while the package navigated the framework. Not in the slightest degree like scattered guiding, in the source coordinating strategy, the way information is passed on by packs, thus switches does not require any extra estimation for settling on directing decisions. This results in a less troublesome guiding unit and a snappier correspondence. In any case, as groups are required to pass on the way information (i.e. that is for the most part broad), the exchange speed essential and versatility get the opportunity to be unmistakably genuine challenges. Right when spread coordinating is used, the way is figured at each widely appealing center point. Passed on guiding can be portrayed into deterministic and adaptable [9]. A deterministic controlling figuring uses a settled path for each join of source and objective centers. Utilization of deterministic guiding computations are direct anyway they can't conform the pile over the associations. The slightest troublesome deterministic guiding methodology is estimation mastermind coordinating. The estimation organize guiding computation courses packages by crossing point estimations in completely growing solicitation, reducing the balance in one making a beeline for zero going before coordinating in the accompanying one. Deterministic directing estimations perform well with uniform development plan while they are astoundingly inefficient under non-uniform movement.[10] Curiously, in adaptable coordinating computations, a package is not restricted to a singular way while going from a source center to its objective. Thusly, adaptable controlling estimations can lessen the

probability of coordinating packages through congested regions. Several midway and totally flexible directing counts are introduced in 2D frameworks, for instance, DyXY [11] and Odd-Even [12]. The coordinating assurance of these figuring is regularly performed using the blockage status of the framework. A noteworthy number of them consider neighborhood development condition in the directing decision in which each switch examinations the obstruct conditions of its own and close-by changes to pick a yield channel. This social occasion of computations could upgrade the execution out and out when diverged from estimation organize directing due to the spread of packages over the framework. In any case, coordinating decisions in light of close-by blockage information may provoke to an unbalanced distribution of development load. Some unique figurings, for instance, obstruct careful trapezoid-based guiding algorithm (CATRA) [13] and Highly Adaptive Routing Algorithm in On-Chip Networks (HARAQ) [14] consider more overall information, diminishing the probability of settling on a wrong decision. In any case, paying little personality to the constrained multifaceted nature and range overhead, giving overall information is eccentric. In total, adaptable coordinating computations in perspective of overall blockage information upgrade the execution over the procedures in light of adjacent stop up information. This execution get is at the cost of an enormous zone overhead, a more capricious coordinating unit, and the prerequisite for stop up area and spread framework. There are few for the most part adaptable systems showed in 3D NoCs, for instance, metal relic diminishment (MAR)[15].

In this paper, 2D switch is our talked about in the segment II alongside 3D directed plan rule. Encourage the proposed strategy alongside 3D switch model is dissected in the segment III alongside arrangement which defeats the downsides of the current technique is examined. In area IV results are looked at and downsides are examined The significance of 3D model, investigated to expand the layers in the topology which wills increment the rate of openness that makes NoC minimal in size and Section V gives out the conclusion.

EXISTING METHOD

[16] In the conventional method Runtime Contention and Bandwidth-Aware Adaptive Routing Selection Strategies for Networks-on-Chip is analysed whereas This paper presents adaptive routing selection strategies suitable for network-on-chip (NoC).Messages in the NoC are switched with a wormhole cut-through switching method, where the different messages can be interleaved at flit-level in the same communication link without using virtual channels. On the Design of Hybrid Routing Mechanism for Mesh-construct thoroughly Network-with respect to Chip the Tag NoC helps all turn adaptation directing calculations, for example, four surely understood ones like XY, NF, WF and NL. Since XY directing calculation is the reference show for the greater part of the NoC related re-look for, This Tag NoC coding values and comparing multiplexer selectors are intended for this [17]set of rules. This configuration bolsters 2D NoC Only with the Ports: North, South, East, West as demonstrated in the [Fig. 1].

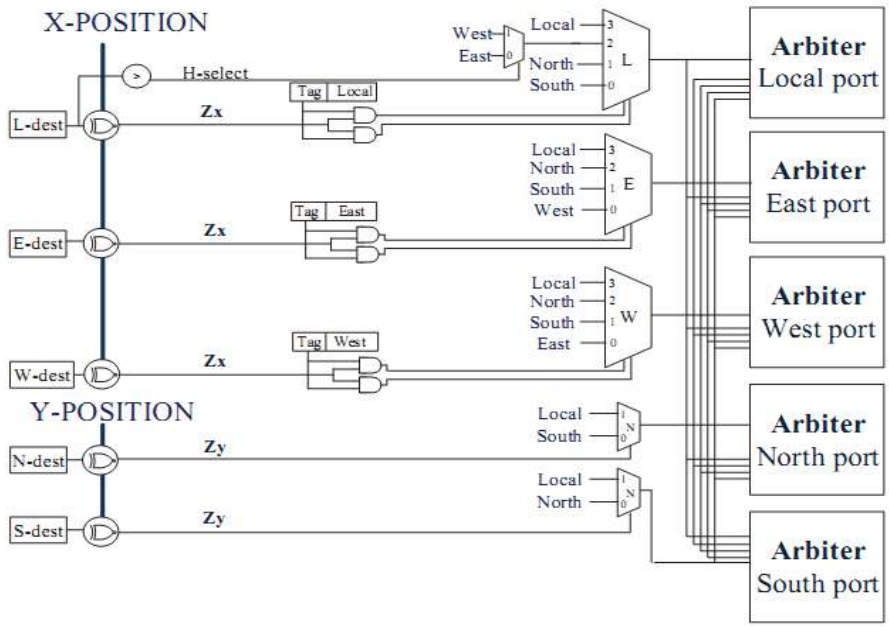
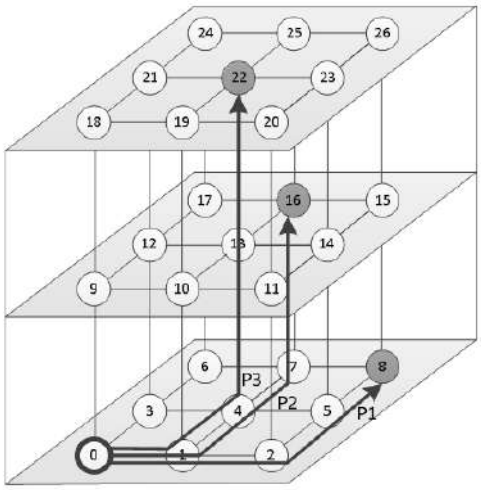


Fig. 1: Design of hybrid routing mechanism for mesh-based network-on-chip

Further, the Fully Adaptive Routing Algorithm for 3D NoCs is analyzed with the Ports: North, South, East, West, Up, Down which is shown in the [Fig. 2] along with the 3D model structure is described below.



Direction	Virtual Channels
ENU	X0,Y0,Z0
END	X1,Y1,Z1
ESU	X2,Y0,Z0
ESD	X3,Y1,Z1
WNU	X0,Y2,Z0
WND	X1,Y3,Z1
WSU	X2,Y2,Z0
WSD	X3,Y3,Z1
EN	(X0,X1),(Y0,Y1)
ES	(X2,X3),(Y0,Y1)
EU	(X0,X2),(Z0)
ED	(X0,X3),(Z1)
WN	(X0,X1),(Y2,Y3)
WS	(X2,X3),(Y2,Y3)
WU	(X0,X2),(Z0)
WD	(X1,X3),(Z1)
NU	(Y0,Y2),(Z0)
ND	(Y1,Y3),(Z1)
SU	(Y0,Y2),(Z0)
SD	(Y1,Y1),(Z1)
E	(X1,X2,X3,X4)
W	(X1,X2,X3,X4)
N	(Y0,Y1,Y2,Y3)
S	(Y0,Y1,Y2,Y3)
U	(Z0,Z1)
D	(Z0,Z1)

Fig. 2: Adaptive routing algorithm

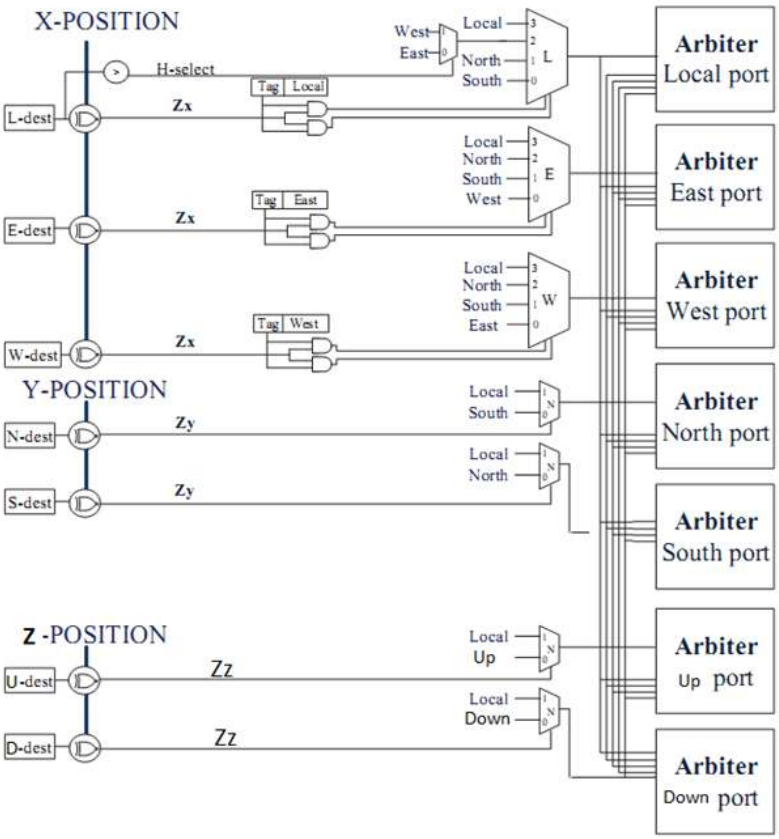


Fig. 3: 3D model structure

As shown in the [Fig. 3] [18], NoC ensures high performance and scalability. To overcome those limitations, in this paper we presents the design of a NoC router based on hybrid model where Turn model and Fully Adaptive Routing Algorithm is combined together which gives reconfigurable architecture. A Turn Model routing algorithm is used to avoid deadlock conflicts. Also the router integrates a dynamic arbiter to increase the Quality of Service of network. Crosstalk avoiding double error correction code (CADEC) is used

to for cross talk avoidance. To evaluate performance of our design, we compared it with various routers in terms of delay, power and clock frequency.

PROPOSED METHOD

Runtime Contention and Bandwidth-Aware Adaptive Routing Selection Strategies for Networks-on-Chip. The above structures were joined and 1/2 breed reconfigurable interpretation is proposed with the hope to grow the unwavering quality of Network-on-chip by staying far away from misunderstandings and crosstalk among the switches. As showed up inside the [Fig. 4].In the 1/2 and half of model Design of a Network-on-Chip move in tender of flip frame praised the plan of a NoC move in light of flip model. A Turn Model organizing calculation is associated with stay faraway from expect clashes. Additionally the switch passes on an element go between to make more noteworthy the Quality of Service of device. The trade parameters are chosen underneath for the 2D represents.

- Router Parameters — 2D router
- Buffer Depth — 4
- Flit size (bit) — 32
- Switching — wormhole
- Flow control — Credit based
- Scheduling — Dynamic arbiter
- Routing — Negative-First
- Target device — Virtex5 XC5VFX70T

The arbiter module of the switch allocator uses a round-robin and a priority scheduler schemes to assign the highest priority packet to the adequate output port. The turn model which is a deadlock-free partial adaptive routing algorithm for mesh NoC.

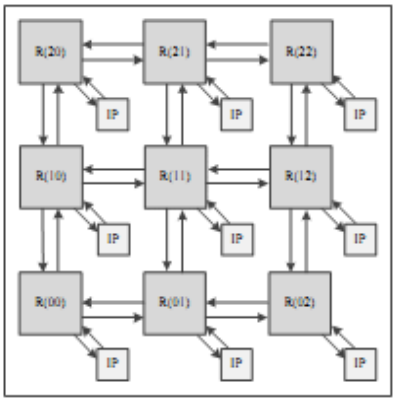


Fig. 4: 3x3 NoC model

Cross talk avoidance can be done through crosstalk avoiding double error correction code (CADEC) In wormhole exchanging, the halt circumstance happens when bundles are sitting tight for each other in cyclic conditions. In 2D work arrange, switches may forward parcels in four bearings: North, East, South and West. Bundles may take eight turns for every bearing. A hand over this setting alludes to a change of 90-level of the voyaging bearing of the parcel. The negative-first turn demonstrate steering calculation is picked because of its versatility and effortlessness.

In the half and half model the Crosstalk shirking and mistake amendment is handled through Crosstalk Avoiding Double Error Correction Scheme Encoder The encoder is a basic mix of Hamming coding took after by DAP or BSC encoding to give security against cross talk.

• Boundary Shift Coding (BSC) is accomplished by keeping away from a common limit between two progressive code words.
• The Duplicate Add Parity (DAP) plot accomplishes joint crosstalk evasion and single blunder rectification capacity by copying every piece of the n-bit flutter and putting the duplicates contiguous each other to evade crosstalk, and by additionally figuring an equality bit from the underlying bits to empower single mistake adjustment.

The unraveling calculation comprises of the accompanying straightforward strides

1. The equality bits of the individual Hamming duplicates are ascertained and contrasted and the sent equality;
2. If these two equalities acquired in step 1 vary, then the copy whose equality matches with the transmitted equality is chosen as the yield cop y of the primary stage.
3. If the two equalities are equivalent, then any one duplicate is sent forward for disorder identification.

4. If the disorder got for this duplicate is zero then this duplicate is chosen as the yield of the primary stage. Something else, the substitute duplicate is chosen.
5. The yield of the principal stage is sent for (38, 32) single mistake redressing Hamming unraveling, at long last delivering the decoded CAD EC yield. As appeared in the [Fig. 5].

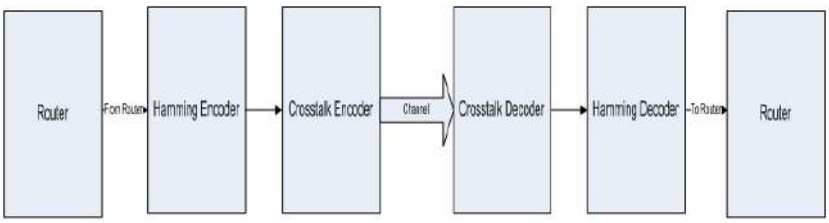


Fig. 5: Flow of the proposed Hybrid model

RESULTS AND DISCUSSION

Xilinx/ISE Simulations and Precision RTL of mentor graphics

The proposed NoC and its related blocks are depicted utilizing basic Verilog and incorporated utilizing Xilinx Synthesis Tool (XST), Web PACK form 13.2 and Precision RTL of Mentor Graphics. The execution was focused to Xilinx Virtex5 low power, Selected Device: Virtex5 XC5VFX70T

The consistent directing can be seen from the acquired Place and course result from the FPGA Editor alternative in Xilinx synthesizer. It is watched that higher utilization around 10% of Basic logic components (BELS) range for the focused on FPGA is secured for the execution of this System in the proposed technique because of hybrid design which can be advanced in further strategies. The configurable rationale blocks are associated in course way to get the usefulness for the outlined framework. To guarantee that the equipment usage works legitimately, simulation test was performed utilizing I-Sim (O.76.xd).

Impact of the proposed flow on peak frequency usage, timing and power

In this paper, the customary approach and the proposed technique is investigated in view of the cost capacity of placer and switch. As appeared in the [Table 1] the quantity of Frequency use, timing and power are diminished in proposed stream because of less utilization of intelligent circuit in the outline. As the [Table 1] appear:

The directed design of the routine and proposed technique onVirtex5 XC5VFX70T is classified in [Table 1] demonstrate the proposed technique beats the customary engineering as far as position and steering which has appeared in the [Table 1] Shows the proposed strategy decreased the postponement of 40% for the 2D however thus it indicates increment in 3D technique because of cross breed design. Promote 11% decline in recurrence use for 3D technique with contrast with traditional strategy. As far as overhead, since the customary approach and the proposed strategy just change the situation and directing of the outline, as the use of the configurable rationale squares shifts which gives the overhead in the current approach. Moreover, no inaccessible configurable rationale pieces are accounted for by the first strategy and the proposed technique which conquers the confinement of the first approach. Henceforth, the traditional approach and the proposed technique manage configurable rationale squares overhead.

The configurable rationale squares are associated in course way to get the usefulness for the outlined system. As the scope zone of the configurable rationale pieces which limit course channel width. The lower defer originates from that the quantity of glitches is littler when the bring proliferates Quicker through the rationale.

Table 1: Optimized parameter comparison for the conventional and proposed method

Parameter	Existing Work		Proposed Work	
Router	2D	3D (proposed)	2D	3D (proposed)
Buffer Depth	8	8	4	4
Switching	wormhole	wormhole	wormhole	wormhole
Flow control	No	No	Credit based	Credit based
Scheduling	No	No	Dynamic arbiter	Dynamic arbiter
Routing	Dimension Ordered Routing	Dimension Ordered Routing	Negative-First	Negative-First
Error Correction	No	No	Hamming Code	Hamming Code
Crosstalk Avoidance	No	No	CADEC	CADEC
BELS	146	151	161	192
Power	252.65mW	252.90mW	270.68mW	273.58mW
Delay	2.739ns	2.964ns	2.370ns	3.348ns
Maximum Frequency	365.050MHz	337.388MHz	421.971MHz	298.663MHz

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Total on chip power

Power dissipation is mainly due to switching power, short-circuit and leakage power.

$$\text{Power} = P_{switching} + P_{shortcircuit} + P_{leakage} \quad (1)$$

Switching activity factor: α

If the signal is a clock, α = 1 then If the signal switches once per cycle, α = ½.besides For Dynamic gates: switch is either 0 or 2 times per cycle, α = ½ and for the Static gates: depending on design, but typically α = 0.1

$$P_{switching} = \alpha .f.C_{eff} .V_{dd}2 \quad (2)$$

Where α is the probability of a signal transition with in clock period, C_{eff} indicates the effective capacitance is the clock frequency and V_{dd} is the power supply voltage.

Short-circuit power occurred when there is a transition between VDD and GND occurs

$$P_{shortcircuit} = Isc .V_{dd}.f \quad (3)$$

$$P_{leakage} = f(V_{dd}, V_{th}, W/L) \quad (4)$$

Power consumption has calculated following this formula As shown in the [Table 1].

$$p = vdd.\frac{\int_0^T I_{dd}}{T} \quad (5)$$

Where V_{dd} is the supply voltage, I_{dd} is the supply current, and T is the period. Isc the short circuit current and f indicates the frequency. As the total power dissipation is increased due to the switching activity of the transistor. The power comparison for various styles due to switching activity has shown in the [Table 1]. The proposed design is the can be optimized further for total on chip power consumption (i.e., least amount) than over all conventional methods.

CONCLUSION

Movement can be conveyed over the system by utilizing elective ways. In this paper, we proposed a hybrid reconfigurable architecture algorithm. In this technique, at every middle of the node hub, a message is sent to a bearing which is less congested which decreases the postponement of the proposed strategy which recorded previously. This calculation is ended up being stop by utilizing 4, 4, and 2 virtual channels along the X, Y, and Z measurements, separately. In spite of the fact that this calculation can ease the clog, it can't be utilized for the applications requesting all together conveyance for less power and territory because of congested design which can be advanced in further work. With a specific end goal to address the altogether conveyance issue in 3D organize and to lessen the power utilization and area, we are attempting to propose a strategy as a future work.

CONFLICT OF INTEREST
There is no conflict of interest.

ACKNOWLEDGEMENTS
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FINANCIAL DISCLOSURE
None

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ARTICLE

COMPUTATIONAL DENSITY FUNCTIONAL THEORY (DFT) APPROACH ON SMART CATALYSTS UTILIZED IN FUEL CELL TECHNOLOGY

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ABSTRACT

Concepts of nanotechnology are utilized in numerous fields. Sustainable or non-conventional source of power is one area in which this smart technology is widely applied. The catalytic property of nanomaterials in Fuel Cell Technology (FCT) is worth mentioning as it would increase efficiency to a great extent. In this work, Monte-Carlo calculations are carried out to check the adsorption of OH- molecule on various platinum catalysts doped with Ru, W, Co and Pd. The catalyst was then made to adsorb on two separate amorphous carbon blocks that acted as cathode and anode respectively. The Membrane Electrode Assembly (MEA) of the fuel cell was made with nafion membrane and Co-doped Pt electrodes. Adsorption of OH- molecule on the final restructured MEA of the fuel cell was studied.

KEY WORDS
Fuel Cell Technology (FCT); catalyst; Density Functional Theory (DFT); adsorption; cathode; anode; Membrane Electrode Assembly (MEA)

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INTRODUCTION

The emergence of fuel cell innovation has made another instrument for the era of cleaner, higher productivity elective vitality for individuals. Various types of fuel cells such as alkaline fuel cell (AFC), polymer electrolyte fuel cell (PEMFC), phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC), and solid oxide fuel cell (SOFC) [1] are available for various applications. PEMFCs are found to be suitable for transportation applications, i.e., buses [2], which utilize packed hydrogen for fuel and can work at up to efficiency of 40%. One major impediment for commercializing such fuel cell is the high cost of precious-metal catalysts which are used for the oxygen reduction reaction (ORR) in PEMFC Fuel Cell [3]. For fuel cell energy production various materials of electro-catalysts for catalyzing can be used. There were two stages for catalyzing the material: the Pt content can be reduced [4] by using the nanostructured engineering and composite material which will increase the mass specific activity and by using the alternative non-noble metal catalyst [5] that provides acceptable catalyst performances for fuel cell applications.

In heterogeneous catalyst, the catalysis event happens on the surface of the particle [6]. It typically consists of crystallites, with an extensive variety of sizes (1-100 nm), irregular shapes and variable creations. In the actual working of a catalyst this complexity can further increase during numerous cycles of a catalytic reaction [7]. The performance (activity, sensitivity, solidness) of a working catalyst is intended by the aggregate behavior of individual active destinations. active sites can be controlled in better manner , which depends on the particle shape, size and the arrangement of surface atoms, may give important relationships between the detected catalytic execution and the atomic or nanoscale structures of the catalyst.[8] The Pt surface area and its natural activity per site can be expanded by utilizing a few methods. One of such strategies is the utilization of Pt based catalysts [9]. For long time Pt compound electro catalysts have been receiving much thought [10]. The ORR action can be upgraded by utilizing a consolidated Pt surface layer of lattice compression. However the lattice withdrawal diminishes the coupling quality. Binding strength is a variable that can be found by utilizing Density Functional Theory (DFT) counts [11] and can be utilized to upgrade the catalytic activity relying upon the adsorption of intermediates of response. As indicated by dynamic analysis [12], desorption of O and OH- are observed to be the rate-constraining steps for the ORR at high possibilities on Pt (111) and Pt nanoparticles. To reduce the greater chances of ORR it is necessary to reinforce a base metal M with Pt to produce Pt-M bimetallic catalyst. Improved ORR energy on these bimetallic catalysts as contrast with Pt is broadly reported [13]. Pt alloying with different metals can enhance the catalytic activity [14] and can likewise enhance its strength and durability [15].

Transition metal based elemental surfaces and bimetallic alloys are evaluated as PEM fuel cell anode catalysts. Trends in surface reactivity are identified. The adsorption energies of O_2 and OH- are used as reactivity descriptors. A procedure is developed for screening for bimetallic alloys of enhanced performance.

OH– bonds firmly to platinum surface particles, leaving less space for O_2 to adsorb onto Pt dynamic sites. Since hydroxide blocking species don't have an active part in reduction of oxygen atoms, their presence generously hinders the rate of cathodic reaction. Pt alloy with metallic particles have an adjusted electronic structure, which changes diverse adsorption properties of Pt. Thus, interaction between OH– particles and Pt is weaker compared to that of the pure Pt catalysts, and surface is less secured by

blocking species, leaving more Pt destinations active for adsorption of OH−. The general impact creates an increase in particular activity for cathodic response: 10 times more dynamic than the Pt surface and 90 times more dynamic than state-of-the-art Pt catalysts used now as part of fuel cells.

The Pt surface has an abnormal electronic structure (d-band focus position) and arrangement of surface particles in the close-surface region. Under working conditions significant to fuel cells, its near-surface layer shows a very organized compositional. This causes exhaustion of the bonds between the Pt surface atoms and the OH− particles. The weakening builds the quantity of dynamic sites available for O_2 adsorption. As the energy of O_2 reduction is determined by the quantity of free Pt sites accessible for the adsorption of O_2, the inherent catalytic action of Pt alloyed material has been observed to be 10 times more dynamic than the relating Pt. The observed catalytic activity for the ORR on Pt is the highest ever seen on cathode catalysts [16].

In the current paper a physical model of Pt doping with various metals like Ru, W, Co, Pd, Ag and Au is developed. Band-gap and electrical conductivity are calculated. Pt doped with Ru, W, Co and Pd show improved catalytic activity compared to that with other dopants.

COMPUTATIONAL METHOD

The adsorption of OH- molecule on various catalysts was studied using Monte-Carlo simulations. Adsorption finds a feasible adsorption configuration by using Monte-Carlo searches of the configurationally space of the substrate – adsorption system as the temperature is slowly decreased (simulated annealing). It finds the highest stable adsorption sites for wide range of materials, including zeolites, carbon nanotubes and activated carbon [17]. The total energy of configuration m is calculated as

$$Em = EmAA + EmAS + UmA$$

Where EmAA is the intermolecular vitality between the adsorbate atoms, EmAS is the communication energy between the adsorbate particles and the substrate, and UmA is the aggregate intra-molecular vitality of the adsorbate atoms. The intra-molecular vitality of the substrate is excluded as its structure is fixed all through the simulation. The standard outfit is portrayed in the generation of substrate-adsorbate setups subject. The likelihood of an arrangement in this group is given by

$$Pmn = \min \{1, \exp[-\beta (En - Em)]\}$$

Where β is the reciprocal temperature and Em is the total energy of configuration m. In other words, transitions to a configuration of lower energy (En < Em) are always accepted, but transitions to high energy configurations (En > Em) are only accepted with a probability which decreases exponentially with the difference in energy to zero [18].

At high temperatures, the molten material is disordered because the kinetic energy forces atoms to explore higher energy states, such as substitution or defect sites. The system is cooled very slowly such that, at any given time, it is approximately in thermodynamic equilibrium. A slow rate of cooling increases the probability that the atoms will find configurations with lower energy, corresponding to more regular positions in the crystal lattice. As cooling proceeds, the system becomes more ordered and finally freezes into a ground state [19].

In the physical model developed platinum electrode is prepared by cleaving the surface to <111> direction and then doped with various metals. Using Adsorption module the OH- molecules are made to absorb on the various catalysts and the density was calculated in each case [20].

RESULTS AND DISCUSSION

Adsorption of OH

To analyze the catalytic activity of Pt it was doped with Ru, Co, Pd and W and then OH- molecules are made to adsorb on the electrode using adsorption locator. Configurations of the adsorbed OH- on various catalysts are shown in [Fig. 1]. At the right side of each figure, density scale is indicated to represent the level of OH- molecule adsorption. The red color indicates lowest OH- density adsorption and blue color highest.

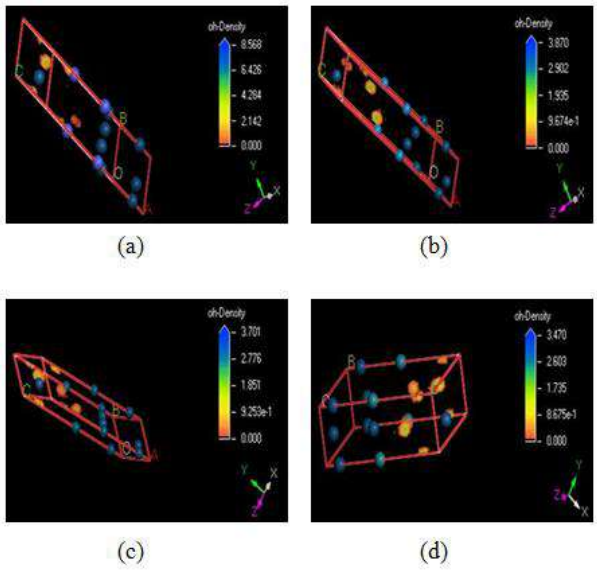

Fig. 1: Adsorption of OH- on: (a) Co doped Pt; (b) W doped Pt (c) Pd doped Pt (d) Ru doped Pt

The maximum density of OH- molecule adsorption on different catalysts is shown in [Table 1]. The maximum density of OH- molecule adsorption is exhibited by Co doping.

Table 1: Adsorption of OH- molecule on various catalysts

Catalyst type	Density of OH^- molecule
Pt/Ru	3.470
Pt/Pd	3.701
Pt/W	3.870
Pt/Co	8.568

Membrane Electrode Assembly (MEA)

[21]Membrane electrode assembly (MEA) is a sandwiched assembly of proton exchange membranes (PEM) and the catalyst doped carbon blocks. In PEM the electrodes were electrically insulated by each other. These electrodes act as anode and cathode. The PEM has a insulator barrier which allows the protons to transport form anode to cathode through membrane [22].

In the current work, nafion is used as the membrane. It has very good thermal and mechanical stability and hence, is used in PEM. The nafion will allow only the cations through the membrane but will not allow the anions or electrons to pass through [23].

The anode /membrane/cathode assembly is shown in [Fig. 2]. Pt/Co catalyst is embedded into the carbon block of anode and cathode with a view of increasing the catalytic activity. The final structure is tested for OH- adsorption and the corresponding maximum density values were noted as 3.974.

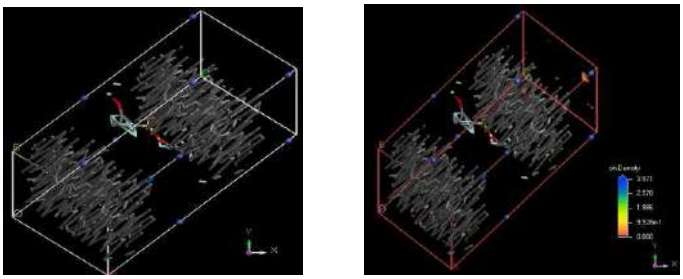

Fig. 2: Final Structure of Membrane Electrode Assembly: (a) Normal Structure of MEA; (b) After the adsorption of OH- on MEA

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CONCLUSION

Camel Based on the results obtained in the present work the following conclusion can be drawn:

1. Co doped Pt showed the best OH- adsorption density and hence, was chosen as the catalyst for the preparation of Membrane Electrode Assembly (MEA).
2. The MEA is assembled utilizing the Nafion membrane and catalyst (Co doped on Pt) embedded carbon blocks that serve as cathode and anode respectively. This MEA structure shows greater OH- adsorption density.

CONFLICT OF INTEREST
There is no conflict of interest.

ACKNOWLEDGEMENTS
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FINANCIAL DISCLOSURE
None

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ARTICLE

OPTICAL CHARACTERIZATION OF PMMA DOPED WITH AN ORGANIC POLYMER

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ABSTRACT

In the field of communication, optical fiber has a vital role in transmitting light between two ends of the fiber. Optical fiber is made of three layers core, cladding and outer jacket. The significant property of optical fiber is that, the refractive index of core must be greater than the cladding. Mostly silicon is used as the core material in the making of optical fiber. Here, we are replacing silicon by PMMA which has good refractive index than silicon. Doping of different polymers of high refractive index possess greater optical properties. In this project, core is made by doping of two different polymers by the method of spin coating. Two samples are made and its optical characterization is done by FTIR analysis, which indicates the various optical properties of the sample. XRD has also been done for the sample to know its crystalline structure. Optical properties of two different samples have been compared for better results. The characterization of the sample is done at the wavelength of 600-850 nm in which it is used for small distance communication.

KEY WORDS
Optical fiber, XRD,FTIR

INTRODUCTION

Polymer composites have steadily gained growing importance during the past decade. Optical properties constitute one of the convenient and sensitive for studying the polymer structure. They are affected not only by the structure and nature of the dopant but also by the doping procedure. Optical properties of polyvinylchloride (PVC) and polymethyl methacrylate (PMMA) have been investigated [1]. These transparent conductors have found major applications in a variety of active and passive electronic and opto-electronic devices ranging from aircraft window heaters to charge coupled imagining devices. [2]The composition of organic polymer plays a vital role in the making of optical fibers.[3] Here, by using different ratio of Polyvinylchloride [4] (PVC) and PMMA, the resulting optical properties vary each other. And from these samples the best composition has been taken and analyzed for the best outcome of fibers.

What are polymers

Polymers are very large molecules that are made up of thousands - even millions - of atoms that are bonded together in a repeating pattern. The structure of a polymer is easily visualized by imagining a chain. The chain has many links that are connected together. In the same way the atoms within the polymer are bonded to each other to form links in the polymer chain.

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The molecular links in the polymer chain are called repeat units that are formed from one or more molecules called monomers. The structure of the repeat unit can vary widely and depends on the raw materials that make up the polymer. For example, polyethylene, the polymer used to make a wide variety of plastic bags and containers, has a very simple repeat unit, two carbons that are bonded to one another to form a single link.

Polymer properties

Since many polymers are made of long, flexible chains, they become easily tangled, much like a bowl of cooked spaghetti. The disordered tangling of the polymer chains create what is known as an amorphous structure. Amorphous polymers are typically transparent and much easier to melt to make materials like kitchen cling film. Polymer chains do not always form amorphous arrangements. Under proper conditions, such as stretching, the polymer chains can line up side by side to form orderly, crystalline arrangements. Crystalline arrangements in polymers can also be achieved through slow cooling, where individual polymer chains fold over on themselves.

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[5]Polymers can also be used to create huge 3-dimensional networks. These networks are made through the reaction of monomers with more than two possible sites for the polymerization to occur. The multiple reaction sites allow for the different chains to connect with each other to form cross-linked chains. The result of the cross-linked chains is a 3-dimensional solid that is essentially one huge molecule.

Requirement analysis

It determines the requirements of a composition and analyze on it and resource requirement, which is required for successful outcome. The product requirement includes the materials required to blend the organic polymers and to analyze the optical properties. As shown in [Fig.1,2 and 3]

Materials required

- PVC
- PMMA

- THF

Fig. 1: PMMA

Fig. 2: THF

Fig. 3: PVC

Working principle

Two samples with different composition have been prepared for analyzing the optical properties of the polymers.

Preparation of the samples

Composition-1

In the first sample, 0.5gm of PMMA [6] is dissolved in 10ml of Tetrahydrofuran (THF) and 1.00gm of PVC is dissolved in 15ml of THF. These solutions are heated separately in stirring hot plate until a clear solution is obtained. Then both the solutions are mixed in 50ml beaker. This final solution is then heated and stirred in the stirring hot plate until the solution becomes semi-fluid as like gel form. A cleansed glass slide is taken for coating the gel like solution on it. It cannot be coated directly. So, a spin coater equipment is being used to coat this. In this equipment, a glass slide is kept in the center which will rotate to 1000 to 2000 (revolutions per minute). When the motor is switched ON, the semi-fluid substance is then poured on the glass slide. Due to this fast rotation, that semi-fluid substance spreads uniformly on the glass slide. Then the glass slide is taken out from that equipment and dried for half an hour .And the sample is covered by a butter paper to maintain its purity. Optical characterization is done for this sample know its effective optical properties.

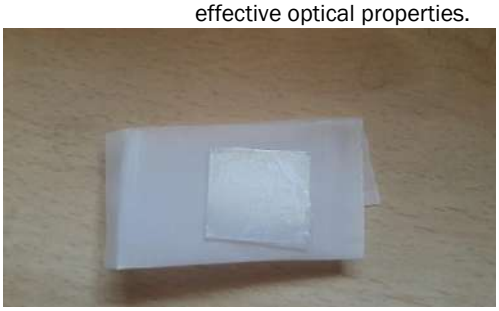

Fig. 4: Thin film of sample-1

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Composition-2

As shown in the [Fig .4].The next sample is prepared by taking 0.5gm of PMMA is dissolved in 10ml of Tetrahydrofuran (THF) and 2.00gm of PVC is dissolved in 15ml of THF. These solutions are heated separately in stirring hot plate until a clear solution is obtained. Then both the solutions are mixed in 50ml beaker. This final solution is then heated and stirred in the stirring hot plate until the solution becomes semi-fluid as like gel form. A cleansed glass slide is taken for coating the gel like solution on it. It cannot be coated directly. So, a spin coater equipment is being used to coat this. In this equipment, a glass slide is kept in the center which will rotate to 1000 to 2000 RPM (revolutions per minute). When the motor is switched ON, the semi-fluid substance is then poured on the glass slide. Due to this fast rotation, that semi-fluid substance spreads uniformly on the glass slide. Then the glass slide is taken out from that equipment and dried for half an hour .And the sample is covered by a butter paper to maintain its purity. Optical characterization is done for this sample to know its effective optical properties.

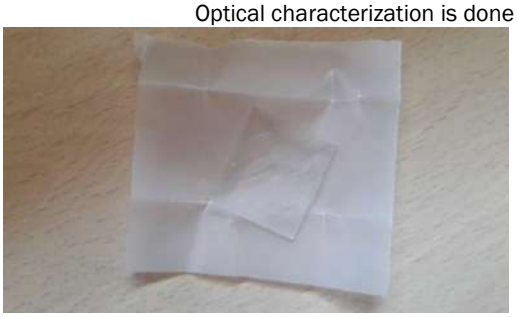

Fig. 4: Thin film of sample-2

Characterization of the samples

As shown in the [Table 1]. The dried sample is then examined in FTIR Spectrometer. Four optical properties such as refractive index, Reflectivity, absorption and velocity of light has been characterized for the wavelength range of 600-850 nm.

Fig. 5: FTIR Spectrometer

As shown in the [Fig .5]. Fourier Transform Infrared Spectroscopy (FTIR) identifies chemical bonds in a molecule by producing an infrared absorption spectrum [7]. This confers a significant advantage over a dispersive spectrometer which measures intensity over a narrow range of wavelengths at a time. It examines plastics, polymers, paints etc....,[8]

RESULTS AND ANALYSIS

This chapter shows the final output scenario of the project.

Optical characterization of PMMA and PVC

Table 1: Values of PMMA and PVC

PROPERTY	PMMA	PVC
REFRACTIVE INDEX	1.4905	1.54
REFLECTIVITY	0.0387	0.457
ABSORPTION	83.13 cm-1	286.12 cm-1

VELOCITY OF LIGHT	55.965 kmps	54.147 kmps
TRANSMITTANCE	6.514e-184	7.8498e-184
SCATTERING EFFECT	3.56A2/amu	6.96A2/amu

Refractive index of PMMA and PVC

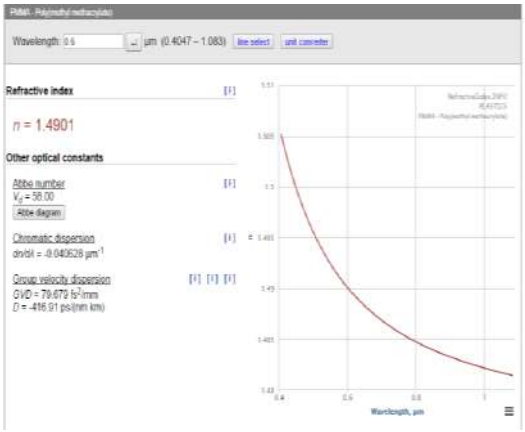

Fig. 6: Refractive index of PMMA.

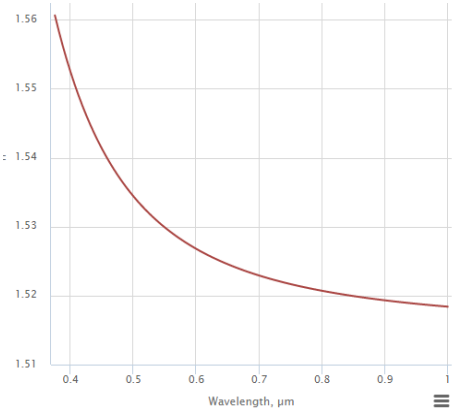

Fig. 7: Refractive index of PVC.

Reflectivity of PMMA and PVC

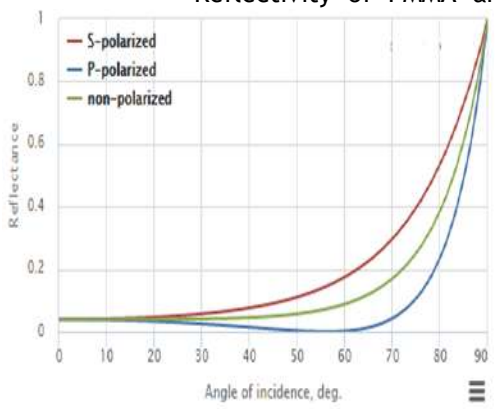

Fig. 8: Reflectivity of PMMA .

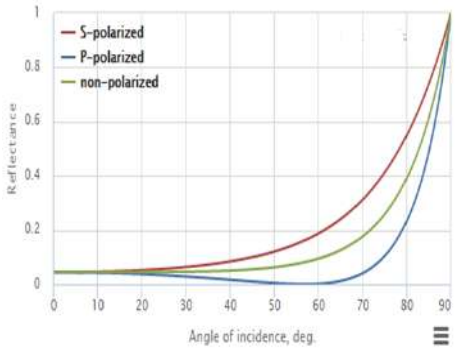

Fig. 9: Reflectivity of PVC.

Ratios of sample

Table 2: Quantity of samples

Material	Sample 1	Sample 2
PMMA+THF	0.50gm+10ml	0.50gm+10ml
PVC+THF	1.00gm+15ml	2.00gm+15ml

Characterization of pmma and pvc blends by ftir

Analysis

As shown in the [Fig .6, 7, 8 and 9] FT-IR spectroscopy has long been recognized as a powerful tool for elucidation of structural information.[9] The position, intensity, and shape of vibrational bands are useful in clarifying conformational and environmental changes of polymers at the molecular level. This analysis

depicts the graph of refractive index, reflectivity, absorption and transmittance [8] which are some of the optical properties of fibers. As shown in the [Table 2].

Sample-1

As shown in the[Fig. 10,11,12] ,0.5gm of PMMA and 10ml of THF+ 1.00gm of PVC and 15 ml of THF

Step 1: Refractive index

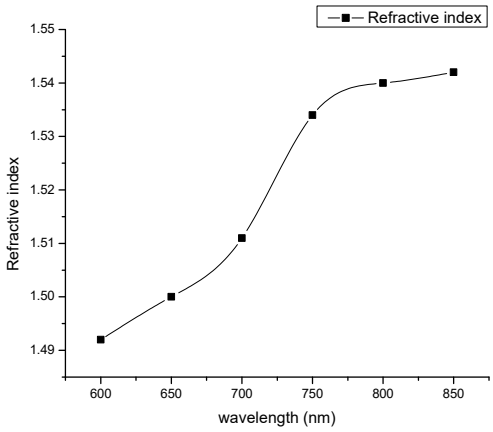

Fig. 10: Refractive index of sample -1.

Step 2: Reflectivity

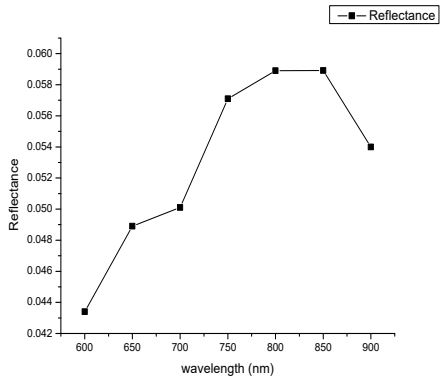

Fig. 11: Reflectivity graph of sample 1.

Step 3: Absorption

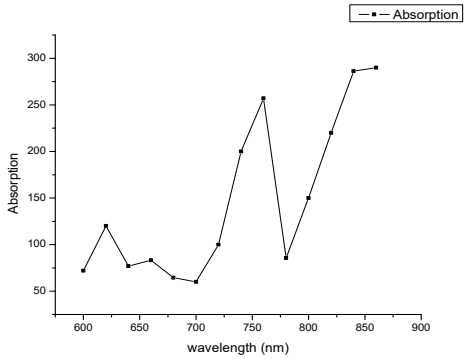

Fig. 12: Absorption of sample 1.

Step 4: Transmittance

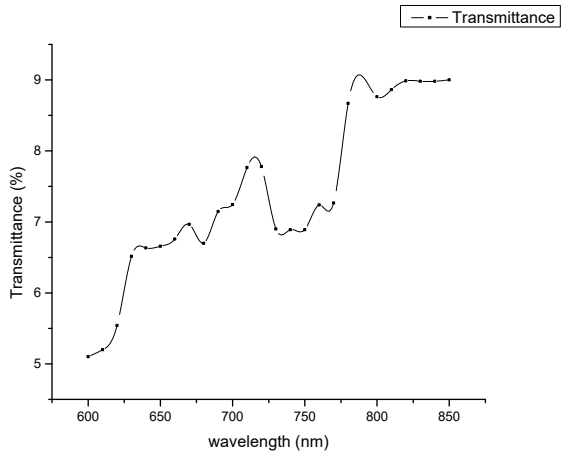

Fig. 13: Transmittance of sample 1.

Table 3: Values of PMMA, PVC and SAMPLE-1(0.5gm of PMMA and 10ml of THF + 1.00gm of PVC and 15 ml of THF)

PROPERTY	PMMA	PVC	SAMPLE-1
REFRACTIVE INDEX	1.4905	1.53	1.542
REFLECTIVITY	0.0389	0.0434	0.0589
ABSORPTION	83.13 cm-1	286.12 cm-1	280.12 cm-1
TRANSMITTANCE	6.514e-184	7.8498e-184	9.00e-184

Sample-2

0.5gm of PMMA and 10ml of THF + 2.00gm of PVC and 15 ml of THF

Step 1: Refractive index

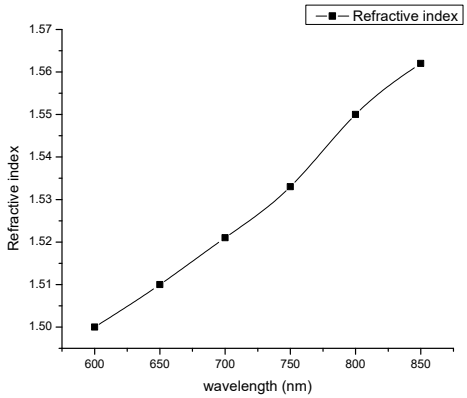

Fig. 14: Refractive index of sample -2.

STEP 2: Reflectivity

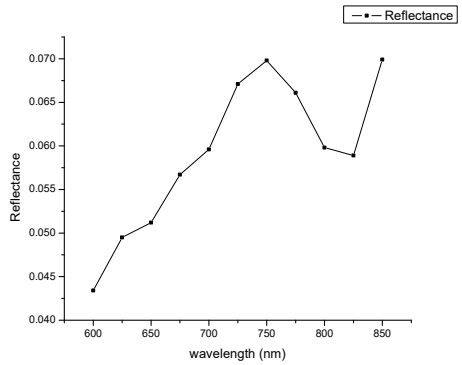

Fig. 15: Reflectivity graph of sample 2.

Step 3: Absorption

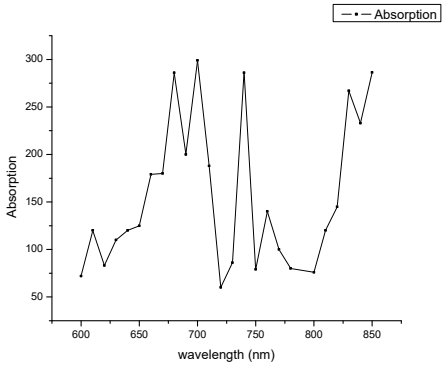

Fig. 16: Absorption of sample 1.

Step 4: Transmittance

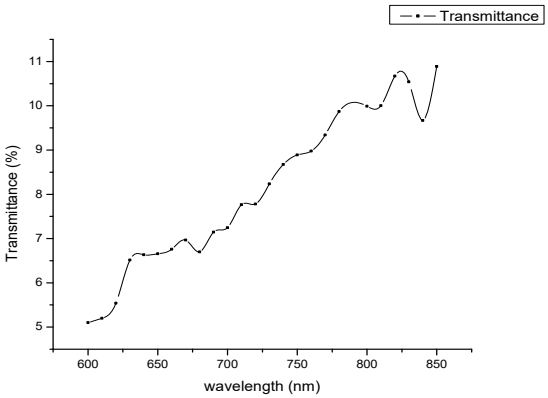

Fig. 17: Transmittance of sample 2.

Table 4: Values of PMMA, PVC and SAMPLE-1(0.5gm of PMMA and 10ml of THF + 2.00gm of PVC and 15 ml of THF)

PROPERTY	PMMA	PVC	SAMPLE-1	SAMPLE-2
REFRACTIVE INDEX	1.4905	1.53	1.542	1.562
REFLECTIVITY	0.0389	0.0434	0.0589	0.0699
ABSORPTION	83.13 cm-1	286.12 cm-1	280.12 cm-1	284.1 cm-1
TRANSMITTANCE	6.514e-184	7.8498e-184	9.00e-184	10.89e-184

The above [Table 3 and 4] clearly depicts that the doping of two organic polymers, PMMA and PVC have proved to be good material in the making of optical fibers. The doping is done in correct composition and it is kept in stirring hot plate to form a semi-fluid like substance .After getting a thin film from this, it is then

characterized by FTIR Spectrometer for getting the optical properties. [10] The two samples have been doped in different composition and the characterization is done. By analyzing the sample 1 in FTIR, the refractive index of the material is slightly higher than the refractive index of the [11] individual polymers .So, it can be suited as a very good core material for the making of optical fibers . As shown in the [Fig. 13, 14 ,15 ,16 and 17] The other parameters reflectivity and transmittance also has high value, when compared to the individual polymer values. It shows that light travels efficiently with low loss of data. Absorption spectra is little lesser, which in turn avoids losses.

Then the sample 2 has been analyzed, which in turn shows greater optical properties than the sample 1. The above all is calculated for the wavelength range of 600nm to 850 nm for which the frequency range is between 499.65THz to 352.69THz.

CONCLUSION

PMMA has found various applications in the optical fibers. In the doping process, PMMA remains constant and the PVC is varied by weight(1.00gm, 2.00gm,....). The thin film samples are optically characterized and its various optical properties such as refractive index, reflectivity, absorption and transmittance have been analyzed by using FTIR spectrometer. From the above result and discussions, it is recommended that PVC is supposed to be a very good material for doping with PMMA .Since PMMA has better optical properties; it can be used instead of silica in the optical fiber for better data transmission. In the future work, many samples can be made by varying the PVC in weight (gms) with PMMA. Then with the thin film, FTIR analysis can be done for all the samples. From this, the best sample can be taken as the core material for the fabrication of optical fibers. The wavelength 600-850 nm is considered to be a good range and which can be used in various applications of optical fibers.

CONFLICT OF INTEREST

The authors declare no conflicts of interest regarding this paper.

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None

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ARTICLE

DESIGN AND IMPLEMENTATION OF CORRUGATED CIRCULAR LOOP ANTENNAS IN WIRELESS POWER TRANSFER TECHNOLOGY

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ABSTRACT

Electronic devices are essential part in our day-to-day lives. The invent of wireless power transfer (WPT) technology provides a gateway for charging multiple number of electronic gadgets simultaneously. Wireless power transfer denotes the transfer of power between a transmitting module and a receiving module for various applications such as charging mobile phones and electric cars wirelessly. While performing wireless power transfer, this technology encounters lot of challenges. This research paper analyzes the impact of orientation of antennas, its alignment, and the energy coupling losses of antennas at transmitting and receiving side. The design simulation is implemented by using Antenna Magus Software -frequency domain solver analyzed by Computer Simulation Technology.

KEY WORDS
Energy coupling, wireless power transfer, circular loop antennas, UHF RFID frequency, E Field norm distribution, S parameters.

INTRODUCTION

Wireless power transfer technology works on the principle on energy coupling by orientation of antennas [1]. This technology has the ability to charge multiple electronic devices concurrently, over long distances and through materials like glass, plastic and wood.[2] The wireless power transfer technology is used in electronic gadgets, smart phones, wearable electronics, in medical industry i.e. a new medical implant to replace power cord or the replaceable batteries in heart pumps and in hybrid electric vehicles, etc.[3] The WPT technology uses electromagnetic field to transfer energy between two objects. The power source is connected to a power transmitting unit (PTU), generates a magnetic field and a power receiving unit (PRU) converts the transmitted energy into usable power. [4] It is important to consider that a device must have to be carefully aligned on the transmitting unit for charging. The matched orientation between the PTU and PRU helps the devices to prevent the losses due to energy coupling.

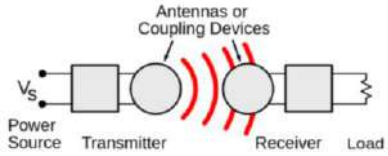

Fig. 1: An illustration of wireless power transfer

WORKING PRINCIPLE

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The wireless power transfer model analyzes the energy coupling between two circular loop antennas [5]. The model describes the wireless power transfer technology by evaluating the two circular loop antennae's energy coupling tuned for UHF RFID frequency [6]. The antenna is designed by reducing its size using chip inductors. The S parameters are investigated for proper coupling by configuring the transmitting antenna as fixed type, while the receiving antenna is rotating type. As shown in the [Fig.1].

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In this model, the antennas [7] designed as a perfect electric conductor (PEC).the antennas are made of a material polytetrafluoroethylene (PTFE) board and have a thin copper layer on top. Each of the antennas is featured as a lumped inductor and a lumped port that can resonate or terminate the loop antenna [8]. The antennas are perfectly shaped to perform inductive coupling. To design [9] the characteristic the antennas should have a UHF RFID operating frequency of 915MHz.[10]

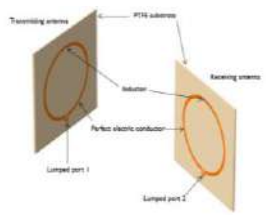

Fig. 2: Model geometry at receiving antenna orientation to determine the coupling effect between two circular loop antennas

MODEL DEFINITION

To model a perfect dielectric conductor ,the thickness of the copper layer is geometrically very thin at the operating frequency, but it must be much thicker than the copper skin depth, $\delta s = (2/\omega\mu\sigma)1/2 = 2.15\ \mu m$. The receiving power and the transmitting antennas are matched for coupling. The surrounding PMLs are made to absorb the radiation from the transmitting antenna which is coupled to infinite free space [11].

By inserting a [12] lumped inductor the diameter is reduced down to approximate value of 0.22 λ0 representing a surface mount device in the middle of each circular copper trace. On the dissected split section of each circular copper trace perfect dielectric antenna is configured as a lumped port .To excite or terminate the antenna the reference impedance is assigned to be 50 Ω.

DESIGN AND IMPLEMENTATION

The geometry parameters and the frequencies can be changed to optimize the antenna's coupling performance. [Fig. 2] shows E-field norm distribution on the xy-plane and an arrow plot of the power flow from the transmitting antenna as a function of the receiving antenna rotation angle. When the two antennas are facing each other; the angle of rotation of the receiving antenna is 0 degrees and the fields are strongly coupled. When the angle of rotation of the receiving antenna is 90 degrees, there is no hot coupling area around the receiving antenna that can be visualized. The red arrows describing the power flow are penetrating the receiving antenna without noticeable distortion. [13] The computed input matching characteristic of the transmitting antenna via S11 is below -20 dB regardless of the receiving antenna orientation.[14]

The coupling relation is summarized by approximating S21 in [Table 1] below:

Table 1: Rotation angle –S parameter function

Angle(degrees)	0	22.5	45	67.5	90
S21	-12.5	-13	-15.2	-20.1	-51.6

The positional set up is similar to mobile charging by having a fixed position for a charger and placing a mobile phone on it at different angles . The S parameter S21 value shows no coupling value at 90 degrees. In my simulation, the receiving power antenna is kept rotating and the transmitting power antenna is maintained in a fixed position. Energy coupling is made by setting the orientation is modeled by E-field norm distribution.

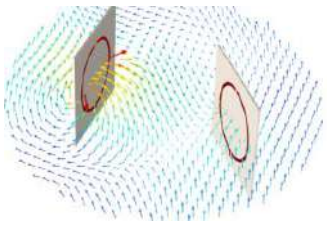

Fig. 3: The arrow plot shows E-Field norm and power flow of wireless power transfer antennas.

To visualize this effect, the E-field norm distribution is modeled and the power flow transfer from the transmitting antenna at different rotation angles of the receiving antenna is viewed. As shown the [Table 2] The results show that when the receiving antenna is adjusted to the angle of rotation to 0 degrees the fields are strongly coupled to each other. As shown in the [Fig.3]. By the time, when the receiving antenna reaches the angle 90 degrees of rotation, the power flow penetrates then receiving antenna has no distortion and no coupling or hot coupling area. As such, we can conclude that the power transfer between these two antennas is greatly reduced at this angle. As shown in the [Fig.4] and [Fig. 5].

Table 2: Design parameters of corrugated circular loop antennas

S_{21} CHARACTERISTICS	DESIGN MEASUREMENTS
Waveguide radius	0.183m
cutoff frequency	4.438Hz
Corrugation thickness	0.105m
Corrugation length	0.155m
Waveguide length	1m
Matching corrugation length	0.25m
Output cross polarization ratio target	5%
Input waveguide cross polarization ratio	17.65%
Output aperture cross polarization ratio	3.025

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SIMULATION RESULTS OF WPT IN CIRCULAR LOOP ANTENNAS

The 3D far field pattern and E field normalization of the WPT antennas are simulated using Antenna Magus software tool with the waveguide length and matching corrugation length for energy coupling at 1m and 0.25m respectively.

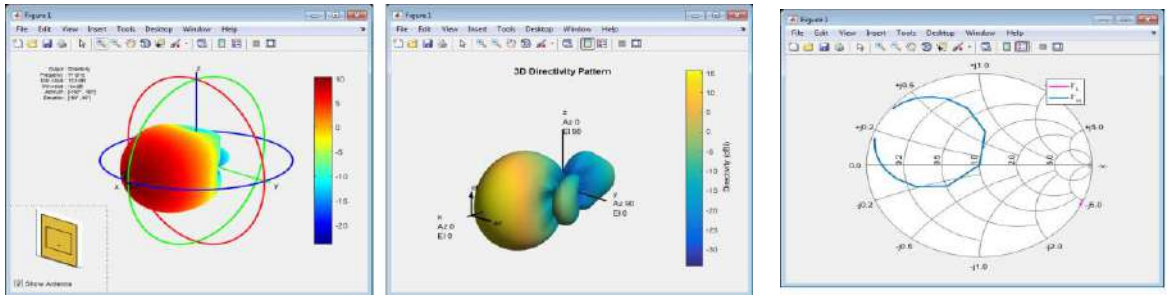

Fig. 4: Far field 3D radiation and directivity pattern for circular loop antenna.

Antenna Magus software Tool-S Parameter comparison

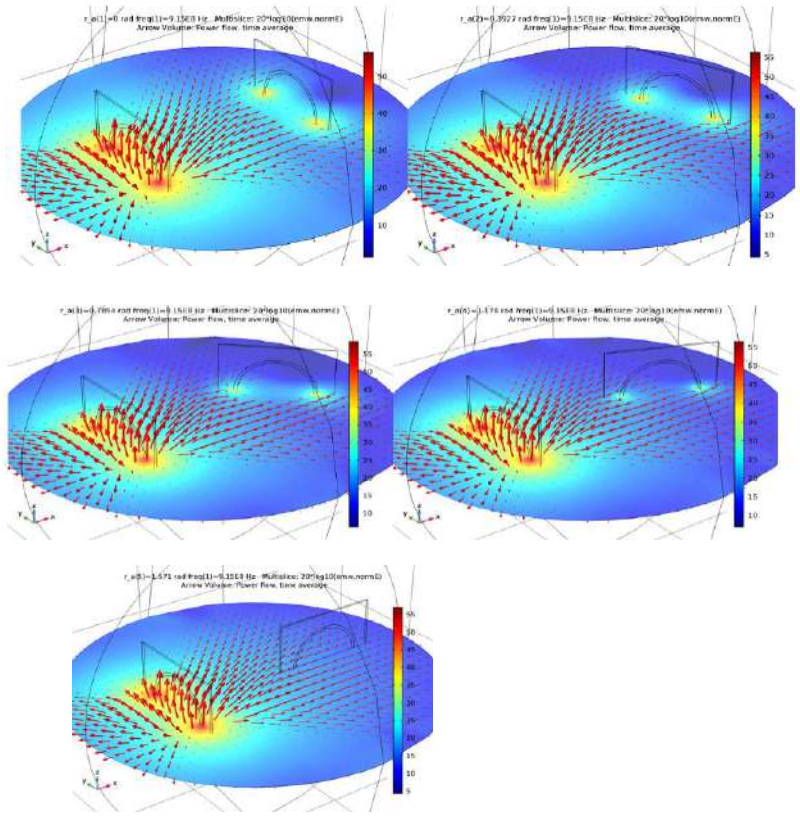

Fig. 5: Plot of E-field norm and power flow at z = 0 while the receiving antenna is rotating from 0 to 90 degrees with a step of 22.5 degrees.

CONCLUSION

This model addresses the concept of wireless power transfer by simulating the energy coupling between two circular loop antennas. The Antenna magus software tool helps to accelerate the antenna design and modeling process. The angles are set at various rotating degrees to identify the energy coupling at exact ranges. The circular antennas are designed to tune for UHF RFID frequency provides inherent inductive coupling by its shape.

The best coupling configuration is examined in terms of S-parameters by adjusting the angle of rotation. The energy coupling is improved by designing the transmitting antenna in fixed state, and a receiving

antenna to be rotating state. In future, we can increase the operation functionality of Wireless Power Transfer antennas by creating systems that function at a wide range of orientations.

CONFLICT OF INTEREST

There is no conflict of interest.

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None

FINANCIAL DISCLOSURE

None

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ARTICLE

OPTIMIZED DIRECT METHOD ROUTING FOR CACHE MEMORY IN RISC ARCHITECTURE

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ABSTRACT

The growing gap between processor speeds and memory speeds is leading to progressively valuable cache misses, underscoring the necessity for classy cache hierarchy techniques. Increasing the associativity of the cache is a way to scale back its miss rate. Whereas set-associative caches generally incur fewer misses than direct-mapped caches, set associative caches have slower hit times. We tend to propose the reactive associative cache (r-a cache), that dynamically provides associativity in response to application demand. The r-a cache employs a unique multi-probe organization that uses a direct-mapped information array and a set-associative tag array. It's accessed sort of a regular direct-mapped cache for many accesses, however it additionally has the power to be accessed sort of a set-associative cache (using some way prediction), once its necessary to alleviate direct-mapped line competition. Circuit analysis indicates that a r-a cache encompasses a hit latency akin to that of a direct-mapped cache for all direct-mapped accesses and every one properly foretold set-associative accesses. Incorrectly foretold set-associative accesses can incur a further probe into the information array. Previous multi-probe cache organizations have suffered from poor initial-probe miss rates, and thus need several secondary probes, that will increase average hit time and demand for cache information measure over that of a direct-mapped cache. What is more, a r-a cache doesn't need cache block swapping, as in statically-probed multi-probe cache schemes similar to column associative and cluster associative. The feedback mechanism permits the r-a cache to live the 'predictability' of sure directions and to ban - ix - associative displacement for unpredictable accesses. Simulations show that direct map prediction resources, can vanquish column associative and prophetical successive associative, moreover as 83% reduction in area which speedups over a direct-mapped cache on a set of the SPEC95 benchmark suite.

KEY WORDS
SPEC95, set-associative, latency, direct-mapped, routing.

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INTRODUCTION

One of the elemental limitations of the performance of recent laptop systems is that the rate at that memory requests are often serviceable. Whereas processors have steady improved in machine performance by many orders of magnitude, memory speeds have not unbroken pace. This rift, likewise because the thought of neighborhood of memory reference, has motivated the event of memory hierarchies, within which tiny and quick SRAM cache reminiscences are wont to satisfy most requests. Sequential levels of progressively larger (and slower) caches are wont to step by step insulate the nimble processor from slower main memory DRAMs. The direct relationship between memory system performance and overall system performance has created cache style a relevant issue in laptop design. The performance of the memory system is especially necessary within the initial level of cache (L1) that is accessed by the processor. In fashionable processors, the L1 cache is on-chip, associated split between an instruction cache (L1 I cache) and a knowledge cache (L1 d cache). The high neighbor-hood and regular access patterns of instruction streams have created the L1 instruction cache perform comparatively well, however the L1 information cache of most systems still may be a vital performance bottleneck. There are 3 major reasons that this is often the case: (1) masses (and so information cache accesses) are within the crucial path of program execution, therefore there are few techniques which might hide the latency of a load operation; (2) for a range of circuit reasons, it's tough to extend the amount of cache ports to satisfy all the requests from the processor; and (3) because the wire delays begin to dominate intra-processor communication, the time to retrieve a cache block from following level within the hierarchy is growing, that makes misses within the information cache increasing costlier. During this thesis, we tend to examine optimizations to enhance the performance of the L1 information cache. The normal measures of a cache are its miss rate (the pc of accesses that are not by the cache), and therefore the hit latency (the time it takes to service cache hits). - Two - The miss rate indicates however usually following level within the hierarchy is accessed; therefore it becomes a lot of necessary because the L2 access latency will increase. The hit latency is usually within the crucial (circuit) path of processor execution, therefore it will figure conspicuously within the clock cycle of the processor. The only sort of a L1 d cache may be a direct-mapped organization, within which every cache block address is mapped to one potential location within the cache array. This structure permits for quick hit times, and conjointly achieves respectable miss rates, sometimes under V-day for typical number applications. Set associative caches permit a given cache block to reside in additional than one place (way) among the array, that will increase occupancy of reused information, and thus decreases the miss rate. The decrease in miss rate is often forceful. For a set of the SPEC95 benchmark suite [1] with an 8k L1 d cache, a 2-way set associative cache has (on average) thirty second fewer misses than a direct-mapped cache. A 4-way set-associative cache has forty first fewer misses than a direct-mapped cache. This decrease in miss rate is sadly amid associate equally forceful increase in hit latency, because of the extra logic necessary to implement the associativity. victimization the cache analysis tool CACTI [2], we tend to estimate that associate 8k 2-way set associative cache is fifty three slower than associate 8k direct-mapped cache. This creates a significant trade-off between hit latency and miss rate within the L1 information cache. In Section one.1, we tend to examine a lot of closely the circuit problems that management the hit time of direct-mapped and associative caches. the big increase in hit latency between direct mapped and a set-associative caches has motivated interest in

multi-probe cache schemes, that have a hit-latency getting ready to that of a direct-mapped cache, however with miss rates nearer to associate associative cache [3].

This paper is organized as follows. Section II shortly provides survey on normal error protection mechanisms and to boot discusses previous schemes projected to chop back vulnerability of cache recollections against transient errors. Section III details tag bits errors classified into four subgroups and normal ways that elaborate draw back Definition of the prevailing associative mapping, describes our projected direct mapping. Section IV presents our experimental results for our Existing and Proposed. Finally, Section V concludes this paper.

CONVENTIONAL CACHES

[4]Statically-probed caches are around for nearly fifteen years, however haven't gained trade acceptance, because of the need for cache block swapping. Prophetical consecutive associative is equally sure, because of its serious increase in information measure utilization. We advise a brand new dynamically-probed theme known as reactive-associative (r-a), that doesn't need cache block swapping, and encompasses an information measure demand the same as that of a [5] direct-mapped cache. The r-a cache employs a completely unique organization within which the information array is direct-mapped, however the tag array is set-associative .aspect contains one data array, like during a direct-mapped cache, which may support only 1 probe at a time aspect doesn't need tag match information from the tag array on the initial probe, and so the crucial path although the information aspect is appreciate that of a direct-mapped cache. The tag aspect contains equivalent logic to the tag aspect of a set associative cache .Specifically, the tag array is split into approach banks that are probed in parallel for a given set (from the cache block address). [6] The critical-path delay of the tag aspect of a set-associative cache is such as that of a direct-mapped tag aspect. This is as a result of the set-associative tag array contains 2 or a lot of approach banks that are every smaller and quicker than a direct-mapped tag array; since the approach banks are probed in parallel, the tag array of Associate in Nursing associative cache is really quicker than that of a direct-mapped cache, that offsets the rise in different logic. [7]

The quicker approach banks that are probed in parallel).While the organization of the r-a cache is attention-grabbing, verity novelty [8] comes from the displacement/prediction subsystems. The r-a cache can solely displace conflicting blocks to line associative positions, so relieving what would be line competition (and thrashing) during a direct-mapped cache. Conflicting cache blocks are detected employing a questionable victim list that tracks recent L1 d-cache misses. By solely displacing conflicting blocks, we have a tendency to relieve pressure on the way-predictor that currently should solely track approach prediction info for displaced (contentious) cache blocks. The notion of solely displacing.

Certain blocks are mentioned as selective displacement. What is more, we have a tendency to determine that in every application, there are a bunch of directions that have poor foregone conclusion. The r-a cache employs a feedback mechanism which can live the dynamic prediction accuracy per individual (or teams of) directions. Directions with poor foregone conclusion are prohibited from accessing displaced cache blocks (i.e. the cache blocks are forced to reside in their direct-mapped positions). By limiting the candidates for associative displacement, the r-a cache can have the next overall miss rate, in general, than the sooner multi-probe cache schemes. However, this performance disadvantage is over offset by the accrued performance because of have a way lower probe0 miss rate and by eliminating the necessity for pricey block swapping. The approach predictor uses a prediction handle that is a few perform of system state that correlates to knowledge access patterns, and is on the market before the effective address. This prediction handle is employed to index into a prediction table that permits for some way prediction. prophetical consecutive associative suggested the employment of XOR approach prediction, within which the supply register contents are logically XORed with the offset price, to supply - ten -an approximation of the information address (this is comparable in favor to zero-cycle hundreds, that were projected in [9]). Sadly, it's unlikely that this technique might be used thanks to the strict temporal arrangement constraints of cache accesses. For XOR prediction, the logic operation would have to be compelled to be performed, and some way prediction table operation completed, all in the time of a traditional address computation. For r-a, we advise .A reactive associative cache as shown the [Fig. 1] Mistreatment laptop prediction that could be a weaker prediction handles that correlates the address of the memory operation (i.e., the PC value) to the approach prediction. Since the laptop is on the market several cycles prior to the memory request is sent, there's lots of time for table lookups, and there's no risk of compromising the crucial path of cache accesses. In this variety of mapping the associative memory is used to store content and addresses every of the memory word. This permits the position of the any word at anywhere among the cache memory. It's thought-about to be the fastest and conjointly the foremost versatile mapping sort. [10]

DIRECT MAPPING

Block identification: let the most memory contains n blocks (which need log2 (n)) and cache contains m blocks, of memory is mapped (at different times) to a cache block. every cache block encompasses a tag oral communication that block of memory is presently gift in it, every cache block conjointly contain a sound bit to confirm whether or not a memory block is within the cache block presently.[11]

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- Number of bits within the tag: log2 (n/m)
- Number of sets within the Cache: m
- Number of bits to spot the right set: log2 (m)

The memory address is split into three parts- tag (most MSB), index, block offset (most LSB) so as to try and do the cache mapping.

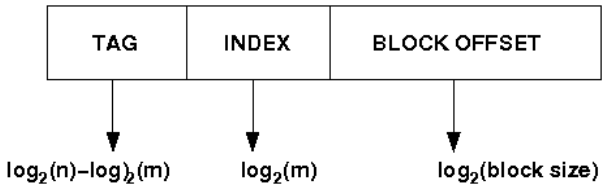

Fig. 1: A Cache mapping

1. Choose set mistreatment index, block from set mistreatment tag.
2. Choose location from block mistreatment block offset.
3. Tag + index = block address

Diagram of a direct mapped cache (here main memory address is of 32 bits and it gives a data chunk of 32 bits at a time):

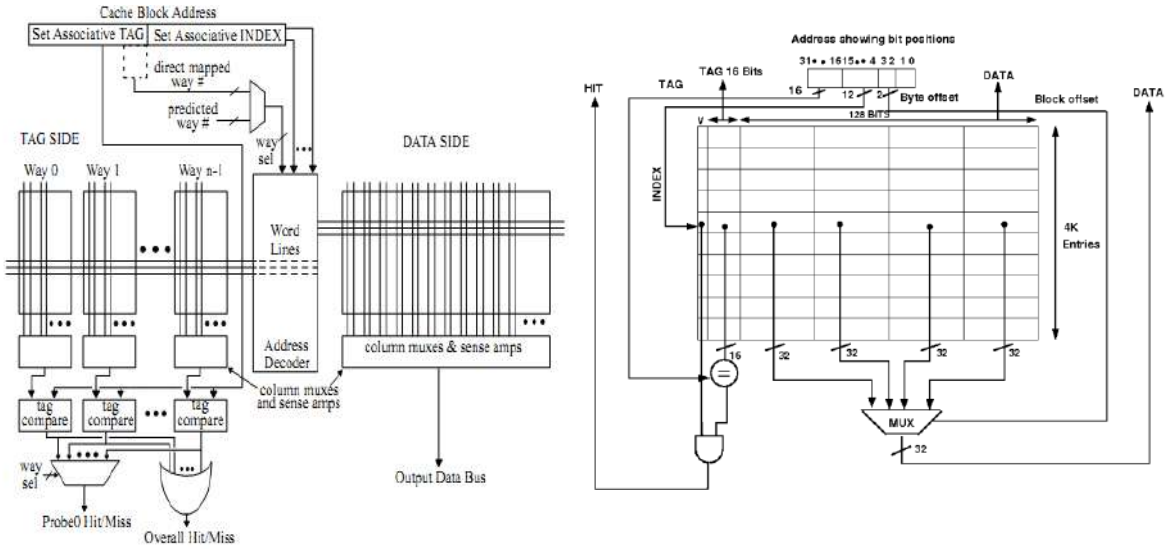

Fig. 2: A Direct mapping

If a miss occur electronic equipment bring the block from the most memory to the cache, if there's no free block within the corresponding set it replaces a block and place the new one. Electronic equipment uses completely different replacement policies to make a decision that block is to interchange. The disadvantage of the direct mapped cache is that it's simple to make. Below could be a straightforward cache that holds 1024 words or 4KB, memory address is thirty two bits. The tag from the cache is compared against the foremost important bits of the address to see whether or not the entry within the cache corresponds to the requested address because the cache has 210 or 1024 words and a block size of 1 word, ten bits are wont to index the cache, departure 32-10-2=20 bits to be compared against the tag. If the tag and therefore the most vital twenty bits of the address are equal and therefore the valid bit is on then the request Hits within the cache otherwise miss happens. No replacement policy has been enforced within the circuit. In direct mapping the RAM is made use of to store info and some is hold on among the cache. Associate in address home is split into two elements index field and tag field. The cache is used to store the tag field whereas the rest is hold on among the most memory. Direct mapping`s performance is directly proportional to the Hit quantitative relation. when the firm analysis we have a tendency to conclude direct mapping terms to be the foremost economical technique in terms of space, power and delay that has simulated within the below mere design. A given memory block is mapped into one and solely cache line. All the higher than problems are corrected mistreatment direct mapping. As shown in the [Fig. 2].

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RESULTS AND DISCUSSIONS

Xilinx/ISE simulations and precision RTL of mentor graphics

The proposed adder and its corresponding blocks are described using structural VHDL and synthesized employing Xilinx Synthesis Tool (XST), Web PACK version 13.2 and Precision RTL of Mentor Graphics. The implementation was targeted to Xilinx spartan-3E low power, Selected Device: 3S250EPQ208.

The logical routing can be observed from the obtained Place and route result from the FPGA Editor option in Xilinx synthesizer. It is observed that about 10% (CLB taken from [Table 1]) area for the targeted FPGA is covered for the implementation of this System. The CLB's are connected in cascade manner to obtain the functionality for the designed system. To ensure that the hardware implementation works properly, simulation test was performed using I-Sim (0.76.xd). [12]

Impact of the proposed flow on peak memory usage, timing and area

In this paper, the conventional approach and the proposed method is analyzed based on the cost function of placer and router. As shown in the [Table 1] the number of LUT's, memory usage and timing are reduced in proposed flow due to less consumption of adder circuit in the design.[13]

As the [Table 2] show:

The routed architecture of the conventional and proposed method on Xilinx spartan-3E low power, Selected Device: 3S250EPQ208 is tabulated in [Table 1] shows the proposed method outperforms the conventional architecture in terms of placement and routing which has shown in the [Table 2] Shows the proposed method reduced the area up to 83% ([Table 2] –COMPARED THE METHODS AND TASKEN THE DIFFERENCE) when compared to conventional method.[14]

As shown in the [[Fig. 3].In terms of overhead, since the conventional approach and the proposed method only change the placement and routing of the design, as the usage of the CLB (configurable logic blocks) varies which provides the overhead and delay lesser than existing approach. In addition, no unreachable CLBs are reported by the original method and the proposed method which helps to overcome the limitation of the original approach. Hence, the conventional approach and the proposed method sustain CLB overhead It is observed that about 83 % ([Table 2] CLB's) area for the targeted FPGA is covered for the implementation of this System as shown in the [Table 2]. The CLB's are connected in cascade manner to obtain the functionality for the designed system. As the coverage area of the CBs reduces minimize route channel width. The lower delay comes from that the number of glitches is smaller when the carry propagates Quicker through the logic. The slice usage of the proposed method is reduced power up to 80% [Table 2] than the conventional approach as shown in the [Table 1].[15]

However, in this work the main target is using the direct mapping result in less area, memory, Power and delay when compare to associative mapping (As shown in the [Table 1 and 2]).

Table 1: Performance analysis for the existing and proposed architecture

	Base paper Existing	Base paper proposed
LUTs	425 out of 63,400	71 out of 4896
BELS	437	90
Delay		
Minimum input arrival time before clock	5.714ns	6.773ns
Maximum output required time after clock	1.102ns	4.283ns
Power	0.165 Watts	0.080 Watts
Memory	506756 Kilobytes	262724 Kilobytes
Flip Flops/Latches	11	43

Table 2: Performance Timing analysis for the existing and proposed architecture

	Base paper Existing	Base paper proposed
Total REAL time to PAR completion	23 secs	8 secs
Total CPU time to PAR completion	22 secs	7 secs

Power

Power dissipated to drive the input of the flip flop is due to switching power, short-circuit and leakage power. [15]

Power= $P_{switching}$ +$P_{short\ circuit}$ + $P_{leakage}$ (1)

Switching Activity Factor: α

If the signal is a clock, α = 1 then If the signal switches once per cycle, α = ½.besides For Dynamic gates: switch is either 0 or 2 times per cycle, α = ½ and for the Static gates: depending on design, but typically α = 0.1

$P_{switching}$ = a .f.Ceff .Vdd2 (2)

Short-circuit power occurred when there is a transition between VDD and GND occurs

$P_{short\ circuit}$ = Isc .Vdd.f (3)

$P_{leakage}$ = f (Vdd, Vth, W/L) (4)

The power comparison for various styles due to switching activity has shown in [Table 1]

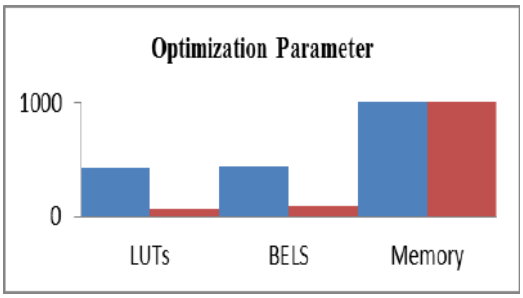

Fig .3: Optimization parameter comparison

CONCLUSION

In this analysis we have a tendency to propose the direct mapping supported the key observation that even for applications that take pleasure in accrued associativity, the common case for a direct-mapped cache may be a hit. This observation implies. That associativity is required just for conflicting block and will not be provided at the expense of upper hit latencies for all accesses. The r-a cache keeps the maximum amount knowledge in direct-mapped positions as attainable, and displaces solely conflicting blocks to set-associative positions. The direct mapping thus provides versatile associativity that will increase or decreases counting on application characteristics. The direct mapping cache may be a dynamically-probed multi-probe organization that includes a direct-mapped hit latency for the initial probe. An on the spot connect mesh routing structure is provided for interconnecting configurable logic blocks inside a programmable logic device. The structure includes multi-bit interconnect busses and a extremely regular structure distributed throughout a configurable array sanctioning high direct interconnect utilization to adjacent and non-adjacent logic blocks, high speed circuit implementation, and improved temporal arrangement characteristics. The direct connections of the invention square measure the well-liked interconnect path between logic blocks as a result of the considerably scale back the common interconnect delay, thereby permitting the programmable logic device to work at a better speed.

CONFLICT OF INTEREST
There is no conflict of interest.

ACKNOWLEDGEMENTS
None

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None

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ARTICLE

ARCHITECTURAL SOLUTIONS FOR SAVING ENERGY IN RESIDENTIAL BUILDINGS

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ABSTRACT

Nowadays, the world of architecture faces crucial changes in the designing process of buildings along with the increasing tendency of designers to the approach of optimizing energy consumption. On one hand, fuel crisis and on the other hand, environmental pollutions and global warming are the situations that human has never experienced before. Hence, the proper design of buildings which are the most vital energy consumers and producers of greenhouse gases can be an effective step in order to improve the existing situation. Since there are numerous intervener factors to increase the quality and efficiency of the building, considering all the factors simultaneously seems very difficult. The current paper is based on the crucial designing decisions which determine the amount of final consumed energy by a building, are taken by architects in initial levels of designing. Therefore, we try to help architects to obtain the designs which are compatible with the environment in order to reduce the energy consumption by understanding the climate and designing solutions.

KEY WORDS
climatic design solutions, energy saving, residential buildings

INTRODUCTION

Architecture and urban design styles based on decreasing energy consumption study the fact that how it is possible to reduce the amount of building's energy consumption by only having appropriate design and choosing the correct factors of architecture and urban planning which affect the amount of consumed energy by the buildings for each climate and dedicated to the same area while they can prevent using the unit schemes for every constructions. Architecture and urban planning methods based on decreasing the energy consumption are sustainable and costless methods; additionally, comparing to the other methods, these are affordable, environmentally and economy in case that the energy fees rise [1].

According to the presented statistic, between15% to 20% of the total energy consumption is used in the building and residential spaces in particular; moreover, this issue results in higher costs, eradicating natural resources, the loss of fossil fuels, and destroying the environment in a wide range [2]. The necessity to optimize and save energy is a must at the current time. One of the solutions for this matter which worth considering is architecture design that tries to offer saving energy solutions and patterns in order to saving and optimizing it [3]. At the recent decades, the new housing design approaches are considered in many countries and since the housing pattern is adapted from the human thinking, costumes, traditions, economy and technology, vast changes can be seen through the time. Architects along with scientists try to find the new approaches to supply the desirable life for humans. It's obvious that life, work, leisure, rest and so on are the activities that are held in the designed spaces by architects. Hence, as the strengths and weaknesses of a building directly influence the ecosystem of the world, architects have a vital duty for that [4].

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Architecture and Climate

Understanding every region's architecture in each era needs to gain knowledge about the ways that each of its details adapts to the certain climate. The architecture is not able to be separated from the conditions that its surrounding environment has, either naturally or artificially. Therefore, according to the climatic conditions of every environment, every geographical location asks for its special architectural method and construction [5]. The obtained experiences from using the residential buildings lead us to witness forming the various types of structures in different climates by considering every region's climatic need which is known as traditional structures. Hence, we find out that urban texture and the material's kind in every zone are in a perfect adaption with the climatic conditions which reach to their best functions [6].

Nowadays, one of the most important concerns of human is protecting the world's natural sources because of the consequences of industrial world. Therefore, architects and designer's attention to create the conditions which the most beautiful and beneficial plans can be designed while they have the least harm to in the environment is one of the hottest and main topics in the architecture [7-9].

By increasing population in the cities, the qualitative and quantitative housing crisis in urban societies began in such a way that quality issues in housing are the main subjects for researches, surveys and comments of cultural officials along with different subjects such as architecture, urban planning, sociology, economy and even politics for several years. Therefore, one of the outcomes of these researches is designing the house by paying the extreme attention to the climatic conditions [10].

One of the issues that human faces inevitably since the primary civilization is how to locate in order to make settlements. Since human naturally demands safety to counter different situations, peace, and a

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place to keep him safe from any vulnerability, providing a house has become a vital matter for the living of humans. On the other hand, housing as one of the subjects of architecture precisely has the strongest links to the most delicate forms, heritage and the cultural- environmental features and is exclusively important [11].

The issue of limited available energy resources, more or less, is a common problem for every country including industrial, developed and developing nations. According to the industrial activities in different countries, between 30% and 35% of the total energy consumption is dedicated to construction consumptions; moreover, up to 50% to 60% of this amount is consumed for cooling and heating the internal spaces of residential buildings. Therefore, the actions that are taken into improving the quality of the buildings by considering thermal exchanges will result in saving considerably total energy consumption [8].

Climate design

Designing the building is the first shield against the climatic factors out of a building. in every climate, the buildings built according to the principles of climate design reduce the necessity to use the mechanical cooling and heating systems and use the natural energy sources around the buildings in exchange. Designed buildings based on the climate operate well against the unpleasant weather conditions; also, they provide a healthy and beautiful living environment for humans. Tools for practicing the climate design are followed as: windows, natural light, green house, covered porch, and court yard. These tools provide an environment all together which leads in creating the balance among the inhabitants and the surrounding world. Therefore, it can be concluded that the climate design is a method to reduce the costs of building's energy [11].

Architecture and urban design styles based on decreasing energy consumption study the fact that how it is possible to reduce the amount of building's energy consumption by only having appropriate design and choosing the correct factors of architecture and urban planning which affect the amount of consumed energy by the buildings for each climate and dedicated to the same area while they can prevent using the unit schemes for every constructions. Architecture and urban planning methods based on decreasing the energy consumption are sustainable and costless methods; additionally, comparing to the other methods, these are affordable, environmentally and economy in case that the energy fees rise [1]. One of the advantages of reducing the energy consumption by using architecture design is its high potential of saving energy. According to the studies, due to climatic conditions in Iran, the impact of architecture design on the amount of energy consumption of the buildings is great. Energy optimization can be simply accessible as a result of using energy efficient methods of architecture and urban planning which their functionality is very high [12].

Climate design is gone beyond of being a construction profession and more noticed by common people. The outstanding matter of understanding the value of each era's architecture understands the adaption of building to the certain climate of each region. How a building benefits from sun, breeze, and the green space and how an architect creates a small climate are the signs of a designer's skill and knowledge. Generally, understanding the climate is not difficult. Human's physical comfort in the building is a result of the balance which is between the building's thermal energy and its environment. When a designer recognizes the climatic conditions of the site, he can choose the principles of climate designs which are special for each weather and compare them [5].

According to the aforementioned issues, we will study some solutions of climate design in the following which considerably lead to decreasing the energy consumption in the residential buildings. These solutions are followed as:

Building's direction

Providing the heating energy: according to the studies, the least heating energy consumption of a building occurs when the building is directed to 170 degree (10 degree from south to the east). As the building's direction differs from the given measures, either to the east or west, the amount of heating energy consumption increases. The maximum amount of heating energy consumption of a building occurs in 40 degree (northeast) and 320 degree (northwest) [12].
Providing the cooling energy: the cooling energy consumption of buildings reaches its minimum when building is directed to the north. The maximum amount of cooling energy consumption occurs when a building is directed to 110 and 260 degrees. By rotating the building from east and west directions to north and south directions, the amount of cooling energy consumption reduces [13].

Building's stretch

Building's direction has a significant impact on the amount of building's energy consumption. Building's direction is one of the most important factors among the architecture's factors related to the energy saving. Energy consumption for a building's cooling and heating systemsis operated in order to have a balance between the wasting and receiving energy by the building's heat shield. Therefore, every changes in the area of this heat shield or its components which are located in different geographical directions, alter the amount of wasted and received energy by this shield which results in changing the cooling and heating energy consumption of a building. Building's stretch affects the heating and cooling energy

consumption of buildings. Also, changing the depth of a building leads to changing in the amount of daylight' penetration in the inner spaces of buildings. Hence, this will have impact on the consuming electricity for providing the building's light. As it's said, the building's stretch is one of the effective factors for building's energy consumption [12].

Number of floors

A building's number of floors is one of the factors that affect the amount of building's energy consumption. A building's number of floor has impact on the ratio of surface to the building's volume and consequently the amount of wasting energy through the building's heat shield which subsequently influences the amount of heating and cooling energy consumption of a building. Also, the building's number of floors affects the ratio of the ceiling's area to the infrastructure area of the building which is a significant factor in the amount of wasted and received energy of a building. Ceilings as the horizontal thermal shield surface compared to the walls are more important due to the receiving the great amount of the radiation in cold days and low radiation in warm days. This item can increase the amount of cooling energy due to receiving a great amount of radiation in summer which results in increasing in received thermal energy by the last floor. Increasing or decreasing of the amount of cooling energy by increasing the area of the ceiling is an issue which is related to the climate, building's usage and the hours which a building is used. Ceiling can cause increasing in the amount of heating energy of a building by wasting energy in the winter. Changing the number of floors can change in the ratio of floor area to the infrastructure area of a building; furthermore, this matter can change the amount of the building's need for cooling and heating energy [12].

Natural ventilation

The natural ventilation can reduce the need for cooling energy by removing the extra heat from the internal spaces and create a healthier conditions by providing the fresh air for the users. During the process of natural ventilation, the natural pressure differences between the inner air and external air leads to providing the external air into the inner spaces and expelling the inner air in to the outer space so that results in exchanging the external and internal air. The pressure difference can be a result of the air flow or the thermal differences between the inside and outside of a building [12].
The natural ventilation can effectively reduce the need for cooling energy in the buildings. Reducing the need for cooling energy by using the natural ventilation is a simple and economy way in order to optimize the energy in the buildings which does not need any special material or tools. This method can provide the pleasant and fresh air for the residents and help to save the energy and reduce the capacity of the cooling system.
One of the climatic components of the indigenous buildings in Iran is wind tower (Badgir). Wind tower is one of the significant samples of natural ventilation in a building as a dynamic cooling system. Wind tower provides the pleasant ventilation by using the renewable energy, Wind. This structure has a vital role in providing the thermal comfort for the residents by using the nature's energy in order to reach the thermal adjustment [7].

The gray water

One of the ways to provide the water requirements is using the gray water as an alternative for water in some consumptions [14]. The Gray water is produced from the wastewater such as washing, bathing and so on and comparing to the black water which is extracted from the fecal sewage has better quality. By using a management perspective, we can bring back this water in to the consumption circle and use it as an alternative for the purified water with the higher quality in some usages such as watering the green spaces, fountains and so on. Therefore, using the gray water can reduce the building's water consumption and its following costs [15-16].

Greenhouse

Greenhouses can be connected to the southern front of building as a glass chamber or some part of this chamber can penetrate in to the building and the outer part can penetrate outside of the building. Also, it can be also closed inside the building which receives the sunlight through the ceiling. Generally, the ideal orientation for glassing in a greenhouse should be directed to the south. However, the orientation with 30 degrees west or east to the south is acceptable as well. For having maximum energy absorption, the glass should have a slope with 50-60 degrees to the horizon [3]. Solar Greenhouse System absorbs the solar energy directly and stores it in its walls in order to transfer the energy to the adjacent spaces [10]. A designed greenhouse can provide more than 50% of a need for home heat. In this case, it is better that the living place is located to the south and spaces such as bedrooms should be located in the north [3].

Canopy

By decreasing the amount of absorbed solar energy, canopies are one of the greatest source of the absorbing heat in the building which has effective usage in reducing the need for cooling energy. The dynamic canopies are the simple and cheap tools which their cooling functions are not dependent on the setting by users. However, this item can reduce the received solar heat in the winter which results in decreasing the demand for heating energy. Therefore, the beneficial canopy can be defined as a canopy that reduces the amount of solar absorption to the least in the period of winter days while it would not

reduce the amount of the solar absorption during the summer days. If the horizontal canopies which are built for the southern windows create the most shadows during the winter and the least shadows on the windows during the summer, effectively will reduce the building's demand for energy [12].

Solar reflectors

Using the solar reflectors as a passive heating method can reduce considerably the amount of demand for heating energy by receiving the radiation through the northern windows. According to the energy supply, the northern façade of a building is the most important part because the receiving thermal energy from the sun through the fluorescent surfaces of this front is very less during the heating period. Employing this solution can reduce the demanded energy consumption for the building's heating considerably [12].

Green Roof

Using the green roof in the buildings can reduce the unpleasant thermal effects, particularly in the summer and increase the roof's stability. Due to the sun's high altitude angle in the summer, horizontal surfaces receive much more radiation energy that vertical surfaces. The absorbed radiation by the roof transfers to the heat which increases significantly the temperature of the external surfaces of the roof. Some parts of the external surface's heat of the roof penetrate in to the building through the ceiling's conductivity. Moreover, the heat enters into the spaces through the internal surfaces in a form of movements or radiation which increases the air and radiation temperature of the space. This matter increases the amount of cooling energy consumption considerably. Additionally, it reduces the level of thermal comfort because of radiation heat on individuals through the ceiling's surface [17].

CONCLUSION

Urbanization According to the conducted researches, we find out that the amount of energy resources in the world such as fossil fuels, coal and so on are increasingly over and in the close future we will face the crucial crisis of lacking the energy. This is the fact that can cause harsh consequences for every human beings due to being not understood by managers and decision makers of each nations.

On the other hand, the most consumed energy in the construction is dedicated to the housing. Therefore, the architects' roles to bring up the topic of assimilating the structures with the existing and future situation and creating the balance between the demand and supply of energy will become more highlighted day by day. Hence, by considering to every aspects and existing problems, we should recommend some solutions in order to reduce the energy consumption in this sector. The following solutions are suggested: determining the proper direction for the buildings, having a proper stretch in order to reducing the need for artificial light, the number of floors and calculating the amount of wasted or saved energy, using the natural ventilation to reduce the demand for cooling and heating by using electronic facilities, reusing the gray water for non-drinking consumption, creating the canopies for decreasing the amount of extra thermal energy received from sun, benefiting from the solar reflectors in order to reduce the demand for thermal energy in some seasons, using the green roof to prevent from wasting energy and also receiving the heat energy from the sun through the used materials in the roof, and also to prevent them from being damaged by cooling and heating during the day and night. All together can be considered as a great step in order to maintain and protect the energy resources for the future generations and natural environment.

CONFLICT OF INTEREST
There is no conflict of interest.

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ARTICLE

ANALYSIS OF EFFECT OF SPRINKLER FUNCTION PRESSURE ON UNIFORMITY OF WATER DISTRIBUTION IN TRICKLE IRRIGATION: CASE STUDY IN TORBAT HEIDARIYEH ZONE

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ABSTRACT

Using of trickle irrigation systems (sprinklers) is one of the efficient solutions in saving and further protection from water supplies. If these systems are properly designed, executed, and managed, they will cause reducing water wastage and improving uniformity of water distribution. Uniformity of water distribution will be possible in trickle irrigation (sprinkler) when the factors, which cause reduction of uniformity, are identified and controlled as possible. In order to analyze effect of pressure of sprinkler function on uniformity of water distribution, several experiments were carried out according to ISO 7749/2 Standard (1990) by single sprinkler technique in a pilot field locating on Torbat Heidariyeh Zone during spring and summer in 2016. The test was implemented at 3 different pressure levels (2.2, 3.5, and 4.7 atmospheres) within the range of suggested pressures by Manufacturing Company. Analysis on results of finding from uniformity of water distribution at different pressure levels signifies that there is significant difference between the studied pressures at level of 5%. The mutual effect of sprinkler type and pressure suggests that following to rise of pressure at any sprinkler, uniformity of water distribution has been increased and water distribution uniformity coefficient has been added by rising pressure (from 2.2 to 4.7 atmospheres) and this relationship was not linear but this gradient was higher at low pressures (2.2-3.5 atmospheres) than high pressures (3.5- 4.7 atmospheres). If pressure level (about 3.5- 4.7 atmospheres) has been selected in the studied sprinkler, uniformity coefficient will be greater than 80%.

KEY WORDS
Sprinkler, Trickle irrigation, Function pressure (stress), Water distribution uniformity coefficient

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INTRODUCTION

Water shortage and limitation of water supplies, particularly in Iran, requires conditions under which water is used at maximum level and in order to prevent from water wastage as possible. Utilization from irrigation systems is assumed as one the basic steps taken in saving and further protection from water supplies in agriculture with potential to achieve high efficiency and uniformity. Uniformity of irrigation means the same quantity of water to be distributed in all points of land. Total uniformity is not practically possible in irrigation because uncontrollable factors play role in this process. Whereas high uniformities are usually accompanies by rise of fixed costs and exploitation and maintenance costs thus the project should be implemented in such a way that in addition to having high uniformity, it should be also economically justifiable. Sprinklers should distribute water more uniformly as possible and without creation of runoff water on ground surface. To this end, various types of sprinklers have been designed and manufactured.

In any case, unsuitable pressure in trickle system (whether high or low) causes some points to be less irrigated on the given land where the effect of this process is visible on growth of plant in those areas. Uniformity of water distribution in trickle irrigation system mainly depends on this point that most appropriate amount of pressure and size of sprinkler to be selected with respect to distance between sprinklers.

Losses of depth penetration are more controllable in trickle irrigation than in surface irrigation and it can be reduced. When the system starts operation in trickle irrigation, irrigation practice begins simultaneously at all points and period of irrigation time is the same at all points. For this reason, losses of depth penetration are lesser than in surface irrigation. In order to explore effect of different quantities of pressure of function, distances, and arrangement of sprinklers on uniformity of water distribution in trickle irrigation, indicated that following to rise of function pressure, Christiansen's uniformity coefficient of water distribution is increased nonlinearly (rise of pressure from 35m to 40m increases further water distribution uniformity coefficient from 40m to 45m compared to rise of operational pressure.

Among the uniformity equations presented by various researchers, Christiansen's equations in Hawaii Sugarcane Association, Hardt and Reynolds depend on field conditions at least level and they can be used in different fields with more confidence. After study on different states and conditions, Christiansen [1] has suggested distances for sprinklers. He has offered ratio of distances between sprinklers with distribution diameters 0.4×0.6 and 0.5 respectively for rectangular and square arrangements.

Effect of wind speed and hydraulic properties on water distribution uniformity on prevalent sprinklers in trickle irrigation have been studied. The results of that survey indicate that there is no linear relationship among pressure and water distribution uniformity in all of tested sprinklers and curve gradient of pressure uniformity coefficient became greater at lower pressures. Uniformity coefficient was increased following to rise of pressure within studied range (all of wind speeds, used sprinklers, and designated intervals). However curve gradient of uniformity coefficient and wind speed is greater at lower pressures (3kg/m3) and this relation has been kept at all wind speeds [3].

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MATERIALS AND METHODS

The given tests were carried out according to ISO 7749/2 Standard [4] by means of single sprinkler technique in pilot field locating on Torbat Heidariyeh zone (longitude: 59°, 13´ and 35°, 20´) in spring and summer 2016. Anemometer (or wind gauge) was utilized to measure wind speed. With respect to the given information by manufacturing companies of sprinkler, this experiment was conducted at 3 different levels with the range of suggested pressures by Manufacturing Company. The needed water for this system was supplied from a pond with dimensions of (2.5×25×30) near to the pilot field. Single sprinkler was utilized on blow sprinklers or the current sprinklers used in under-pressure irrigation projects (Weir-35 Sprinkler) implemented with operational range of sprinkler (2.5-4.7 atmospheres) in Torbat Heidariyeh zone. The period of system operation was at least an hour in any experiment. After preparation of land and system implementation, the identical collector vessels with 3×3m2 arrays were arranged before any assessment and water depth irrigation system were collected at any assessment step and accurately measured with graded cylinder at any vessel. The measurable parameters include wind speed, water pressure, discharge and amount of collected water in cans due to water output in this study. Similarly, it was tried these tests to be repeated accurately under similar conditions with respect to change in quantities of atmospheric parameters in respective of time and non-occurrence of the previous conditions. In order to achieve objectives in this study, tests were conducted at six levels of intensity of flowing wind this zone (2, 3, 5, 5, 6, 7, and 11) and in three treatments of sprinkler average pressure (2.2, 3.5, and 4.7 atmospheres).

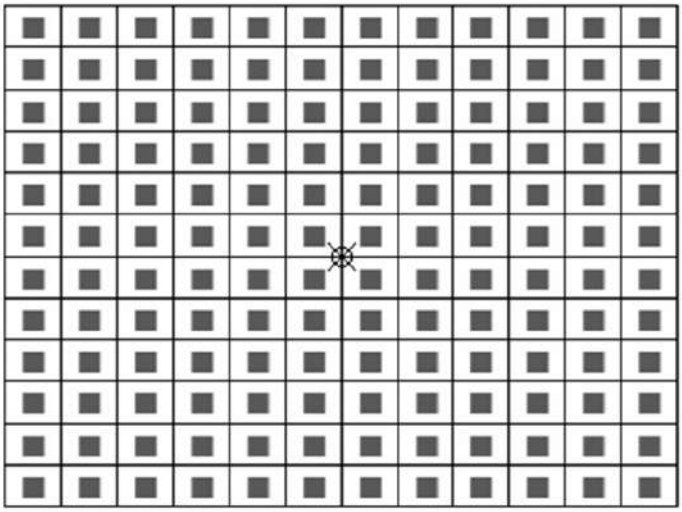

Fig.1: General view of settlement of water collection vessels where these vessels are placed as a grid with dimensions of (3×3m) around Weir-35 sprinkler.

After preparation of ground and system implementation in this study, identical collector vessels were arranged with distances (3×3m2) and square arrays (12×12) before any assessment and after any assessment phase of irrigation system, depth of collected water was accurately measured in any measurement vessel. One hour was designated for period of system operation at any phase of test. Depth of collected water in any measurement vessel was measured accurately after any phase of assessment of irrigation system. Likewise, meteorological parameters were measured by installation of anemometer system in the given zone.

Christiansen's uniformity coefficient formula was used to compute uniformity coefficient of system.

$$UC = 1 - \sum_{i=1}^{n} \frac{|x_i - \bar{x}|}{n\bar{x}}$$

UC: Christiansen's uniformity coefficient (decimal)
xi: Depth of water in each of water collection cans (mm)
: Mean depth of water in collection cans (mm)
n: Number of water collection cans
Given that the rate of propagation has been measured around a single sprinkler in this test therefore effects of adjacent sprinklers have been considered by assuming identical climatic conditions and propagation pattern around sprinkler and employing of simulation technique and distribution uniformity was calculated by Christiansen's uniformity coefficient.

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And finally values of water distribution uniformity and Christiansen's uniformity coefficient calculated by simulation technique were analyzed for water pressure and different wind speeds by means of SPSS software.

RESULTS AND DISCUSSION

According to [Table 1], water distribution uniformity coefficient has been increased with rise of pressure (from 2.2 to 4.7 atmospheres) and this was not linear relation but it has greater gradient at low pressures (2.2- 3.5 atmospheres) than high pressures (3.5- 4.7 atmospheres).

As it seen in [Table 1], when pressure is increased from 2.2 atmospheres up to 50% and reached to 3.5 atmospheres, uniformity coefficient is increased 4.9% but if pressure is increased 113.6% and 4.7 atmospheres, uniformity coefficient increases 5.6%. It is observed this relationship is not linear and gradient of this curve is greater at lower pressures. Based on studies of Christiansen [24], as water pressure is reduced at any specific sprinkler, intensity of propagation becomes greater (discharge and radius of propagation is reduced with decrease in pressure but effect of reduction of area is greater than reduction of discharge and this is led to rise of propagation intensity) and also intensity of blow by water drops increases on soil while water distribution uniformity is reduced. Particles are pulverized at higher pressures and easily carried by wind and therefore uniformity is reduced. Likewise, drops exiting from sprinkler fall near to it at lower pressures and they create weak sprinkling profile where this is also led to reducing uniformity coefficient.

Table 1: Effect of operational pressure on water distribution uniformity in trickle irrigation system

Pressure (Atmosphere)	Uniformity coefficient (%)	Percent of pressure rise compared to pressure 2.2 atmosphere	Percent of uniformity rise compared to pressure 2.2 atmosphere
2.2	81.5	-	-
3.5	87.5	59.1	4.9
4.7	86.1	113.6	5.6

Table 2: Regressive equations for estimation of uniformity coefficient using sprinkler operational pressure

R2	Equation for estimation of uniformity coefficient in respective of operational pressure	Wind speed
0.8705	Y= 1.9776x + 82.478	2km/h
0.8746	Y= 1.7335x + 81.491	3km/h
0.8982	Y= 1.7335x + 81.491	5km/h
0.8642	Y = 1.8166x + 79.202	6.5km/h
0.7466	Y = 2.5544x + 71.612	7km/h
0.7016	Y = 1.2996x + 70.328	11km/h

Analysis of the given results from water distribution uniformity under different pressures signifies that there is significant difference between the studied pressure values at level 5%. Review on relationship among sprinkler pressure and mean of water distribution uniformity for all the given wind speeds showed in this study that when pressure level was increased from 2.2 atmospheres to 3.5 atmospheres (59%), water distribution uniformity was also added up to 4.9% but rise of pressure from 3.5 to 4.7 atmospheres indicates only 0.5% increase in water distribution uniformity. These findings suggest that there is no linear relationship among pressure and water distribution uniformity while gradient of this curve is greater at low pressures so these findings are consistent with the results of studies done by other researchers. Although pressure level greater than 4.7 atmospheres has not been tested in this study, the trend of increase in water distribution uniformity versus rise of pressure signifies that rise of pressure more than 4.7 atmospheres will not have noticeable effect on uniformity of water distribution. Based on studies of Christiansen, as pressure lessens in any specific sprinkler, discharge and radius of propagation is reduced in sprinkler but the effect of reduction of level will be greater than reduction of discharge and as a result intensity and pattern of distribution exits from favorable state and this is led to problem of reducing uniformity of water distribution. Based on results of this study, relatively high propagation of water in environmental areas is the most efficient factor in reducing uniformity coefficient at low pressure (2.2 atmospheres). Rise of pressure decreases water propagation in environmental areas and propagation pattern is relatively corrected and this causes rise of uniformity in water distribution. Although appropriate pressure varies depending on type of sprinkler, generally if pressure level is selected among 3.5 to 4.7 atmospheres in the studied sprinkler, value of uniformity coefficient will be higher than 80% that has been recommended by many researchers as a suitable criterion for trickle irrigation systems. However if pressure level is selected lesser than 3.5 atmospheres, uniformity coefficient will be decreased according to the above-said reasons. Although in order to find appropriate pressure it is recommended to examine wider range of pressure, due to pulverization of water particles under pressure higher than 4.7 atmospheres and effect of wind speed on these particles, higher pressure than this [Fig. 1] is not recommended for the given sprinkler [5-7].

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CONCLUSION

It is recommended that if pressure level is lower, sprinklers should be placed within smaller distances. Based on this study, relatively high propagation of water within perimeter of distribution circle is the most efficient factor in reducing uniformity coefficient at low pressure. Rise of pressure may decrease high propagation of water within perimeter of distribution circle (it adjusts propagation pattern to some extent) and it causes increase in uniformity coefficient. If pressure value is selected about 3.5-4.7 atmospheres in the given sprinkler, uniformity coefficient will be greater than 80% that is accepted by many designers. Results came from this study are consistent with the given findings by other researchers who have worked on medium and high pressures.

The reciprocal effect of sprinkler type and pressure suggests that water distribution uniformity is added following to rise of pressure in any sprinkler but this trend is not linear within range of studied pressure.

CONFLICT OF INTEREST
There is no conflict of interest.

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ARTICLE

INTERNAL CURING EFFECT ON PROPERTIES OF SELF-COMPACTING CONCRETE

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ABSTRACT

One of the most common problems after concrete casting is shrinkage due to water loss from the hydrated cement paste. This phenomenon causes crack creation and increases the permeability of concrete where causes concrete durability reduction. In this research, the effect of internal curing on the mechanical properties of self-compacting concrete, shrinkage strain, permeability and corrosion of rebar has been evaluated. According to the obtained results, the internal curing of self-compacting concrete containing lightweight aggregates reduced or even eliminated the shrinkage strain. As a result, concrete durability will be increased by controlling the concrete crack propagation. Also, the mechanical properties of concrete specimens and concrete resistance against corrosion were improved due to internal curing.

KEY WORDS
Shrinkage, diffusion, internal curing, fraction, durability

INTRODUCTION

Self-compacting concrete (*SCC*) is a type of concrete which can be compacted by its weight without any vibrations. According to *ACI 237R-07*, SCC is a high workable concrete without any segregation which can fill up the concrete molds and cover the rebar up without any mechanical compaction [1]. The necessity of this type of concrete was proposed by Okamura in 1986. Studies to develop self-compacting concrete, including a fundamental study on the workability of concrete, have been carried out by Ozawa and Makala at the University of Tokyo [2]. The prototype of self-compacting concrete was first completed in 1988 using materials already on the market. The prototype performed satisfactorily with regard to physical and mechanical properties [3].

Internal curing by compensating the consumed water by hydration development and surface evaporation can help to decrease shrinkage, crack creation and permeability of concrete structure; it can also increase the durability and the service life of concrete. Thus, with regard to some areas with high risk of volumetric changes, investigating a method which can decrease shrinkage strain probability seems necessary.

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Leemann et al., have figured out that the drying shrinkage strain value in *SCC*, is about 10-15% more than the corresponding value in normal concrete [Fig. 1]. This difference also rises up to 24% at the age of 90 days [4].

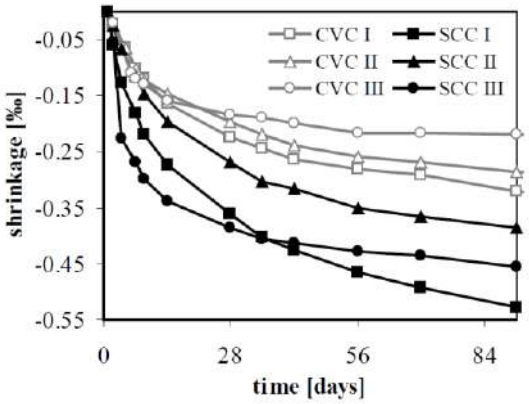

Fig. 1: Cson of shrinkage between *SCC* and normal concrete.

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In external curing in the concrete, water just can penetrate into the limited thickness of the members; while in internal curing, water molecules can be distributed in the whole body of the concrete members [5]. The possibility of using different additives that can be applied as internal water resources like *SAP* (Superabsorbent Polymers) [6,7], limestone aggregates [8], Cenospheres [9], Paraffin wax [10] and Pre-Wetted Wood Fibers [11] is studied recently.

The reasonable explanation for the effect of internal curing on decreasing or elimination of shrinkage has been presented by Weber and Reinhardt [12]. Based on the explanations, a set of capillary pores form in the cement paste during hydration. The diameters of the pores are less than the pores in lightweight aggregate. After the reduction of relative humidity in concrete the drying process develops due to hydration

process and humidity gradient. The pores of hydrated cement paste, absorb the water in aggregates with capillary suction. Thus, anhydrous particles of the clinker will have more free moisture for hydration. The new products of hydration form in the pores of hydrated cement paste and make them smaller and more discrete. As the pores size and capillary networks get smaller, capillary tension, which is inversely related to the square of the pore diameters, is increased. Thus, water transfer from the saturated lightweight aggregate will continue until it is completely transferred from lightweight aggregate to hydrated cement paste [12].

When the concrete is internally cured, as the water in capillary pores of concrete is completely consumed by hydration process, water lack is compensated by internal water sources. So, less tensile stress is created in capillary pores and as a result, induced shrinkage strain is reduced. In this regard, volumetric dilatation of concrete is also possible in the first few days of concrete production [4]. The most important result of internal curing is the reduction of shrinkage which decreases the stresses during hardening process and also reduces cracking risk in low water to cement ratios.

On the other hand, as it's necessary to externally vibrate the normal concrete for a better compaction, bleeding and segregation phenomena are observed in concrete. While these phenomena do not occur in *SCC* because there is no vibration process. Less porosity in transition area and the physical presence of mineral fillers are the main reasons of a more compressibility of the material in *SCC*. *SCC* mixes without any additive powder material which gain their stability and workability from plasticizers, usually have much permeability in compared to other *SCC* mixes [13]. Containing materials of hydrated cement paste, especially fillers, can have an important role on the behavior of *SCC* in the aggressive environments [14].

RESEARCH SIGNIFICANCE

In this study, the effect of using Light Expanded Clay Aggregate which is named *LECA* on the properties and characteristics of fresh and hardened concrete has been investigated. In order to reach this purpose, the water absorption characteristics of lightweight aggregates were measured and the final mix design of the self-compacting concrete has been obtained after performing several primary experiment at the trial and error procedure.

Fresh concrete tests include Slump-Flow test, *V*-Funnel test, *L*-Box test and *J*-Ring test; have been performed to assure the self-compacting characteristics of the mixes according to *EFNARC* [15]. Also, the mechanical properties, dimension stability, permeability of concrete and corrosion potential of rebar are measured to study the effect of internal curing on the solid properties and cracking potential of the concrete.

MATERIALS AND METHODS

Portland cement type I was used in this study. Crushed gravel with the maximum size of 20*mm* and river sand were respectively used as coarse and fine aggregates which were both graded according to [16]. Fine *LECA* with the dimensions of 0-4mm with the special gravity of 510 kg/m^3 was used as lightweight aggregate. The variations of water absorption related to the *LECA* during 72 hours is shown in [Fig. 2]. In the concrete mixes a superplasticizer was also used to maintain suitable workability.
In the mix design name, the first number represents "water to cement ratio" and the following number indicates the "the percentage of *LECA* replacement instead of fine aggregate". The specimens mix designs of Self-compacting concrete (*SCC*) and ordinary Portland cement concrete (*OPC*) are summarized in [Table 1].

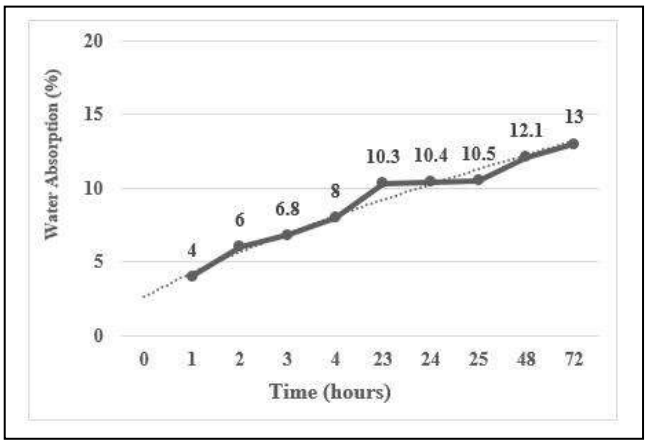

Fig. 2: Water absorption of Lightweight aggregates (*LECA*).

Table 1: Mix designs of concrete specimens

Mixture	w/c	Cement Content (kg/m^3)	Silica Fume (kg/m^3)	Gravel (kg/m^3)	Sand[1] (kg/m^3)	*LECA*[2] (kg/m^3)
0.3 SCC+10	0.3	450	50	850	630	70
0.3 SCC+20	0.3	450	50	850	560	140
0.3 SCC+30	0.3	450	50	850	490	210
0.35 SCC+10	0.35	450	50	850	630	70
0.35 SCC+20	0.35	450	50	850	560	140
0.35 SCC+30	0.35	450	50	850	490	210
0.4 SCC+10	0.4	450	50	850	630	70
0.4 SCC+20	0.4	450	50	850	560	140
0.4 SCC+30	0.4	450	50	850	490	210
0.4 OPC+10	0.4	360	40	900	720	80
0.4 OPC+20	0.4	360	40	900	640	160
0.4 OPC+30	0.4	360	40	900	560	240
0.3 SCC	0.3	450	50	850	700	0
0.35 SCC	0.35	450	50	850	700	0
0.4 SCC	0.4	450	50	850	700	0
0.4OPC	0.4	360	40	900	800	0

1-In Saturated with dry surface condition, 2-In 48hr saturated with dry surface condition

All specimens were kept in laboratory condition and without any external curing. According to *BS EN 12350-9* [17], the plastic viscosity and filling ability of the self-compacting concrete has been evaluated with *V*-Funnel test which *EFNARC* [15] declares it as a criterion of passing ability and detachment strength evaluation. In this study, *L*-Box test has been carried out to evaluate (passing and filling ability and blockage possibility of the fresh concrete while encountering rebar. *J*-Ring test has also been utilized to investigate rheological characteristics of the studied mix designs [15].

The concrete volume changes, shrinkage, was measured 24 hours after removing the molds according to *ASTM C157* [18]. Modulus of elasticity has been measured in 28-day age of concrete according to *ASTM C215* [19].

To measure the permeability as an important criterion for concrete durability, 24h water absorption of the specimens in the 28-day age of concrete has been measured. Also, chloride penetration depth has been specified by spraying silver-nitrate ($AgNO_3$) on the internal surface of specimens were kept in water with 3 percent of *NaCl* solution for 28 days [20]. In order to investigate rebar corrosion potential, electrical resistance of the specimens in the age of 7, 28 and 60 days was measured and the corrosion potential against the reference saturated calomel electrode was recorded within 8 weeks after applying corrosion condition.

RESULTS AND DISCUSSION

The rheological properties of fresh concrete for the mentioned mixtures are shown in the [Table 2]. According to this [Table 2], as the water to cement ratio increases, Slump Flow and J-ring diameter increase accordingly.

Table 2: Rheological behavior of the studied mixes design

Test	Slump flow (*cm*)	*T50*cm (s)	*V*-Funnel (s)	*L*-box (*h ratio*)	*J*-ring (*mm*)
0.3SCC+10	70	4.5	9.5	0.9	7
0.3SCC+20	69	4	10.7	0.92	8
0.3SCC+30	68	5	11.5	0.85	9
0.35SCC+10	70	4.4	8.2	0.9	7
0.35SCC+20	71	5.1	8	0.85	8
0.35SCC+30	69	3.8	7.7	0.8	8
0.4SC C+10	73	4.1	10.2	0.93	3
0.4SCC+20	72	4.3	9.6	0.9	3
0.4SCC+30	70	4.8	9.1	0.85	4
0.3SCC	70	4.2	9	0.92	7
0.35SCC	72	4.5	8.5	0.88	5
0.4SCC	75	4	10.7	0.8	2

In order to evaluate the effect of internal curing on the compressive strength of the specimens, compressive strength test results at 7 and 28 days are displayed below [Fig. 3].

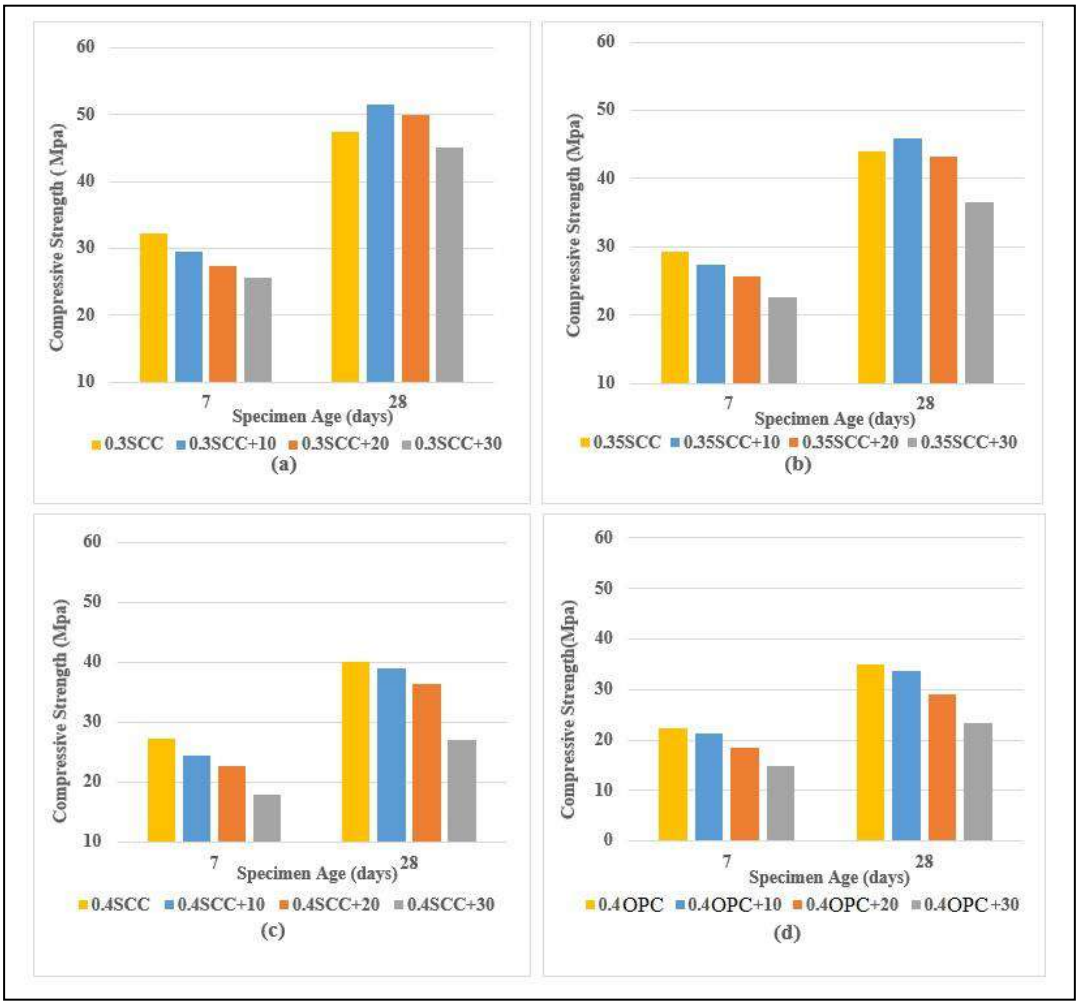

Fig. 3: Compressive Strength at 7 and 28 days of the specimens with different *w/c* ratio.

As shown in the [Fig. 3], in *w/c=0.3*, the maximum 7-day compressive strength belongs to the specimen without *LECA* and after that, there are specimens with 10%, 20% and 30% *LECA* content. Whereas in 28-day compressive strength, specimens with 10% *LECA* content had the highest compressive strength with about 8% of increase compared to the control specimen. After that, there are "*0.3SCC+20* and" and "*0.3SCC*". Meanwhile, the specimen with 30% *LECA* content has the minimum compressive strength. Thus, it can be stated that in *w/c=0.3* [Fig. 3(a)], internal curing can affect the compressive strength positively and can improve mechanical properties of concrete specimens in 28-day tests. While in 7-day tests, the effect of *LECA* usage is totally negative. The considering increase in compressive strength can be related to cement paste hydration and the improvements of the transition zone. As the lightweight content increases in concrete specimens, the decrease in the compressive strength seems to be overcoming the strength increasing due to cement phase hydration and the improvement of transition zone. This results repeated in the 30% *LECA* content specimen.

In *w/c=0.35* [Fig. 3(b)], *LECA* had a negative impact on compressive strength at the age of 7 days. However, 10% replaced *LECA*, increased compressive strength compared to control specimens at 28 days. But unlike *w/c=0.3*, in *w/c=0.35* replacing 20% of *LECA* with sand, had a negative effect on 28-day compressive strength.

According to the [Fig. 3(c)] for *w/c=0.4* ratio, internal curing of concrete has a reduction effect on compressive strength at 7 and 28 days. It seems that in *w/c=0.4* ratio, as the water content is increased compared to the previous specimens, less shrinkage strains is created and as a result, internal curing seems less necessary. By increasing *LECA* replacement with sand, not only the aggregate strength decreases, but also the result is like increasing water to cement ratio. Studying normal concrete with *w/c=0.4* has shown the same trend [Fig. 3(d)].

The [Fig. 4] show tensile strength changes at 7 and 28 days.

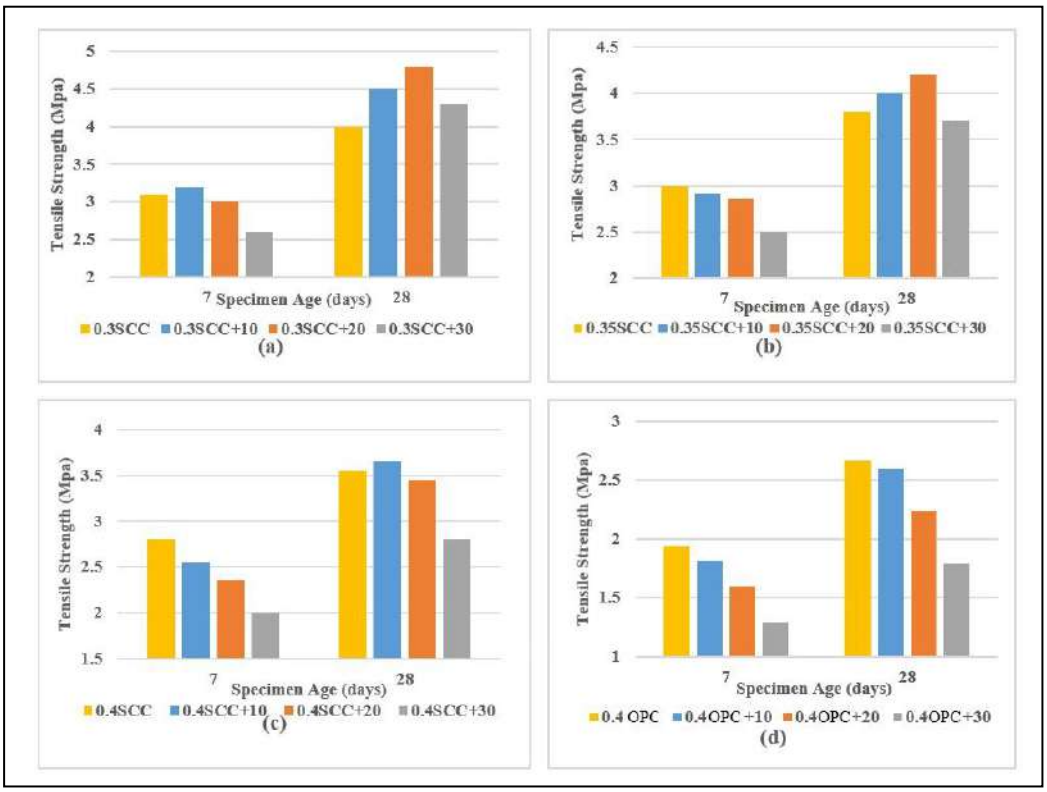

Fig. 4: Tensile strength at 7 and 28 days for of the specimens with different *w/c* ratio.

In *w/c=0.3* [Fig. 4(a)], 10% *LECA* content specimen has the maximum tensile strength at the age of 7 days. Whereas the maximum tensile strength at 28 day is related to 20% *LECA* content specimen. The 30% *LECA* content shows the minimum tensile strength at 7 days and the control specimen shows the lowest tensile strength at the age of 28 days. The most important reason for such increase in tensile strength as a result of internal curing is the decrease of the micro cracks creation in cement paste due to the decrease of shrinkage strains. The maximum tensile strength in *w/c=0.35* ratio [Fig. 4(b)] and at the age of 7 days is related to the control specimen. Totally, *LECA* has a negative impact on the concrete at 7 days. But with comparing the tensile strength results at 28 days, positive effect of internal curing is obvious in 10% and 20% *LECA* replacement. Also, 30% *LECA* content has a tensile strength similar to the control specimen. In the mixes with 10% and 20% *LECA* content, within 5% and 10% increase of tensile strength can be seen respectively.

In *w/c=0.4* [Fig. 4(c)], tensile strength results have a decreasing trend at 7 days, same as the results in *w/c=0.35*. Also, in this water to cement ratio, internal curing effect seems to be less efficient in 28- days tensile. Therefore, it can be stated that generally, internal curing has a positive impact on tensile strength but the actual appreciable increase occurs in the water to cement ratios less than 0.4. No efficient effect of internal curing on tensile strength was observed in Normal Concrete specimen with *w/c=0.4* [Fig. 4(d)]. Measured dynamic modulus of elasticity are shown in [Fig. 5]. It can be understood from the result that, in the specimens with *w/c=0.35* ratio the maximum amount of E_c is gained in the 10% *LECA* content specimen and after that stands the specimen with 20% *LECA* content. Whereas the 30% *LECA* content specimen has the least amount of E_c. It can be seen from the figures that the modulus of elasticity and compressive strength changes follow the same trend. According to this, improvements in internal hydration and the decrease of micro-cracks creation in cement paste (especially in transition zone) can be stated as the main reason for this changing trend.

Also, in *SCC* specimen with *w/c=0.35* and *w/c=0.4* ratios, the control specimen has the maximum amount of E_c and replacing lightweight aggregate with sand, results in modulus of elasticity decrease. Finally, the 30% *LECA* content mixture has the minimum E_c in all water to cement ratios.

Shrinkage strain changes of insulated specimen from a day after concrete production until the age of 28 days are shown in [Fig. 6]. According to [Fig. 6(a)], internal curing has a considerable effect on shrinkage decrease of *SCC* concrete with *w/c* equals to 0.3. As the maximum shrinkage is recorded for the control specimen with 700 micro-strains. Shrinkage has decrease as the more lightweight is replaced with the sand in a way that, in 10% *LECA* content mixes, 400 micro-strains and in 20% *LECA* content, around 300 micro-strains were observed in the first few days. The shrinkage in these specimens has decreased to the

amount of 150 micro-strains at 28 days which has totally decreased 550 micro-strains compared to the control specimen.

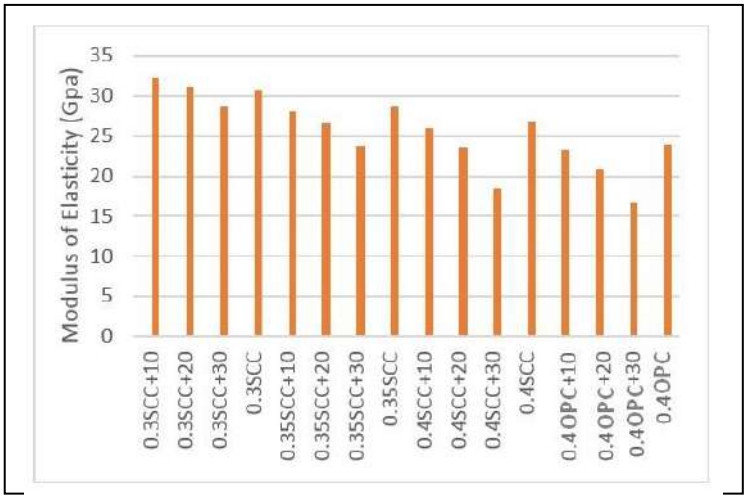

Fig. 5: Modulus of Elasticity of the concrete specimens at the age of 28 days.

In [Fig. 6(b)] it can be seen that the maximum amount of shrinkage is about 560 micro strains and it's for the control specimen with *w/c=0.35* and similar to the previous statements, the more lightweight aggregate is added to the mixes, the more shrinkage decreases. The 30% *LECA* content specimen had a longitudinal increase of 150 micro-strains, during the first 4 days and in the end, not only shrinkage has been completely eliminated as at the age of 28 days, but also 50 micro-strains of longitudinal increase has been observed.

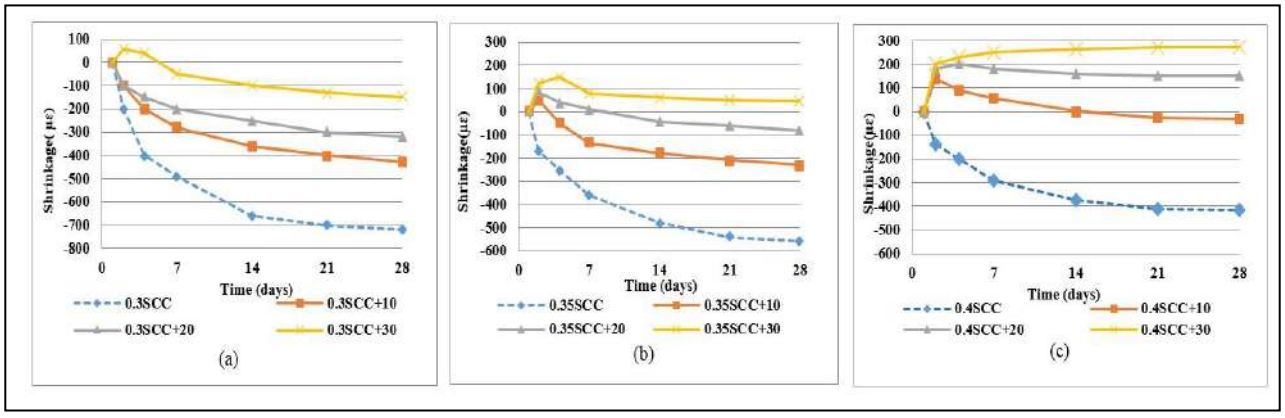

Fig. 6: Shrinkage strain variation for specimens with different ratio of w/c.

Twenty-four hour water absorption results are shown in [Fig. 7]. According to this, water absorption in specimens with *w/c=0.3*, was less than the other specimens which is due to denser structure of hydrated cement paste in low water to cement ratios and less permeability of the specimens.

Also, replacing *LECA* in the specimens with the water to cement ratio of less than 0.4, has a more positive effect on water absorption decrease. In lower water to cement ratios, hardened cement paste faces lack of water and self-desiccation occur due to hydration reactions. Therefore, the lower the *w/c* ratio gets, the more internal curing seems to be necessary and its positive impacts on the concrete features take over its negative ones. Normal concrete specimens show more water absorption than the *SCC* in *w/c=0.4*. Actually, *SCC* shows less permeability due to its more compact micro structure. Also, in *w/c=0.4*, replacing 20% and 30% sand with *LECA* had a negative effect on concrete permeability. Normal concrete seems more sensitive to this because of its lower volume of cement paste.

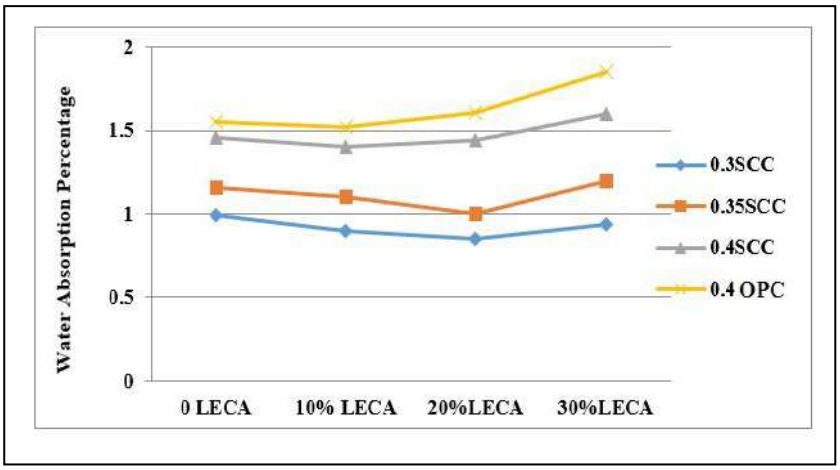

Fig. 7: The water absorption of concrete specimens.

The depth of chloride ion penetration in all of the specimens after 28 days of being in *NaCl* water solution, has been measured and illustrated in [Fig. 8]. According to this figure, in lower ratios of water to cement, the depth of chloride ion penetration was also less which shows denser micro structure of hardened cement paste and its less permeability due to discrete internal pore network in concrete body.

Among all of the specimens with *w/c=0.3*, the 20% *LECA* content seems to have the minimum amount of penetration depth. Control specimen has the maximum amount of penetration depth with about 6mm of infiltration. The results represent the positive effect of internal curing on decreasing the permeability in this w/c ratio. In *w/c=0.35*, the specimen with 10% *LECA* content had the minimum amount of chloride penetration depth and the maximum amount goes to the specimen with 30% *LECA* content.

In *SCC* specimens with *w/c= 0.4*, 10% *LECA* content specimen has the minimum penetration depth of 8mm and the 30% *LECA* content has the maximum amount of 12*mm*. Although the general trend of the changes in normal concrete is similar to *SCC*, they have higher amounts of infiltration due to their more porous micro structure.

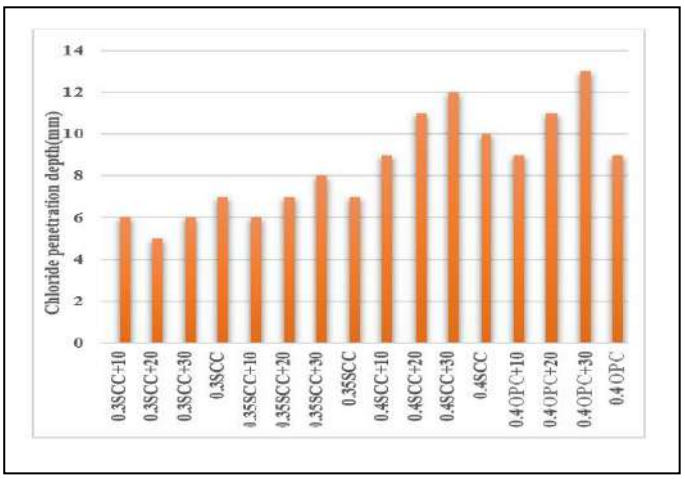

Fig. 8: Chloride penetration depth after 28 days.

Electrical resistivity of the specimens has been measured at 7, 28 and 60 days in order to evaluate the quality of internal pore network of concrete and investigate of the internal curing effect. In w/c=0.3 ratio [Fig. 9(a)], specimens with LECA have been observed to have less amount of electrical resistivity at 7 days compared to the control specimen. This trend has changed at 28 days in a way that, the 20% LECA content specimen had the maximum amount of electrical resistivity while the control specimen was the least resistant of all. This trend kept on at 60 days but the amount got larger. While studying the electrical resistivity diagram, in w/c=0.35 [Fig. 9(b)], control specimen had the maximum amount of electrical resistivity at 7 days. At the age of 60 days, the specimen which contains 20% LECA showed 25% increase in electrical resistivity compared to the control specimen. After that, there are 10% and 30% LECA content specimens which had an increase of 14% and 4% respectively compared to the control specimen. As the water to cement ratio rises, electrical resistivity decreases gradually which is because of the porosity increase (as the saturated and semi- saturated internal pore network gets more and also more continuous and the electrons can move easier inside pore electrolyte liquid) and the permeability of cement paste

increases as a result. Thus, less amount of electrical resistivity can be seen for the specimens with w/c=0.4 [Fig. 9(c)], than the ones with w/c=0.3 and w/c=0.35 ratios.

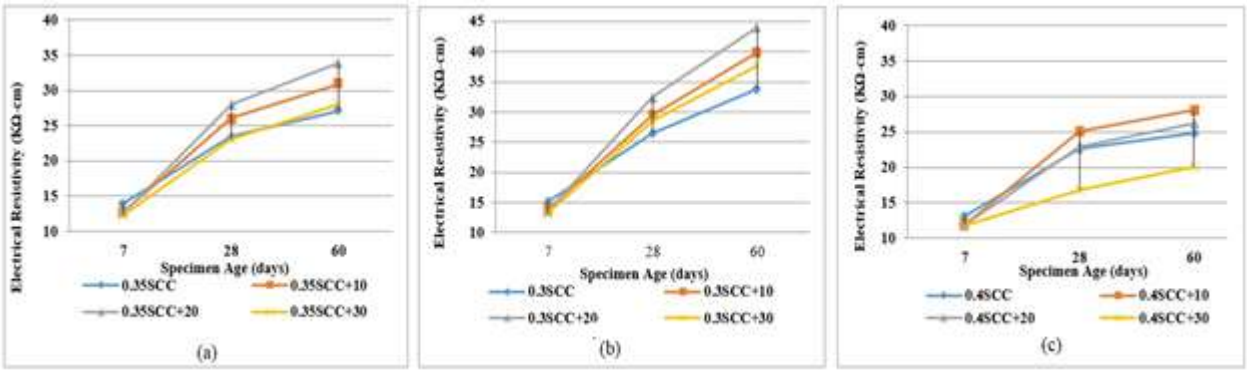

Fig. 9: Electrical resistivity of concrete specimens.

CONCLUSION

In addition to decreasing shrinkage, internal curing of concrete by hydration of unhydrated cement particles can have a positive effect on the mechanical properties of concrete. On the other hand, replacing too much of lightweight aggregate with sand, can result in a reduction in mechanical properties. So, it is necessary to determine the optimal proportions of lightweight aggregate replacement in the mix design by measuring absorption features of the aggregates. The gained results represent positive impact of internal curing on decreasing permeability of concrete elements. Based on the obtained results, the following can be concluded:

-Internal curing had different effects on the mechanical properties, modulus of elasticity and permeability of the concrete depended on the amount of lightweight content and the water to cement ratio. These effects are depended on the curing duration as the short-term effect is negative but the long-term effect shows a total positive trend.

-Internal curing decreased the permeability of the concrete specimens.
-As the permeability of the specimens decrease, electrical resistivity of the specimens increase, especially in low water to cement ratios mixtures.
-Internal curing was more effective on *SCC* than *OPC* concrete in all aspects of concrete volume changes, permeability and mechanical properties.

CONFLICT OF INTEREST
Authors declare no conflict of interest.

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ARTICLE

A STATE-OF-THE-ART STUDY ON MULTIPLIERS: ADVANCEMENT AND COMPARISON

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ABSTRACT

In modern era digital signal processor are the crucial components of the communication system setup. The essential part of the digital signal processors are multipliers, which helps to control the communication speed and also plays key role in other various applications such as Image Processing. Real time multimedia applications necessitate high speed computations. The key arithmetic operation i.e. Multiplication process depletes most of the time and hardware resources of a processor among all the arithmetic operations. Therefore, it necessitates a fast multiplier to be designed for enhancing the system performance. Procedure such as multiply, accumulate and inner products are the frequently used computation intensive arithmetic functions. These functions are applied to process many computations such as Fast Fourier Transform (FFT), filtering and convolution. These multiplications based calculations determines the instruction cycle time of the most algorithms and dominates the execution time of the digital signal processor. Currently, high speed processing devices are one of the primary demands which developed the necessity of higher throughput operational devices. Hence fast, reliable and efficient multiplier design is essential. Also the multipliers are more power consuming devices. As the portable, battery operated systems are the necessity nowadays due to the mobility, the power consumption is one of the major design constraints. Though multiplier is also a complex circuit designed device and consumes greater area. Therefore, it is imperative to design compact and efficient multipliers with less power dissipation. Again, the multiplier performs multiplication operation on unsigned numbers only. Thus, modern computer requires a committed and rapid multiplier unit, which can operate both types of numbers i.e. signed and unsigned. This paper presents a comprehensive study on different multipliers specifically, Array multiplier, Booth multiplier, Modified booth multiplier, Wallace tree multiplier, Modified Booth-Wallace tree multiplier and Vedic multiplier based on their operational procedures and working principals along with the advantages and limitations. A comparative analysis is also takes place on various performance parameters of these multipliers such as speed, area, power utilization and circuit complexity.

KEY WORDS
Array multiplier, Modified booth multiplier, Wallace tree multiplier , modified Booth-Wallace tree, Vedic multiplier

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INTRODUCTION

Nowadays, digital signal processing (DSP) systems are essential to improve the quality of digital signals and one of the major components used in DSP systems are multipliers. As reflected, multipliers contributed for the multiplication process. Since it contains a large amount of computation, therefore high speed and greater efficiency are highly required. There are several approaches such as decrease the delay time, lessen the number of partial products, reduce the processing time of accumulation of the partial products, decrease the number of stages to enhance the overall speed of the computation, which directly improves the efficiency of the device along with to advance the multiplication performance [1], it is also essential to take care off some important factors such as compactness, consumption of power speed, area, regularity of layout etc. Every multiplier has worked on a set of defined instructions: Algorithm. There are various algorithms such as Add & Shift, Booth algorithm, Modified booth algorithm, Wallace tree algorithm, Basic hardware algorithm etc. This paper presents the comprehensive study, analysis and comparison of several multipliers such as Array multiplier, Booth multiplier, Modified Booth multiplier, Wallace multiplier, modified booth Wallace multiplier and Vedic multiplier, on the basis of Power, Speed and Area.

ARRAY MULTIPLIER

Array multiplier is a regular shaped multiplier based on “add & shift” algorithm. This algorithm follows standard ‘add and shift’ operation for computation. Multiplicands are multiplied to get the partial products and in each turn, a single bit of multiplier is shifted as per their bit order and finally added at the last stage. Here the number of partial products and multiplier bits are same; hence the number of components and computation stages increases. Due to this, Array multipliers are large in size and having more delay time along with the power consumption, which make them less efficient and complex structured multipliers [2] [3].

Array multiplier’s working procedure is discussed with an appropriate example of 4-bit array multiplier as follows:

Assume two 4-bit data for the multiplication are ‘A3 A2 A1 A0’ and ‘B3 B2 B1 B0’. The process of multiplication is shown in [Fig.1].

4x4 array multiplier needs16 AND gates, 4 half adders and 8 full adders. It requires 12 addresses. In general ‘mxn’ array multiplier requires the product of ‘m and ‘n’ of AND gates, ‘n’ numbers of half adders, product of ‘(m-2)’ and ‘n’ full adders and product of ‘(m-1)’ and ‘n’ addresses to complete the operation. The schematic illustration of 4x4 array multiplier is shown in [Fig. 2].

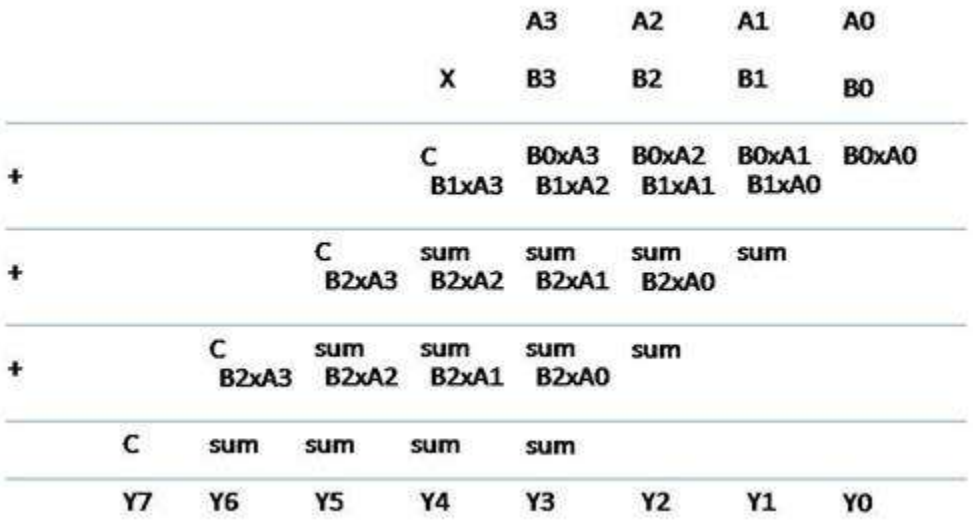

Fig.1: Array multiplication structure of two 4-bit data

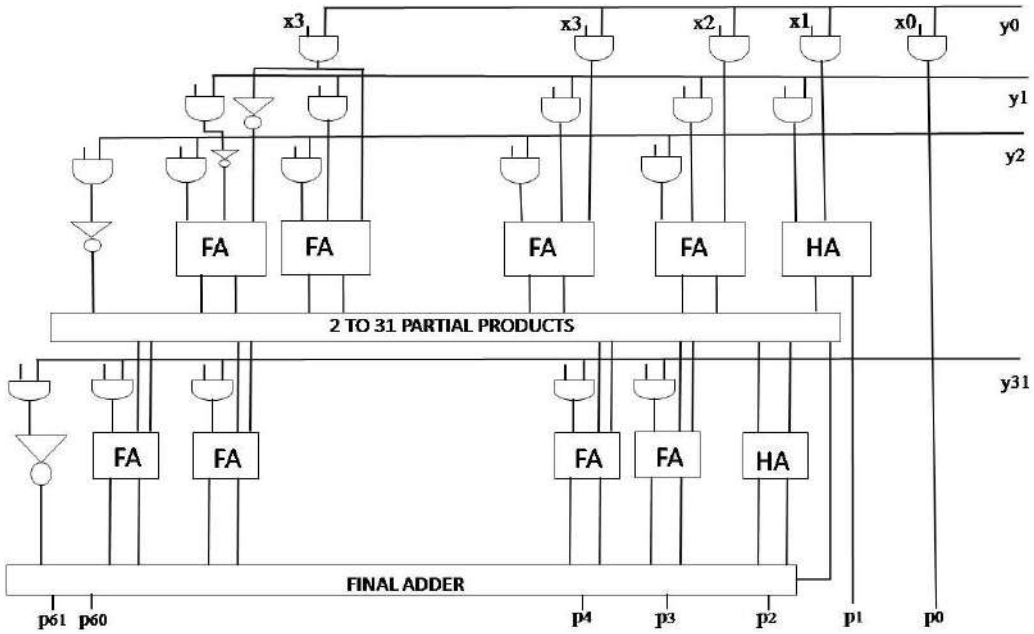

Fig. 2: 32-bit array multiplier [63]

This conventional architecture consumes much power and time. Also it is complex in structure due to more number of components is used to make it. Various architectures have presented to enhance the efficiency and response time. In the year of 1993, Min C Park et. al. proposed a new design using dual tree structure. Due to this dual tree structure technique, the multiplier processing speed is increased twice as compared to the conventional one. However, the silicon area increases by 30% [4]. It was also suggested by the researchers that the performance of the multiplier could be improved by using low power array multiplier techniques in terms of delay & power dissipation [5]. Junghwan Choi et. al. in 2000, minimize the power consumption of the array multiplier with the help of Partially Guarded computation technique by 44%. This technique also helps to reduce the delay and overhead area by 3% and 30-36% respectively. Several researchers contributed their works for the development of the Array multiplier, which has been coated in the following table [Table 1].

BOOTH MULTIPLIER

The deficiency with the Array multiplier is its execution speed. Therefore, a new multiplier named Booth multiplier is developed to improve the performance by reducing the number of iterations. This multiplier is worked on Booth algorithm, which was invented by Andrew Donald Booth in 1950 at Birkbeck College in Bloomsbury, London. In this multiplier three bits are scanned at the same time. Out of these three bits,

present pair is made, which includes two bits and the higher bit of an adjacent lower order pair belongs to the third bit. After examined these three bits, booth logic is used, which converts the triplets into a set of five control signals. These five control signals are then used to perform the operations and controlled by using adder cells [11] in the array. The operation procedure signed numbers by booth multiplier is shown below with the help of flowchart [Fig. 3]

Table 1: Summary of findings of array multiplier

Sl.No.	Author Name	Technique Used	Objectives	Advantages	Limitations
1	Joseph Whitehouse et. al. [6]	FinFET models with array multiplier topology and low power Predictive Technology Models (PTM)	To Investigate the static power and delay using low power Predictive Technology Models (PTM)	Enhanced static power reduction in delay and feature size	Further reduction in channel length haven't effect on significant change
2	Zhong-ye Yanga et. al. [7]	Pipeline Techniques	Analysis of time complexity of two's complement	Improvedspeed of systematic performance is approximately twice as compared to non-pipelined multiplication.	Serial adder must be needed
3	S.K. Sahoo et. al. [8]	Delay optimization inter connection	To enhance the operation speed	Less delay time up to 12 bit multiplication	Consume more time for higher bit multiplication
4	S.Srikanth et. al. [9]	Using multiplexers	To reduce the power consumption	Average reduction of power consumption, area and delay by 35.45%, 40.75% and 15.65% respectively	Notsuitable for high power and large area applications.
5	PriyankaSrivastava et. al. [10]	New hybrid adder	Low power and high speed array multiplier	Works on low power and less delay approximately by 24% and 56%	Suffer from voltage swing problem

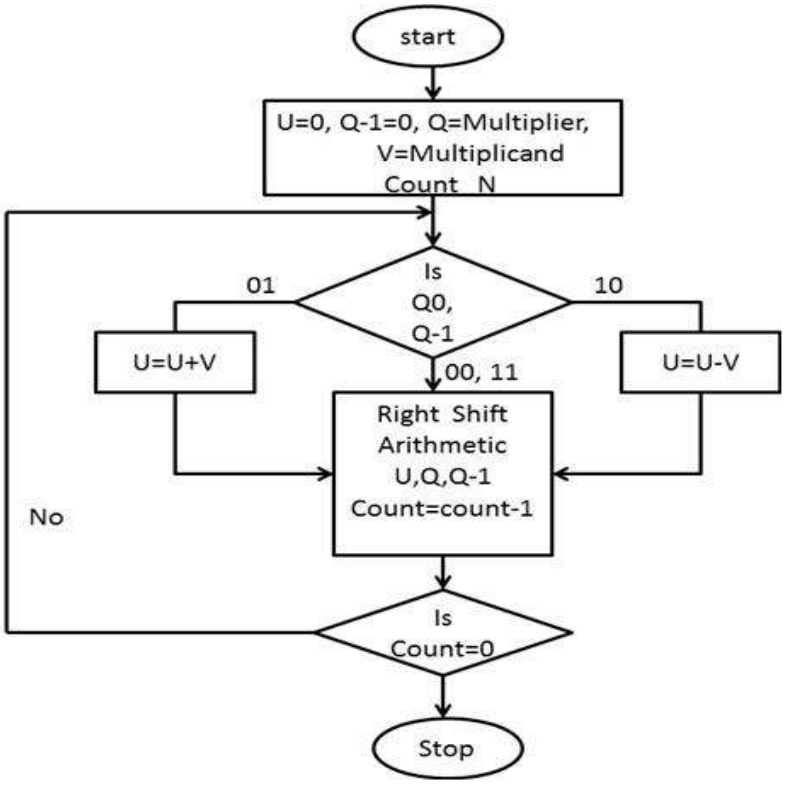

Fig.3: Flowchart of Booth Multiplication process

In the above flowchart, three conditions are applied for multiplication:
1) If Q0=0 and Q-1=1 then add V in U and perform the right shift.
2) If Q0=1 and Q-1=0 then add V, subtract U and perform the right shift.
3) If Q0= Q-1=0 or Q0=Q-1=1 then perform right shift only.

At first, this multiplier examined the two least significant bits with various conditions then performed the multiplication and repeated the same step up to 4 times. Then the sum of two partial products is accumulating, taking the product register as an accumulator. The power consumed of the multiplier is more due to the involvement of large number of adder cells to perform the multiplication operation with the help of this method. Therefore, efficiency is a crucial issue for this system.

Table 2: Summary of findings of booth multiplier

Sl.NO	Author Name	Technique Used	Objectives	Advantages	Limitations
1	Wen-QuanHe.et al. [12]	Probability and computer simulation (PACS).	To developed a high accuracy dynamic error-compensation circuit for fixed-width Booth multipliers	Highly accurate and area effective	Power consumption of proposed PACS multiplier is higher
2	A N Nagamani et. al. [13]	Garbage Cost and Ancillary inputs	To present a design for a Reversible Radix-4 Booth Multiplier for DSP application	The proposed design is capable of both signed and unsigned multiplication. Lower heat dissipation. The circuit area reduces by almost half.	High Quantum cost and delay
3	Daichi Okamoto et. al. [14]	Ring Oscillator	To make a Serial Booth Multiplier	High working frequency and low power consumption	Booth encoding is needed to reduce partial products
4	Rahul Shrestha et. al. [15]	Additional clock gating and resource sharing,	To present an area-efficient low-power architecture for configurable booth multiplier.	The proposed multiplier architecture requires 43.12% of lower area and consume 75.65% of less power as compared to previous one	Slight increase in latency
5	Jakia Sultana et. al. [16]	Reversible mode	To develop a design methodology for the realization of Booth's multiplier	Both signed and unsigned multiplications can be done	Need to examine this proposed logic on Redix-4 approach

MODIFIED BOOTH MULTIPLIER

To enhance the efficiency of the Booth multiplier, several modifications has done on it such as modified booth encoder and selector technique to rearrange and reduce partial products [17]. The booth encoder presents here, performs various steps simultaneously, therefore, the speed of the multiplier increases and due to this method the number of gate count reduces and hence the multiplier's performance is improved. It also uses modified radix4 booth algorithm, when the operands are greater than or equal to 16 bits. The area of the multiplier circuit is also get shortened by using this algorithm. In this algorithm the number of partial products, those are to be added is reduced by encoding 2's compliment. In this same algorithm, the multiplier bits are divided into 3 blocks and it is divided into 4 blocks, when radix8 algorithm is applied. These divided blocks are rearranged in such a way that each block overlaps the other by 1 bit. Also the computation time and the logarithm of the word length of operands are proportional to each other and due to this way the number of partial products reduces. The partial products are generated from the multiplied and encoded multiplier with the help of PPG (partial product generator). Then partial product reduction tree is used to add these partial products. Again the results are added using carry propagate adder (CPA). [Fig. 4] represents the block diagram of this process/multiplier.

From time to time several modifications have been done to improve the performance of this multiplier. At year 2000, Wen Chang Yehet.al. developed a design using a new developed booth encoding scheme (MBE) [18-19]and enhanced the speed of the multiplier up to 25%. At the same year Fayej Elguibaly [20] developed a parallel multiply accumulate hardware using the modified booth algorithm [19] which is three times quicker operator as compared to other standard parallel MAC units. Again at 2007, Zhou Shun et al. (2007) [21] designed a multi precision reconfigurable Radix -4 booth multiplier which can be cascaded to comply with the different input length which improved the performance in terms of delay & area. To increase the performance of FAM (fused add multiply) Kostas Tsoumanis et al. in the year of 2014 [22]

incorporated structured and efficient modified booth recording technique to reduce power consumption, hardware complexity and critical delay. Some of the progressive development of this multiplier is listed below in [Table 3].

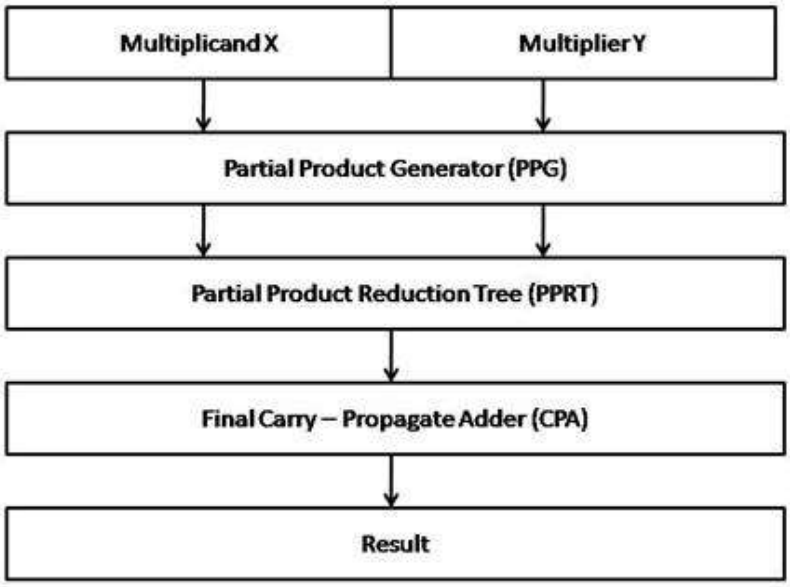

Fig. 4: Block diagram of Modified Booth multiplication process.

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Table 3: Summary of findings of modified booth multiplier

Sl.No.	Author Name	Technique used	Objectives	Advantages	Limitations
1	Kei-Yong Khoo et. al. [23]	Modified Booth encoding Algorithm	Improved booth encoding for low power multipliers	Reduce the power dissipation	Unit delay of canonic signed digit is more in proposed multiplier
2	Ravindra P Rajput et. al. [24]	Modified booth encoding (MBE) technique	To design a signed-unsigned Modified Booth Encoding (SUMBE) multiplier	Less hardware and chip area reduces the overall cost and also power dissipation	Low speed due to more number of partial products
3	Babu M. Pranay SrivatsavaJandhyala [25]	Booth encoder and booth decoder	A new architecture design is proposed for an accuracy configurable modified Booth multiplier (ACMBM) with two types of approximate adders, which or can be configured in terms of error during run time	Delay reduction achieved of 15.3% and 15.8% for type I and type II adder. Again power is decreased by 5% in type I and increased by 2% in type II	Error configuration depends on the approximate adders working at adding operation on partial products
4.		2's complement and 1's complement representation	To design efficient 1's Complement Modified Booth multiplier	This multiplier is efficient than modulo 2(power n) -1 modified booth multiplier.	Aarea and power complexity
5	Bipinlikhar MsSakshi [27]	Modified booth algorithm, carry select adder, ripple carry adder	To propose an efficient technique to find 2's compliment for generation of regular partial products	Reduced power modified booth encoding (MBE) multipliers with less occupied area	To reduce the amount of delay a Carry select adder is required

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WALLACE TREE MULTIPLIER

Statics show that 70% of instructions and algorithm performs addition and multiplication in microprocessors [28-29]. Therefore the important challenge is to establish a highly quick multiplier for shortening the entire operation time period. In 1964 C. S. Wallace proposed fast parallel multiplying scheme to reduce the partial products/ intermediate steps, which in turns introduced Wallace multiplier. It is a hardware implementation for multiplying two binary numbers. In this multiplier, at first it generates set of bit by bit multiplications for each bit and assigned it with a particular weight. These weights maintain the track of binary digits corresponding to the obtained partial products. These partial products are now divided into set of rows, named reduction layers. The partial products having same weight are combined in a series of reduction layers as shown in [Fig. 5]. Thereafter, it is added with the help of full and half adders. Then the repetition of the process occurs until to get the two last rows. Finally, the final result is achieved with the help of Carry Look Ahead adder.

This multiplier requires many numbers of gates to operate, which make these multipliers bulky and slow. To overcome with this slow processing, Wallace multiplier configured with the parallel AND gates that make partial products simultaneously, which in turns helpful to reduce the execution time and enhance its speed.

In the year 1998, Moises E. Robinsonet.al. modified its design. He inserted counterat the first layer,to manage the reduction process and reduce the delay without increasing the structure complexity [30]. Again Ron S. Waters et. al. reduces the number of half adder and S. Rajaram et. al used parallel prefix adders to fix final adders, which decreased the delay. In 2014, Damarala Paradhasaradhi et al. [31] presented a new structure of Wallace multiplier based on square root carry select adder. In this design common Boolean logic is shared to remove the duplicate adder cells, hence decreases the number of gates which in turn reduced the delay and power consumption of the multiplier. These multipliers are highly used in 3-d computer graphics and high speed floating point processing.

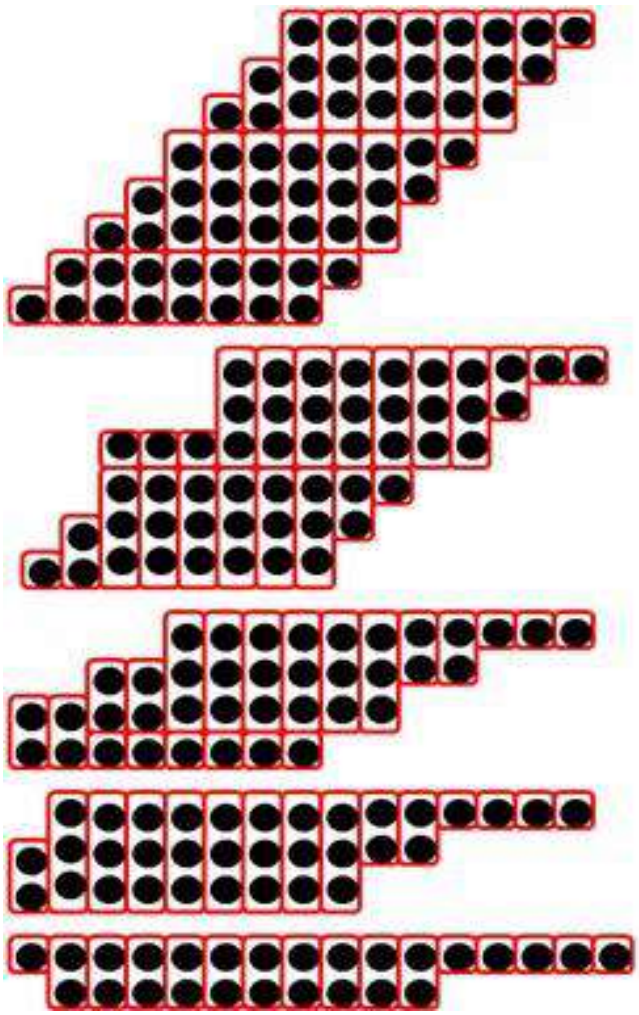

Fig. 5: Multiplication of 8-bit wallace tree

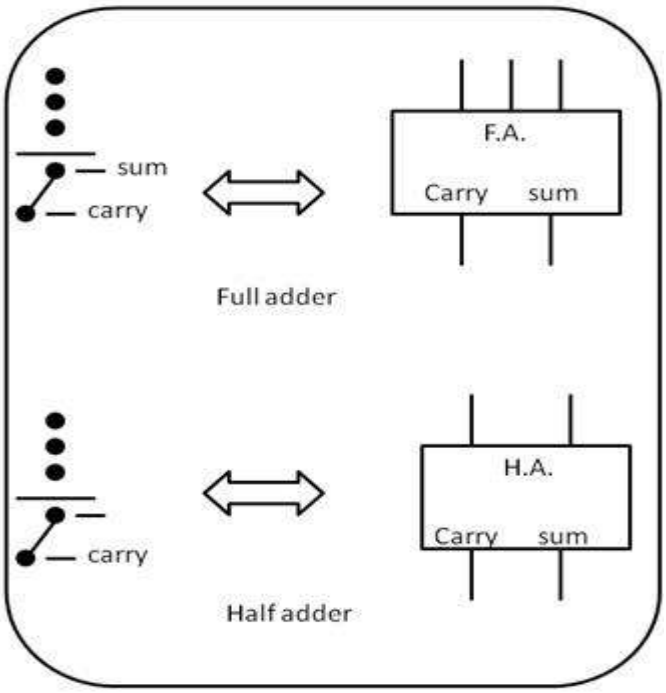

Fig. 6: Representation of half adder and fulladder

Table 4: Summary of findings of wallace tree multiplier

Sl.No.	Author Name	Technique Used	Objectives	Advantages	Limitations
1	Shahabaz Khan et. al. [32]	Energy Efficient CMOS based full adder	Reducing the intricacy of Wallace Multiplier	Reduced area and power.	No improvement in terms of delay as compared to the standard Wallace tree multiplier
2	ShahzadAsif et. al. [33]	algorithm uses high speed 7:3, 6:3, 5:3, and 4:3 counters	to construct the counter based Wallace tree multipliers for higher speed	Speed enhanced up to 22% as compared to the traditional Wallace multiplier	Not suitable for low speed applications
3	DamarlaParadhasaradhi et. al. [34]	Modified Square Root Carry Select-Adder (MCSLA), Square Root Carry Select Adder using RCA and Carry Select Adder (CSLA)	To proposed an area efficient Wallace tree multiplier	Reduction of delay and area	Delay enhances
4	R. BalaSaiKesava et. al. [35]	Carry select adder(CSLA),Binary to excess one converter (BEC),Square root carry select adder(SQRTCSLA)	To established compact Wallace tree multiplier with the help of CSLA technique	CSLA based Wallace tree multiplier having BEC occupies Less area and memory. It also able to works on low power	CSLA based Wallace tree multiplier having BEC has higher delay than CSLA based Wallace tree multiplier without BEC
5	Kazuteru NAMBA and Hideo [36]	Bit-slice reconfiguration design	To design a Defect Tolerant Wallace Multiplier	Defects can be tolerated through this multiplier	Not applied to barrel shifter

MODIFIED BOOTH WALLACE MULTIPLIER

For larger multiplier such as 32-bit, the performance of Booth algorithm is limited. To overcome this problem, the Modified Booth Wallace multiplier introduced with the help of Wallace multiplier. It is a combination of both Booth and Wallace multiplier. This new designed multiplier contains four key components i.e. booth encoder, partial product generator, Wallace tree and carry look ahead adder [37]. Booth encoder is dedicated to the encoding of multiplier bits by using Radix-4 and Radix-8 algorithm. Then the partial products are produced with the help of multiplicand and encoded multiplier by the partial product generator. Thereafter the Wallace tree operates on these partial products (see section Wallace Tree multiplier). Finally, the result is achieved by the carry look ahead adder. This multiplier contributes to minimize the consumed power and circuitry area as compared to Booth and Wallace multiplier.

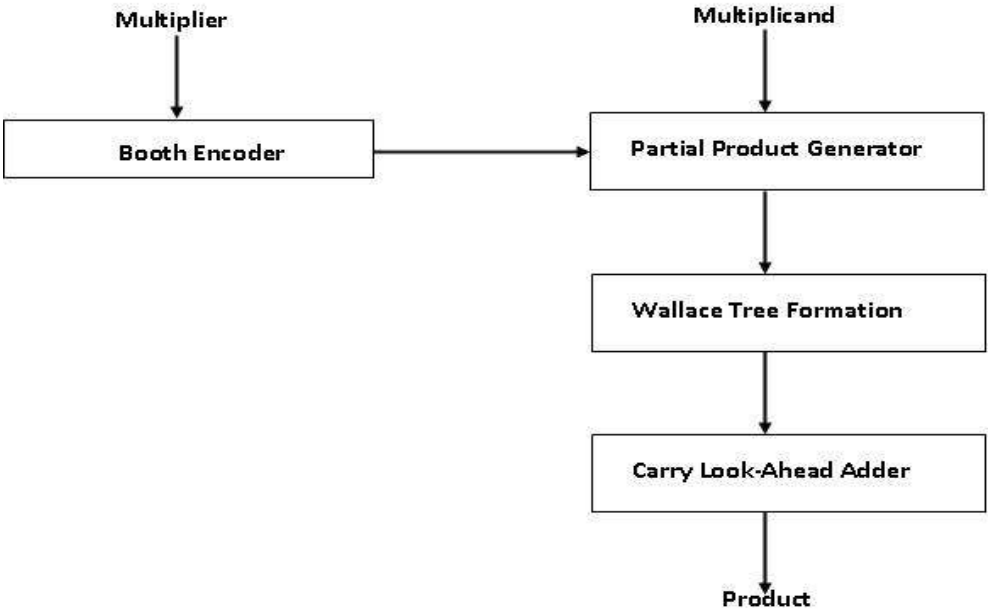

Fig 7: Block diagram of modified booth wallace tree multiplier [64]

In the year of 1993, Jalilfadaviardekani [38] developed a new architecture to optimized the partial product of booth encoded [11, 19] parallel multiplier. According to this, the inputs are encoded into booth equivalent and a Wallace tree [39] and then the partial product are added with the help of carry select adder. To reduce the delay, an algorithm was presented by M J liaoet al. [40] using portioning carry select adder. In this algorithm the carry select address are partitioned into the number of blocks. The algorithm reduces the delay of 9.125 with less than 1% overload. Also in the year of 2006, a parallel complex number multiplier was proposed by Rizalafandecheismail and Razaidi Hussin[41],based on Radix-4 modified booth algorithm and Wallace tree [40].Again M. Jagadeshwar Raoet. al. [42] proposed a new architecture of Wallace multiplier using booth recorder and compressor .This modified multiplier is 67% quicker than previous Wallace tree multiplier and 22% quicker than radix-8 booth multipliers. Recently a new structure of multiplier has developed [43], which divided the multiplier architecture into four different modules. This new multiplier consume less time for computation and also operation independent multiplier.

Table 5: Summary of findings of modified booth wallace multiplier

Sl.No.	Author Name	Technique Used	Objectives	Advantages	Limitations
1	M.-J. Liao et. al. [44]	Carry-select-adder partitioning algorithm	To enhance the performance of Booth-encoded Wallace-tree multiplier	The average delay and area overhead is reduced by 9.12% and 1% with the help of proposed algorithm for multipliers ranges from 16XI6-bit to 64x64-bit.	Power dissipation effects need to be realized
2	JalilFadavi-Ardekani [45]	Optimized Wallace Trees	To define and design the architecture of MxN bit Booth encoded parallel multiplier generator	Fast data paths are achieved using ASIC (standard cell based) designed multipliers	If the number of cells increases, then this will lead to increase in area
3	Rahul D Kshirsagar et. al. [46]	Pipelining	To introduce pipelining system for in-between nodes of the modules	Enhanced speed and computation.	Independent operation cannot be done in a given clock period

4	LiangyuQianet . al. [47]	Utilizing approximate modules in the Booth encoder	To design an approximate Wallace –booth approximate multiplier	Improved efficiency in terms of power consumption, delay and combined metrics	Moderate loss in accuracy
5	M Jagadeshwar Raoet. al. [48]	Booth algorithm, 5:2, 4:2, and 3:2 compressor adders	To reduce latency and power consumption of the Wallace tree multiplier	The proposed architecture is around 67% faster	No effect on power improvement

VEDIC MULTIPLIER

In the modern world the Vedic mathematics is based on 16 aphorisms and 12 corollaries. These formulations are selected from Atharva Ved by Swami Bharati Krishna Tirtha (1884-1960). Thereafter, the former Jagadguru Sankaracharya developed and presented the techniques to modify the principles in these selected sutras and sub-sutras. Among all of these sutras and sub-sutras, the Nikhilam Navatashcaramam Dashatah and Urdhva–Tiryagbhyam sutras are used for the multiplication purpose. These Vedic mathematic techniques when implemented for the multiplication, showed very good results in terms of saving computational time. Therefore it is concluded that the multiplier design integrated with Vedic mathematic techniques based upon "Urdhvatriyagbhyam" (vertical and cross wise algorithm) sutra [49] enhanced the speed of multiplication operation. The methodology for 4x4Vedic mathematics is given below to clarify the procedure:

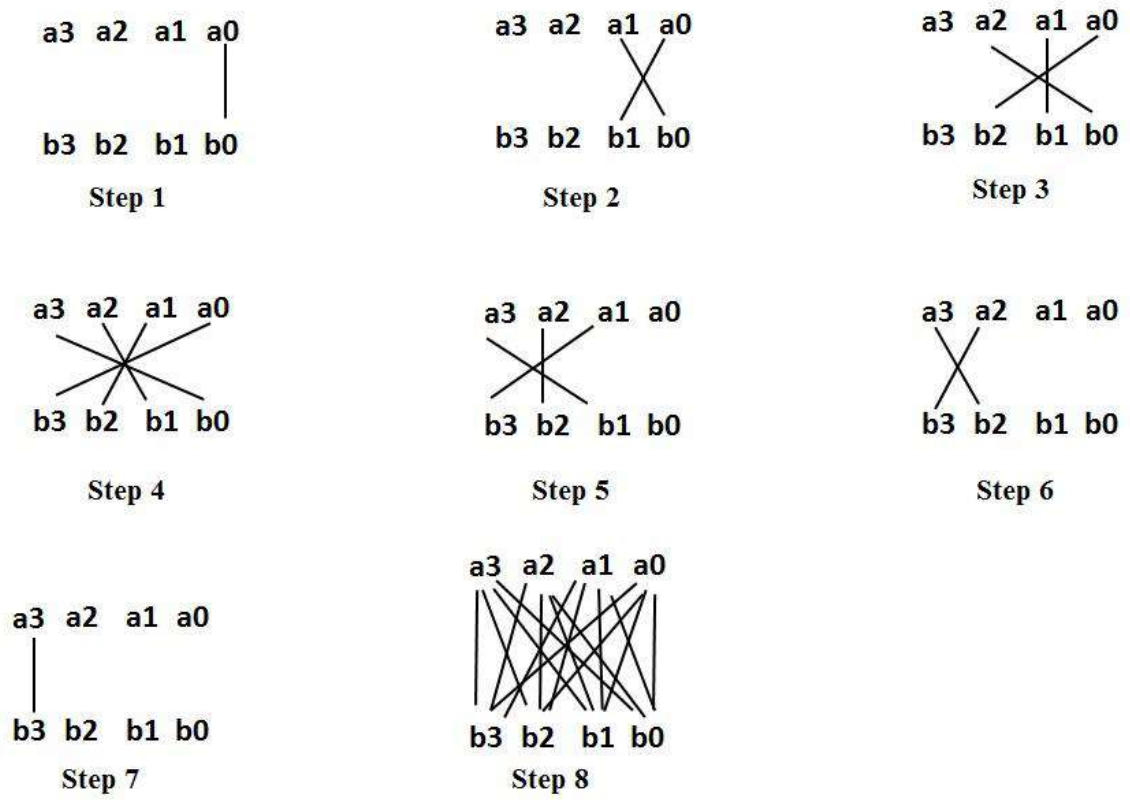

Fig. 8: steps of vedic multiplication.

Here, in the first row a3a2a1a0 represented the multiplicand bits row and multiplier bits are represented by b3b2b1b0 lies in a second row. At first in the step 1, the least significant bits having equal weights are added hence the addition of 0^{th}bits take place i.e., 'a0' and 'b0'. Then the cross adding are done as shown in steps 2, 3 and 4. Again the same process have done but from the most significant bits side as indicated in steps 5, 6 and 7. These whole processes (steps) are continuously repeated until the final output has come out.

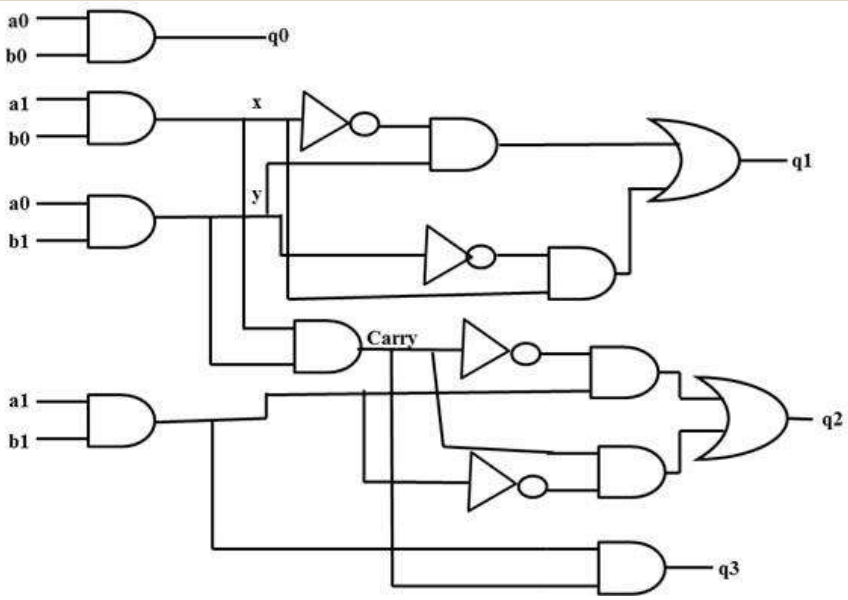

Fig. 9: Block diagram of 2x2 vedic multiplier

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The idea of implanting/using vedic mathematics as the key function of multipliers, attract the attention of all over the world due to its enhanced performance. In 2012, Vaijyanath Kunchigi et al. designed a pipeline architecture using Vedic mathematics. This proposed architecture consists of 3 stages:-

1st stage consist of 4 bits Vedic multiplier units,2nd stage is for the parallel products reduction and the 3rd stage is the addition of those parallel products .This projected multiplier shows high performance in the area of speed and power consumption as compared to other multipliers (Array multiplier, Booth multiplier etc.). Also this same architecture could be functional for larger word length input such as 16 bit, 32 bit, 64 bit etc. multiplier. In 2013, using another Vedic sutra named modified Nikmilamsutra Pavan Kumaret. al. [50] implemented a multiplier with the help of parallel shifter. This new modified Vedic multiplier enhanced the speed highly by reducing the delay up to 45% as compared to the Array and Booth or conventional Vedic multiplier. Thereafter R. Anganaet. al. [51] proposed and developed a new architecture of Vedic multiplier by combining it with the Kogge Stone adder [52], a parallel prefix form of carry look ahead adder. This new architecture provides one of the fastest multiplier. Again to minimize the consumed power, another architecture was proposed by Hardik Sangani et.al.[53]. This architecture is based on Vedic multiplication and adiabatic logic .They proposed a Vedic multiplier build-up on differential cascade pre-resolve adiabatic logic (DCPAL) and reduces the amount of consumed power by 57% and 68.5%, as compared to the conventionally designed Vedic and Array multiplier on traditional CMOS respectively. In the later years, various researchers are continuously working to enhance the performance of the device using vedic multipliers along with other techniques embedded in it. R. Katreepalli et. al. [54] introduced a new design of vedic multiplier which is more efficient in terms of power, delay and area using adaptable manchester carry chain adder. G. V. Nikhil et. al. [55] also proposed same by using kogge-stone adder and reversible logic gates. To enhance the speed of the vedic multiplier D. K. B. Kahar et. al. [56] implemented a new algorithm in the year 2017. At the same year ancient India Vedic mathematic is used to optimized the multithread for long digit multiplier [57] and the vedic multiplier is used to develop a processor for single-path delay feedback pipeline FFT which is highly-speedy [58].

Table 6: Summary of findings of vedic multiplier

Sl.No.	Author Name	Technique Used	Objectives	Advantages	Limitations
1	G.Challa Ram et. al. [59]	Vedic mathematics	To design a high speed Vedic multiplier	Provide minimum delay for multiplication for all numbers	Requirement of BEC(binary to excess code converter) is necessary for utilized memory reduction
2	EktaMasurkar PravinDakhole[60]	Urdhvatriyagbhyam sutra, Adiabatic logic	To optimize vedic multiplier design in terms of high speed and low power useing vedic sutra UrdhvaTriyagbhyam	Low power consumption	Requirement of Adiabatic logic is necessary
3	Ms. G. R. Gokhale et. al.	Carry select adder	To design an efficient multiplier	Requires less area	Delay is more

	[61]		in terms of area and delay		
4	Kunjpriya Morghade PravinDakhole [62]	Build-in self-test (BIST) Technique	To design and implement 4-bit Vedic multiplier along with build-in self-test (BIST)technique for testing multiplier circuit	More efficient Algorithm	
5	K Pranav et. al. [63]	Urdhvatriyagbhyam Sutra	To perform linear convolution	Enhanced speed	Pipelining is needed

All of these discussed multipliers are using efficiently as per the application requirements. From the discussion above a table [Table 7] is shown below to represent the comparison among the multipliers by taking into the account of some very important parameters such as: time delay, power consumption, circuit complexity and area required for simple understanding.

Table 7: comparison table

Multiplier	Speed	Area	Power consumption
Array	Low	Small	Most
Booth	Low but better than Array	Small	Less than Array
modified booth	High	Medium	Less
wallace tree	Higher	Larger	More
modified booth Wallace	Highest	Largest	More
Vedic	Higher than Wallace tree	Larger than Wallace tree	More than Wallace tree

CONCLUSION

To enhance the performance of the modern communication setup, multipliers with higher efficiency are extremely required. Fast multipliers improved the speed of computation, which also increases the performance of the other digital applications such as image processing. The main parameters which need to be take care off in case of multipliers are delayed time, power consumption, circuitry complexity and area requirement.

All the multipliers discussed above are efficient in terms of these all performance parameters. Out of all, the array multiplier is the simplest due to its simple circuitry, which leads to less space usage. Although, this multiplier suffers with low speed and maximum power consumption. The fastest multiplier among all is the modified booth Wallace tree multiplier by taking the advantages of both multipliers: modified booth multiplier and Wallace multiplier. In this multiplier the number of partial products is minimized to either half or one by third of the number of multipliers bit by using radix 4 algorithm and radix-8 algorithms respectively. The Wallace tree multiplier, where the overall speed of the accumulation increases due to using carry save adder (CSA) has occupies the largest area. Here by minimizing the number of partial products and examine more than one partial products at the same time, the speed is further enhanced and these techniques also make the system more accurate. One of the fastest and less power consuming multiplier is Vedic multipliers, which is based on the vedic mathematical formulations. It is proved by several researchers that the vedic multiplier reduces the delay time and power consumption by approximately 45% and 57% as compared to the array multiplier.

CONFLICT OF INTEREST
None

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None

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REVIEW

LOCATION BASED PROTOCOLS IN WSN: A REVIEW

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ABSTRACT

Nowadays, wireless sensor network (WSN) technology is one of the fast emerging and growing technology due to its several features such as easy installation, low maintenance requirements, self-organizing capability and a wide range of applications. The nodes used to form a network, adjust themselves according to the temperature and having good processing capabilities. These developments have led to many designed protocols, which are accountable for maintaining the routes and to confirm trustworthy 9communication with low power consumption. In this paper, the location-based routing protocols have been studied, investigated and compared.

KEY WORDS
Wireless Sensor Network (WSN), sensor node, location based routing protocols

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INTRODUCTION

The Wireless Sensor Network is built of nodes, which are connected to one or several sensor nodes which have sensing, computation and wireless communication capabilities [1,2]. These nodes are distributed all over the monitored area and associated with a base station, which regulates the path of the transmitted information. In1950's, WSNs were first in use when US navy established it for the detection of the Soviet submarine. In present days, these networks are used to determine various physical parameters such as temperature, pressure, sound, etc.

Each node is assembled with a radio transceiver associated with an antenna; a microcontroller based electronic circuit for interfacing the sensors and energy sources, usually batteries or an embedded form of energy harvesting [1]. The sensors collect information from the events occurring around it, process the gathered information and then transmit it to other sensor nodes or the base station. A sensor node can also receive information. Thus a network is created [2]. The modern WSNs are bi-directional in nature and are capable of controlling the sensing activities. Low power consumption, ability to cope up with failures, mobility, scalability and capability to withstand in unfavorable environmental conditions are the other attracting key features of WSNs [3].

Since the recharging of nodes is not feasible, therefore energy saving is an important issue in Wireless sensor network design. Also, nodes must possess self-organizing ability due to its highly distributing behavior [4]. The sensor nodes used in unfavorable conditions, such as environmental changes, often result in higher energy consumption and reduces performance of the sensor network. Therefore, to compensate for the higher consumption and to maintain the efficiency of the wireless network, certain mechanisms are used while designing the sensor networks, i.e, a robust routing protocol. There is no standard or single solution protocol. These may have different memory resources, strategies and complexities. The choice of the routing protocol is a very important task so that it fulfills the requirements of the network and performs all the necessary tasks of the network [5].

The main constraint in WSNs routing is mainly due to the lack of infrastructure, the unreliability of wireless links, failure of sensor nodes and strict energy saving requirements [1].As resources are extremely limited in wireless sensor networks, hence it is important to use them efficiently. The main objective is to make the routing protocols in such a way that it maximizes the lifetime of the network without sacrificing quality of service [6].

There are various approaches for making the protocols that consider the sensor resources. Initially, protocols were focused on the sensor energy resources only but nowadays they also consider the sensing resources [7]. The proposed major routing protocols for WSNs are divided into seven categories, Location based routing protocols are one of them.

Location based routing is established on the location of node [8], which defines the address of each node. These protocols exploit the position information to convey the signal. The data transmission consumes more energy; therefore energy conservation is one of the most important challenges for this routing. To estimate the energy consumption, all the routing protocols should evaluate the distance among two specific nodes, which is determined by the strength of the incoming signal. In this routing, the inactive nodes sleep to save the energy. Location information enables the networks to select the best route for the reduction of consumed energy and optimizes the entire network [9].

Since sensors are spatially deployed all over the region [6], different techniques are used to find location of the node, such as anchor based or anchor free, centralized or distributed, GPS based or GPS free, fine grained or coarse grained, stationary or mobile sensor nodes, and range based or range free [10], along

with various algorithms such as flooding restriction scheme, virtual area partition or position computation scheme, distance estimation, best routing choice scheme [8,9]etc.

The basis of location based protocols is the localization of sensor nodes for determining the node location using special algorithm because without the idea of geographical position of nodes the data and information communication would be useless. The simplest method for localization of nodes is by using GPS. But this method cannot be used if there are a large number of nodes in a network as it becomes very expensive. The proposed algorithms are however application specific or are not suitable for wide range localization. The geometrical placement or the position of the nodes in WSNs is estimated through the communication of localized and unlocalized nodes, i.e, through distance and angle between the nodes such as Lateration, Multilateration, Angulation, Triangulation etc. [10].

This paper presents a study on different Location based protocol along with their advantages and drawbacks. A comparative study of different Location based protocols has also presented in the paper.

EXTENSIVE STUDY OF VARIOUS LOCATION BASED PROTOCOLS

Geographic adaptive fidelity (GAF)

Geographical adaptive fidelity is an energy aware routing protocol. It is based on energy consumption during the transmission and reception of data as well as during the idle time to maintain the level of fidelity. In GAF, the sensor field is divided into grid squares; each sensor uses its position information to associate with the other grids [8]. Nodes in the same grid are considered equivalent in terms of cost of packet routing [11]. The location information is provided by GPS or other location systems [8]. GAF consists of three stages. First, the route or the grid area has to be discovered, second, all the non-active nodes go to sleep and the active nodes indicate about their participating in routing in order to save the energy and finally the packet is transmitted to the destination. The sleeping or the inactive nodes adjust their sleeping time in order to maintain the routing fidelity. These nodes must wake up before the leaving time of the active nodes expires and one of them must become active [12].After the routing is over, all the nodes automatically go to sleep. GAF performs better than ad hoc routing protocol as far as latency and packet loss is concerned, thus enhances the lifetime of the network and save energy [9].

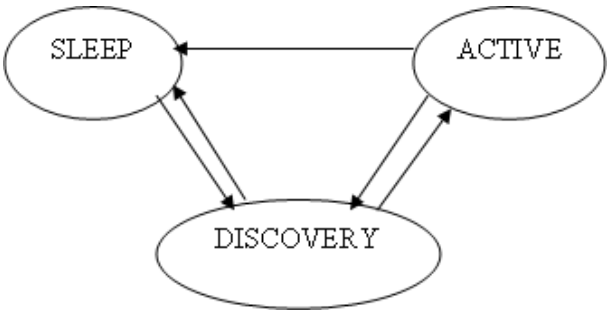

Fig. 1: State transition diagram

The [Fig. 1] represented the State Transition Diagram for GAF which consists of three states. Two states are the sleeping and active nodes. The third state is the discovery. In this state, a sensor exchange messages with other sensors within the same grid, i.e, it communicates with the other sensor nodes [8,11].

The GAF protocol turns off all the unnecessary nodes, which makes it energy efficient and it can be implemented for both mobile and non-mobile nodes. This protocol uses more number of nodes, hence it [Table 1], given below represents the various modifications in GAF protocols for better application.

Coordination of power saving with routing(SPAN)

Similar to GAF algorithm, SPAN technique also work on power conservation without compromising the capability, capacity or the connectivity of the nodes[18]. In this technique, a node is selected as a coordinator node from all the nodes in the network to participate in routing. Thus, it forms a backbone network which participates in actual routing, while the other nodes in the network turn off their radios to conserve energy[19]. To avoid congestion, the capacity and the backbone network formed by the awake nodes must be equal to the total capacity of the original network [20]. Load balancing is achieved by rotating the role of coordinator node among all the nodes in the network.

SPAN uses local information to know about neighboring nodes and elects the coordinators. Coordinators are elected in such a manner that every node is covered by its radio range. Unlike GAF, a node can be only in two states: coordinator and non-coordinator. A node participates in routing by considering two factors: the energy remaining in the node and the number of neighbors it can connect by using up its

battery life. This ensures maximum connectivity is achieved with least possible number of active nodes, thus maintaining the longer lifetime of the network [19] and also confirms higher probability and a capacity preserving backbone. The nodes tend to consume approximately the same amount of energy. Using SPAN, the network lifetime is doubled without significant performance degradation [20].

Table 1: Various modifications in GAF protocol

Authors Name	Protocol Name	Objective	Advantages	Challenges/Issues (if any)
Vaibhav Soni et. al. [13]	honeycom virtual Grid(GAF- HEX)	To keep hoop count as low as possible so as to reduce the number of active nodes participating in routing of data packets	Energy efficiency and increased network lifetime. Lesser packet delay	Cannot achieve optimum energy usage
PayalWali et. al. [14]	Energy Efficient Geographic Adaptive Fidelity (EEGAF)	1)To enhance the discovery Stage 2)Reduce Energy consumption 3)Enhance Network lifetime.	1)Improved execution and superior efficiency in terms of dead nodes 2)Balance energy and QoS matrices like throughput and routing overhead.	Requires More Memory
Kun Wag et. al. [15]	McTPGF (Two-Phase Greedy Forwarding)	1)Modify the routing metric of TPGF 2)To enhanced performance on the end-to- end delay	Improved performance on the aspect of end-to-end Delay	Hop count increases
Jitender Grover et. al. [16]	Optimized GAF	1)To improve the discovery phase and reduce the energy used by nodes 2)Increase the Network Lifetime	Simplicity, energy efficient, lesser number of dead nodes, increased data transmission, increased throughput and decreased network routing Overhead	requires more memory
Amandeep Kaur et. al. [17]	Improved Optimized GAF	Improving the network lifetime	Increased energy efficiency, lesser number of dead nodes	

In this protocol the network life time with span is twice better than without span. It also preserves network connectivity for relatively long time. The major drawback of this protocol is its limited scalability. Quality of service (QoS) is also poor for this protocol. [Table 2], represents the various modifications in SPAN protocols.

Table 2: Various modifications in SPAN protocol

Authors Name	Protocol Name	Objective	Advantages	Challenges/Issues (if any)
Benjie Chen et. al. [20]	Energy efficient SPAN	To present a power saving technique for multi-hop and ad hoc wireless network which reduces the energy consumption without significantly diminishing the capacity or connectivity of network.	1)It improves the lifetime of the system. 2) Save significant energy 3) Latency reduced	Density increases
T. Manimek alai et. al. [21]	RA-SPAN (rate adaptive sustainable physical activity in neighborhoods)	To integrate the power saving algorithm of SPAN with dynamic switching of data rates	1) Reduced latency 2) Improved throughput 3) Enhanced packet delivery ratio 4) Reduction in end to end delay	Overhead increases

A. W. Awan et. al. [22]	1)Static mobility model 2)Dynamic mobility model	actor-actor coordination with the help of an efficient event tracking algorithms to target all the sensors	Reliable and efficient Communication with low energy consumption	Cannot work with dynamic clustering
Parminde R Kaur et. al. [23]	Nearest neighbor Node clustering algorithm	To proposed an algorithm based on cluster topology for synchronizing clocks of Sensors	1)Consume less energy 2)Improve synchronization accuracy	
Sachin Sharma [24]	Speed Aware Modified Span	To modify coordinator withdrawal procedure and add average speed of node as a condition for withdrawing	1)Higher Throughput 2)Less packet Loss 3)Latency Reduces	More energy consumption per received packet

Trajectory based forwarding (TBF)

In this method of routing, the packet is routed along a predefined curve. TBF is based on two mechanisms: - source based routing and Cartesian forwarding. In source based routing, route is directed by the source without proper identification of the intermediate nodes and in Cartesian forwarding, decisions taken by each node is greedy and is not based upon the distance between the source and the destination. It uses position instead of routing tables, but defines a single forwarding policy along a straight line[9]. Thus, the intermediate nodes are relieved of using and preserving huge forwarding data tables [8]. In TBF, the nodes must aware of their location relative to a coordinate system. Since the packet overhead increases with the path length, this routing uses one single forwarding policy to determine the next hop position that is the closest to the trajectory fixed by the source sensor[8]. If the positions of the nodes are known, the packet is transmitted to the neighbor node which is geographically nearest to the preferred trajectory. If the destination node is known, the mechanism followed is Cartesian forwarding and the trajectory of packet might be a line [25].Since the names of the forwarding sensors are not included in the given source route, therefore, the maintenance of route in TBF is unaffected by sensor mobility [8].

As it can be visualized from [Fig. 2], discovery, flooding, multipath routing and ad-hoc routing are the major applications of TBF. The main advantage of TBF is its flexibility, i.e, it can work over various positioning systems. It can be considered as a layer between global, ad hoc and local positioning services, and network management services [25]. The reliability and management capability of the network enhances by using TBF protocol. It also helps to secure the network perimeter but this protocol is highly overloaded, which makes it more time consuming. The several modifications done by the researchers for making TBF protocol more efficient is represented in [Table 3].

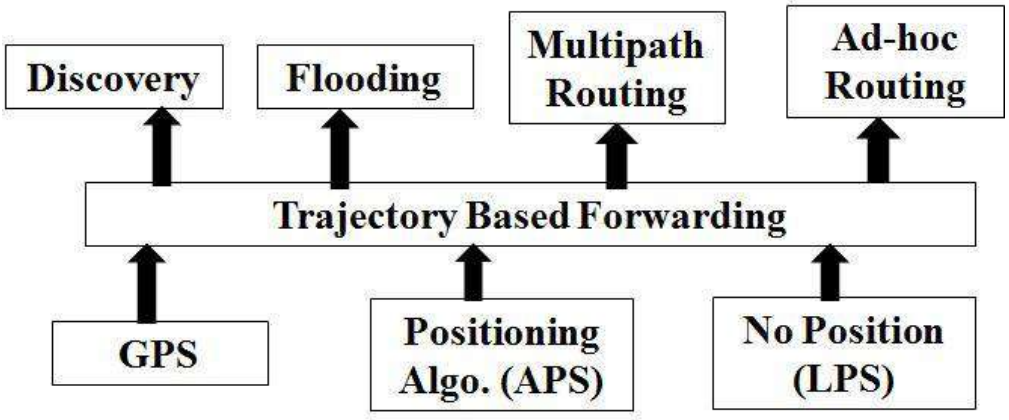

Fig. 2: TBF layer

Table 3: Various modifications in TBF protocol

Authors Name	Protocol Name	Objective	Advantages	Challenges/Issues (if any)
DragosNiculescu et. al. [25]	TBF (trajectory based forwarding)	To introduce the method of LPS i.e, local positioning system for finding the location of nodes.	Very useful at the times when GPS is not available	Extra computation or communication is required
Chi-En Chan et. al. [26]	TFNP (trajectory based data forwarding with future neighbor prediction)	To extract the future neighbors and its characteristics for forwarding data so that the path would be created according to the sequence in which efficiency is high.	1)More efficient as Data forwarding 2)More accurate 3)Enhanced delivery performance	The server must has accurate trajectory information else there may be delay
Maocai Fu et. al. [27]	TMODF (trajectory based multi objective optimal data forwarding)	To develop a multi- objective optimal data forwarding methodology.	1) Delay reduction 2)Accuracy in data forwarding due to network disruptions and fast topological changes.	Cannot work under the multi object framework
JaehoonJeong et. al. [28]	TSF (trajectory based statistical forwarding)	To investigate the efficient utilization of packet destination vehicle trajectories	It creates an efficient infrastructure which reduces or minimizes the delay in delivery of packets.	Cannot account the partial deployment of stationary nodes

Geographic and energy aware routing(GEAR)

GEAR is an energy efficient protocol which has proposed for routing queries to target regions in a sensor field. The nodes are equipped with the specific hardware such as GPS unit so that the current position is identified by them. The sensors are also aware of their residual energy as well as the location and the residual energy of the neighbors. It uses energy aware mechanism, based on geographical information to select sensors for routing the packets [6]. The packets are spread within the target region towards destination, instead of a particular node, using recursive geographic forwarding scheme. In this scheme, once the packet reaches the target region, the packet is divided among all the nodes. This causes flooding in the target region. So to avoid flooding, the packets send to recursively small sub divisions [29].

The main objective is to limit the region so that the consumption of energy is reduced and improved the network lifetime [30]. It also increases the connectivity of the nodes by dividing the whole region into partitions or subdivisions [29]. The main disadvantage with this protocol is its limited mobility and scalability. [Table 4], shows the various modifications in GEAR protocols.

Table 4: Various modifications in GEAR protocol

Authors Name	Protocol Name	Objective	Advantages	Challenges /Issues (if any)
Bo Tang et. al. [31]	Centralized clustering geographic energy aware routing (GEAR- CC)	Balancing the energy consumption among all nodes in the scope of the global network and find the best route based on global information of the network	Greater energy efficiency and increased network Lifetime	Tradeoff between energy cost and node's residual power
M.A. Koulali et. al. [32]	QoS-Geographic energy aware routing	QoS routing issue is considered taking into account constraint to bandwidth and delay	1)Avoid to link with scarce bandwidth 2)Improved packet delivery Ratio	Lesser sensor mobility
Guodong Wang et. al. [33]	Energy Aware Geographic Routing algorithm (EGR)	1)Balance the energy consumption during perimeter routing 2)Improved the lifetime of the network	Increased Network lifetime and data delivery Rate	It has been assumed that a the nodes are of two-Dimensional type and all of them are aware of their Position through some type of position mechanism

Mohamed Younis et. al. [34]		network clustering and assigns a less- energy- constrained gateway node that acts as a centralized network manager	Good performance in terms of Network lifetime, throughput and end-to-end Delay	Mobility, network clustering approaches, inter-cluster interaction, operations, and handling of sensor or Gateway failure.
rinda Gupta et. al. [35]	Improved version of the Energy Aware Distributed unequal Clustering Protocol (EADUC)	To improve the working of EADUC,by electing cluster heads considering number of nodes in the neighborhood in addition to the location of base station and residual energy	Increased Network lifetime and effective energy Balancing	

Bounded Voronoi Greedy Forwarding(BVGF)

BVGF is also a localized protocol algorithm which makes greedy decisions based on multi hop neighbor localization. BVGF chooses the next hop neighbor which is nearest to the destination among all the nodes. If two or more nodes are at the same distance from the destination, the source node randomly chooses any one node to be the next hop [18]. This algorithm is based on the concept of Voronoi diagram [Fig. 3]. In Voronoi diagram, the sensor nodes are aware of their geographical positions. In this routing, a packet is forwarded by sensors to their neighbor through the shortest distance from the destination. Sensors, whose Voronoi regions are traversed by the segment line joining source and destination, are selected to act as the next hops. In this protocol, every sensor is allowed only one next hop for forwarding its data, thus the propagation path between source and sink is always involved the same chain of next hope. Due to this identical selection, sensors are severely suffered from battery power depletion. Hence energy consumption is more and considered as one of the demerits of BVGF protocols [8]. The [Table 5] below represents the several modifications in BVGF protocols.

Geographic Random Forwarding(GeRaF)

GeRaF was presented by Zorzi and Rao. In this protocol the root node collect data from outlying nodes directly through a spanning tree. Here the sensor acts like a relay which is not known a priori by a sender and uses geographic routing. The message forwarded by the sender has no surety that it will always be able to reach to the destination node i.e. sink, hence GeRaF is known as best-effort forwarding [40].

GeRaF is a combination of two algorithms, one of them is geographical routing algorithm whereas the other is an awake- sleep scheduling algorithm, due to which sensors are not required to keep track of the locations of their neighbors and their awake-sleep schedules. A source sensor when senses the data, which is to be forwarded to the sink, it first assured that the channel is not preoccupied to prevent the collisions. For the definite period of time if the sensor remains unoccupied, a request-to-send (RTS) message is broadcasted by the source sensor to all of its active neighbors. The message includes location of both the source and the sink. After the RTS message is received by active neighboring sensor, based on locations of itself and the sink, they determine their priorities. The source sensor waits for a CTS (clear to send) message from one of the highest priority region. If no CTS message is received by the source then the highest priority region is considered to be empty. Hence, it sends out another RTS polling sensors in the second highest priority region. This series of action continues till the CTS message is received by the sensor. When the relay sensor found the source, sends its data packet to the selected relay sensor, which replied back with an acknowledgement frame (ACK).The relay sensor will act in the similar manner as the source sensor in order to find the second relay sensor. This process is repeated till the sink receives the sensed data packet emerged by the source sensor.

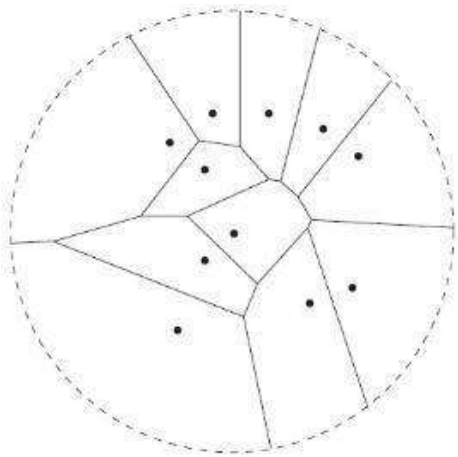

Fig. 3: A Voronoi diagram of 11 points in the Euclidean plane

Table 5: Various modifications in BVGF protocol

Author's Name	Protocol Name	Objective	Advantages	Challenges/Issues (if any)
Xiaoqing Li et. al. [36]	GRTR	To proposes a geo casting routing based target region(GRTR) to make match road topology in VANET	1)Enhance success rate 2)Reduce flooding	Cannot work effectively inside the region
Habib M. Ammari et. al. [37]	Energy-Aware-Voronoi-diagram-based data forwarding (EVEN)	To propose a sensor deployment strategy based on energy heterogeneity so that all the sensors drain their energy simultaneously	3) Improvement in the network lifetime	Cannot work in three-dimensional WSNs
Kuan Zhang et. al. [38]	VSLP	To enhance the efficiency of packet forwarding and shield the receiver's position	1) Improved the packet delivery ratio 2) Reduce the average packet delay	
Ivan Stojmenovic et. al. [39]	VD-GREEDY and CH-MFR	To propose an algorithm, which forwarded the message to exactly those selected neighbors which may be the best choices for destination	1)Flooding ratio reduces 2)Success rate improved	Cannot efficiently manage the inside region

The main advantage of this protocol is to consume less energy due to its association with awake- asleep schedules of nodes. The sensors are also virtually stateless and don't create the multi hop overhead. On the other hand, it requires more time to achieved efficient output and the involvement of user. [Table 6], below shows the modifications in GeRaF protocols.

Table 6: Various modifications in GeRaF protocol

Author's Name	Protocol Name	Objective	Advantages	Challenges/Issues (if any)
Bin Zhao et. al. [41]	Harbinger	To proposes and analyzes a new cross- layer protocol for ad hoc and sensor networks that unifies the concepts of Geographic Random Forwarding (GeRaF)	1)The nodes in HARBINGER combine transmissions thereby achieving an additional time-diversity benefit. 2)Almost same delay and energy efficiency is achieved by lower density of active nodes	
ZurinaMohd Hanapi et. al. [42]	Dynamic windows implicit geographic forwarding (DWSIGF)	To analysis the impact of black hole and Sybil attacks on the DWSIGF	1)Provide superior protection against black hole/selective forwarding and Sybil attacks 2)high packet delivery ratio	Not much effective, when there is no attack
Andrea Odorizzi et. al. [43]	M-GERAF	To propose a novel data dissemination protocol form multi sink wireless sensor networks	1)Fixed overhead 2)The amount of transmission and the sensor density are uncorrelated	Not effective, when node is mobile
G.Pradeebaa et. al. [44]	Energy saving via opportunistic routing (ENS_OR) and geographic random forwarding algorithm (GeRaF)	1)To reduce the energy during routing 2)To enhance the network lifetime	Reduction in used energy and increase the network lifetime	

Liping Wang et. al. [45]	Cooperative-Random Progress Forwarding (C-RPF) and Cooperative-Nearest with Forward Progress (C-NFP).	To propose a cooperative geographic routing (cGeorouting)for wireless mesh networks	1)Achieved higher average transport capacity 2)Gain enhancement with transmitted SNR	Cannot evaluate the effect of interference

Minimum Energy Communication Network(MECN)

MECN i.e. minimum energy communication network is a location-based protocol. It uses mobile sensors to find and maintain a path which consumes less amount of energy so that the communication network could work efficiently. It takes minimum power from the sensor to the sink node and makes minimum power topology for each other [30].

This protocol transfers the packets of data in two stages. An enclosure graph is made which contains local computation in the nodes and optimal link in terms of energy in the first stage. In the second stage data is transferred using minimum energy with the help of a link which is generated using Bellmen Ford Shortest Path Algorithm [9]. As it is a self- reconfiguring protocol, therefore it suffers from a severe problem of battery depletion in static network [8].

This protocol uses less number of nodes and maintains high connectivity. The major advantage is its self-reconfiguring ability, thus this protocol adapts with the node failure. However it cannot be implemented for mobile nodes and due to the requirement of large sub-network, it is complex in structure.

Small Minimum Energy Communication Network (SMECN)

SMECN protocol was proposed against MECN, in an improved form. In this protocol a minimal graph is characterized with respect to the minimum energy property [8].This property shows a minimum energy efficient path between any pair of sensors, associated with a network. This energy efficient path consumes less energy, as compared to all other possible pairs between the selected sensors. In SMECN protocol, every sensor uses some initial power to broadcast a neighbor discovery message, through which sensor discover their immediate neighbors. Later the information is updated with the usage of power. The immediate neighbors of a given sensor are computed analytically and checked whether the sensors who replied belong to the subset or not. After that the information is communicated to the closest neighbor [46].

The energy consume by this protocol is less as compared to the MECN. Also it required less number of nodes due to the formation of small sub networks for working. Highly connected network and low maintenance cost are the other major benefits with this protocol. As any node in the network can transfer data to the other node, this protocol acknowledges all the possible obstacles in between any pair of node, which introduced more load upon the algorithm. [Table 7] summarize the modifications in MECN and SMECN protocols.

Table 7: Various modifications in MECN and SMECN protocols

Author's Name	Protocol Name	Objective	Advantages	Challenges/Issues (if any)
Ossama Younis et. al. [47]	HEED	To propose a novel distributed clustering approach for long-lived ad hoc sensor networks.	Prolongs network lifetime and the clusters it produces exhibit several appealing characteristics.	Only provided algorithms can work for building a two-level hierarchy
Chuan-Chi Weng et. al. [48]	MTEC	To reduce energy consumption and prolongs network lifetime in user-centric wireless networks.	1)Lower energy consumption 2)Higher network lifetime	Unavailability of a dynamically adjust MAC layer protocol and across-layer protocol to improve network throughput and energy consumption.
W. Chee-Wah Tan et. al. [49]	PMAR	To propose an on-demand routing protocol for choosing a route based on reduction in node battery power and total transmission power to reach the destination	1)Able to restrict control packet flooding during route discovery and pre-empt link breakages because of node mobility. 2)Enhanced network lifetime, number of data packets carried and reduce delay in mobile networks.	the speed and heading direction is not too accurate

Shusuke Takatsu et. al. [50]	Zigzag	To introduce a self-optimizing routing protocol Zigzag in virtual grid networks, which can transform any given inter-cell path to a shortest (or minimum-hop) one by repeatedly applying local updates on the path.	Only on local information are required to update the routers	
D. P. Dahnil et. al. [51]	Clustering protocols	To propose a clustering algorithm that considers node degree to form clusters	1)Minimum energy consumption 2)maintain intercluster connectivity	Not able to find the number of connected nodes in cluster heads

CONCLUSION

To monitor and control industrial equipments at emergency situation, network needs to be designed with optimized routing protocols to deliver the packets in unfavorable conditions through wireless sensor networks. Though introduction of sensors in network helps to create a reliable network but it has opened numerous challenges such as battery depletion, delays etc. Several innovative aspects are needed to be taken care off to establish an advance and efficient wireless and mobile electronic communication through wireless sensor network. From the several protocols of wireless sensor network, Location based protocol proven themselves as an energy efficient protocol, which in turns enhanced the network life time. These protocols work on the basis of position information and find their applications in a number of areas such as industry, home, military, automotive and commerce. In the above discussion, the usages, features and challenges of the several Location based protocol are addressed with their progressive advancement. A comparative analysis has also done with these various Location based protocols in terms of different characteristics shown in [Table 8].

Table 8: Comparison between all the protocols

	Mobility	Power Management	Network Lifetime	Scalability	Query Based	Multipath	Data Aggregation	Overhead
GAF	Limited	Limited	Good	Limited	No	No	No	Moderate
GEAR	Limited	Limited	Good	Limited	No	No	No	Moderate
MECN	Low	Low	Good	Low	No	No	No	High
SMECN	Low	Low	Good	Low	No	No	No	High
SPAN	Low	Limited	Good	Limited	No	No	Yes	High
TBF	Moderate	Limited	Good	Moderate	No	Yes	No	High
GeRaF	Low	Low	Good	Good	No	No	No	Limited
BVGF	Low	Limited	Good	Good	No	No	No	High

CONFLICT OF INTEREST
None

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FINANCIAL DISCLOSURE
None

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ARTICLE

EXPERIMENTAL LOAD ANALYSIS OF AODV, OLSR IN MANETS

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ABSTRACT

Routing Protocol selection is the major challenging task in any Adhoc network. In Mobile Adhoc Networks protocol selected should have best results in terms of various QoS (Quality of Service) parameters such as better throughput, better Packet Delivery Ratio, to minimize end to end delay, and to minimize energy requirement for data transmission from source to destination. In this work, AODV and OLSR routing protocols are compared for different number of nodes with different values of pause time of nodes .Different Scenarios with varying number of nodes have been generated and simulated using NS-2 simulator and further default energy model has been implemented for evaluating node energies. After regress simulation OLSR proved to be better in comparison to AODV in case of minimum end to end delay as route searching from routing table takes lesser time but memory overheads are larger in case of OLSR due to large number of routing tables.

KEY WORDS
Energy, AODV, OLSR, PDR, Throughput.

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INTRODUCTION

Due to fast progress of Wireless Communication Adhoc networks has become very popular during last two decades. A Mobile Adhoc network (MANET) is set of mobile nodes without any infrastructure. It does not have any central controller. Each node in a MANET is free to move in any direction. For communication of information inside the network there is a requirement to define a protocol or some set of rules /regulations in order to communicate effectively from source to destination. In MANETS these protocols has been categorized into reactive, proactive and hybrid routing protocols. Proactive routing protocols are those in which each node maintains routing table entries. OLSR (Optimized Link State Routing Protocol) [1,2] come under this proactive category. Reactive routing protocols search route on demand basis. AODV (Ad hoc On Demand Distance Vector) routing protocol come in this category. In this paper, we have compared AODV and OLSR routing protocols for different QoS parameters.

Another important feature of MANETS is that independent nodes have very limited battery power. So this is the major thrust area of researches to further optimize QoS parameters of the network. With the above discussion it has been found that power of nodes is limited and if an overloaded node comes down then whole network collapses .In this work energy required to transmit data from source to destination is compared for varying number of nodes for both AODV [3] and OLSR.

Further in this paper, scalability factor of MANET routing protocols has been exemplified. The network should be scalable also i.e. for ready to use for large as well as small network. Simulation results show that OLSR is better scalable as compared to AODV. Section II discusses about routing protocols in MANETS. Section III gives illustrative scenarios. Section IV gives simulation results, discussions and conclusions.

ROUTING IN MANETS

Based on the topology of the network routing protocol has been broadly divided into proactive, reactive and hybrid routing protocols as shown in [Fig.1].

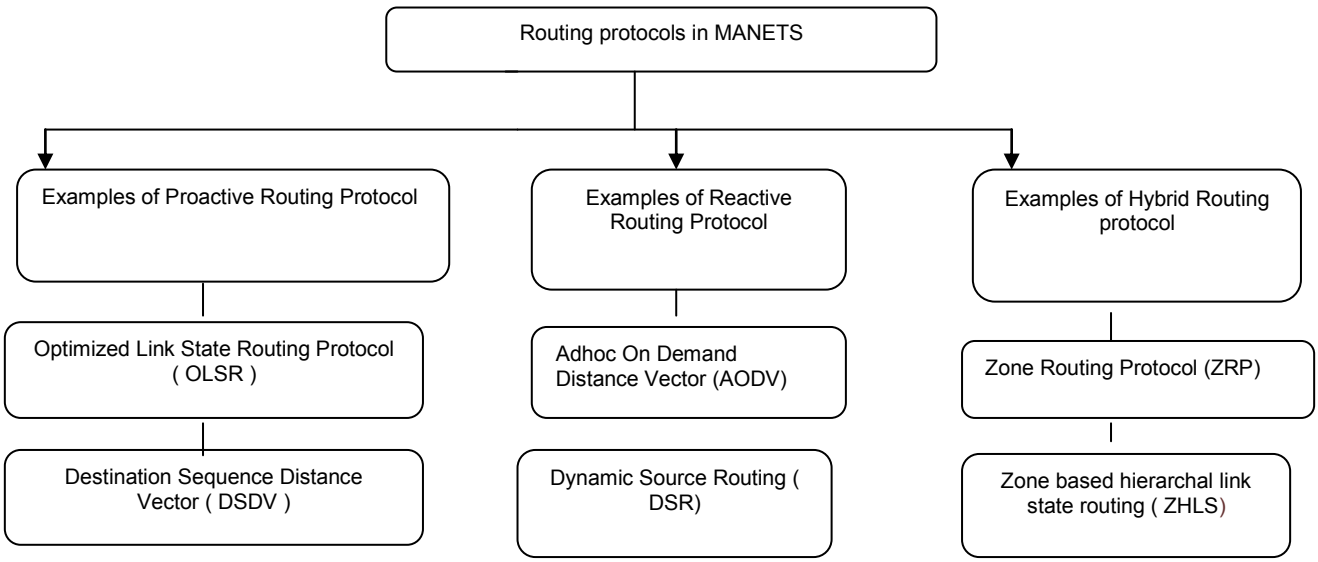

Fig. 1: Classification of routing protocols in MANETS

Proactive Routing protocols: In these routing protocols each node maintains a routing table. If there is high mobility among nodes then it requires large overhead to maintain the table. DSDV [4], OLSR are examples of proactive routing protocols.

DSDV (Destination Sequenced Distance Vector): It uses distance vector algorithm. It avoids loop problem by periodically sending routing updates [5]. Since each node uses a sequence number to tag itself. As topology of network changes frequently so a new sequence number is essential before network reconverge itself. So it is suited for small Adhoc networks with low mobility [6].

OLSR (Optimized Link State Routing Protocol): This protocol works well for large number of nodes with sporadic traffic. Instead of each node maintaining routing table, MPR (Multi Point Relays) are selected which maintains information for their 1-hop and 2-hop neighbors. Hello Messages and TC (Topology Control) [7] messages are used to control the transmission.

Reactive Routing protocols: In this category route is searched after receiving route request to forward data. There is no maintenance of routing at each node as in AODV [8].DSR, AODV [9-10] are most popular examples of reactive routing protocols.

DSR (Dynamic Source Routing): This protocol initiates a request from source which is passed to neighboring nodes and then each node adds itself to the address till destination is reached. After reaching at the destination complete address is passed to source and a route is established. As source node sends data packet to destination in which complete route is there in packet header so it is called source initiated routing.

AODV (Ad hoc on demand distance vector routing protocol): In DSR each packet carry complete information of intermediate routes whereas in AODV packets carry only the address of destination node. AODV [11] route replies carry only destination IP address and its sequence number. AODV is suitable for dynamic environment but as the network grows extra delay is introduced in the network [12].

Hybrid Routing Protocol: It combines the benefits of both table driven and Reactive routing protocols. In ZRP (Zone Routing Protocol) [13] inside radius of zone it maintains table entries just like proactive while outside the zone reactive protocol is adopted.

Associativity based Routing: proposed by C.K.Toh [14], he preferred stable link over transient links. If link exists for a threshold time period it is considered to be stable. This threshold time is given as Tth = (2* r)/s where r is the radio range of node and s is the relative speed of two nodes. This proposed scheme considers that after threshold time devices will be together for long duration but that is not practically possible.

Signal Stability Adaptive Routing (SSA): It tries to differentiate between strongly connected links with weak links [15]. A link is stable if it remains active for some specific time duration. This approach eliminates the use of weak link as that link is having more signal fluctuation.
Route lifetime Associativity based routing (RABR): This approach finds the time when received signal falls below threshold value [16]. It only considers movement pattern of nodes but does not consider various losses involved with wireless such as fading, path loss etc.

WORKING METHOD OF AODV, OLSR

AODV does not maintain routing table at every node. Route is searched when necessary. Routing table of AODV stores destination address, next hop address, destination sequence number and life time field. life time field is updated after every usage of route otherwise if route is not used this field expires. Route request RREQ packet is forwarded by source node which is acknowledged by RREP packet.

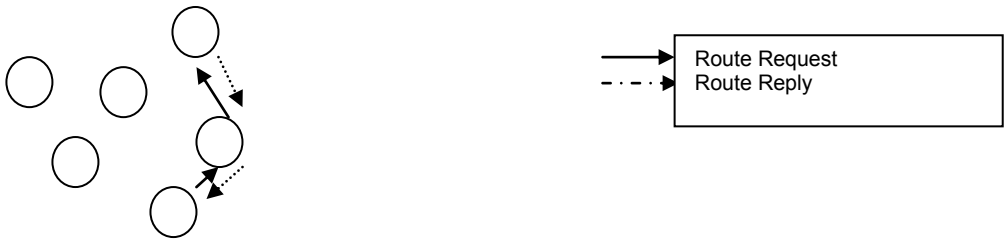

Fig. 2: Propagation of route request and route acknowledgement

In OLSR routing protocol MPR (Multi Point Relay) is responsible for data propagation among 1-hop and 2-hop neighbors.

EXPERIMENTAL ANALYSIS AND RESULTS OBTAINED

In this work, different scenarios files are generated for varying number of nodes for both OLSR, AODV routing protocols. Simulation Runs were conducted for 120 seconds to analyze the performance of both AODV and OLSR. Different scenarios were generated for pause time 2s as well as for 5s. Initial energy of each node is assumed to be 100 Joule. QoS parameters such as through put, PDR ,End to End delay and total energy spent in data transmission using default energy model were measured .Network parameters are listed below in [Table 1].

Table 1: Network parameters

Network Parameters	Values
Channel Type	Wireless Channel
Radio Propagation Model	Two Ray Ground
Mobility Model	Random Way Point
MAC Type	IEEE 802.11 a
Interface queue type	Drop Tail
Antenna Model	Omni directional
Agent	UDP
Application	CBR
Topology	Dynamic
Speed of nodes	0.01m/s
Maximum Packet in ifq	50
Number of nodes	20,30,50,70,100
Simulation area (X)	1000
Simulation area (Y)	1000
Simulation time	120 s
Initial Energy	100 J per node

Table 2: Comparative analysis of AODV, OLSR for 30 nodes

	Results for 30 Nodes (Pause Time=2 s)		Results for 30 Nodes (Pause Time=5 s)	
Parameter	**AODV**	**OLSR**	**AODV**	**OLSR**
Packet Delivery Ratio(PDR)	15.4464	15.898	25.4874	47.4708
Throughput (Kbps)	575.059	1074.1	1023.61	1548.18
Delay(s)	3.89662	1.97	1.97976	1.36733
Remaining Energy (J)	960.035	1192.0	1330.9	1359.42

[Table 2] suggests that PDR is much better in case of OLSR as we increase the value of pause time. OLSR is showing better results for different QoS parameters as better throughput, higher values of PDR, minimizing. End to End delay as shown in [Fig. 2] and energy spent is almost same for pause time 5 s.

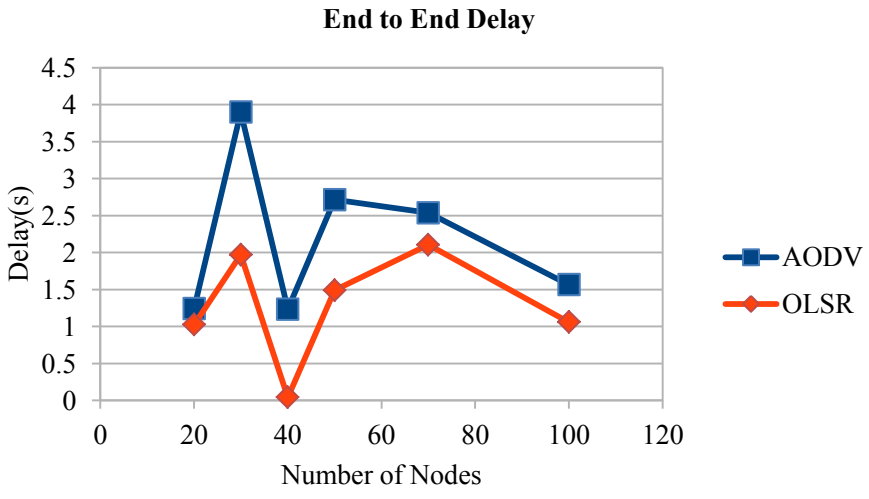

Fig. 2: End to End Delay (pause time=2 s)

Table 3: Comparative Analysis of AODV,OLSR for 50 nodes

Parameter	Results for 50 Nodes(Pause Time=2 s) AODV	OLSR	Results for 50 Nodes (Pause Time=5 s) AODV	OLSR
Packet Delivery Ratio(PDR)	18.7382	26.097	37.7005	44.8102
Throughput (Kbps)	775.975	1495.1	1496.31	1953.7
Delay(s)	12.7132	1.48816	2.18199	1.71962
Remaining Energy of Nodes(J)	2299.3	2495.68	1701.46	1842.49

[Table 3] suggests that PDR improves in case of OLSR as shown in [Fig. 3]. OLSR is showing better results for different QoS parameters as better throughput, higher values of PDR, minimizing End to End delay but energy spent is slightly more in case of OLSR.

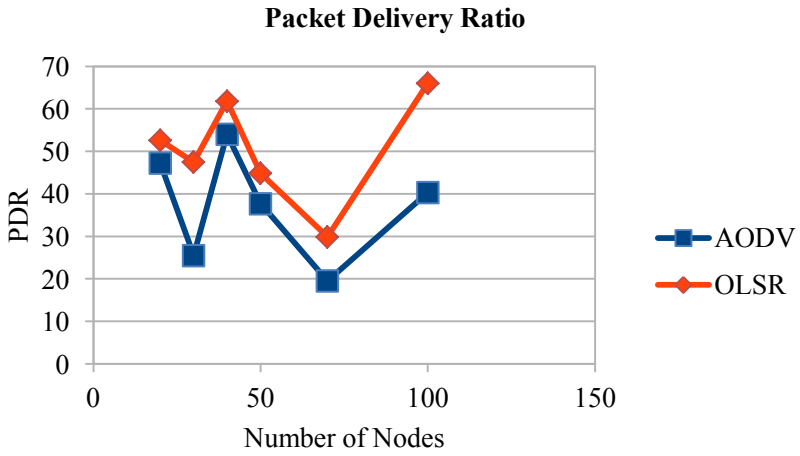

Fig. 3: Packet Delivery Ratio(pause time=5 s)

Table 4: Comparative Analysis of AODV,OLSR for 100 nodes

Parameter	Results for 100 Nodes(Pause Time=2 s) AODV	OLSR	Results for 100 Nodes(Pause Time=5 s) AODV	OLSR
Packet Delivery Ratio(PDR)	32.8541	57.614	40.2906	65.97
Throughput (Kbps)	1257.65	2877.5	1576.62	4710.3
Delay(s)	1.56513	1.0580	2.15506	1.4727
Remaining Energy(J)	3552.96	3739.4	2598.09	1707.4

As we increase scalability of the network as shown in [Table 4] , OLSR is still outperforming AODV with higher PDR, throughput, lesser end to end delay and energy consumption also reduces when we increase the number of nodes as shown in [Fig. 4].

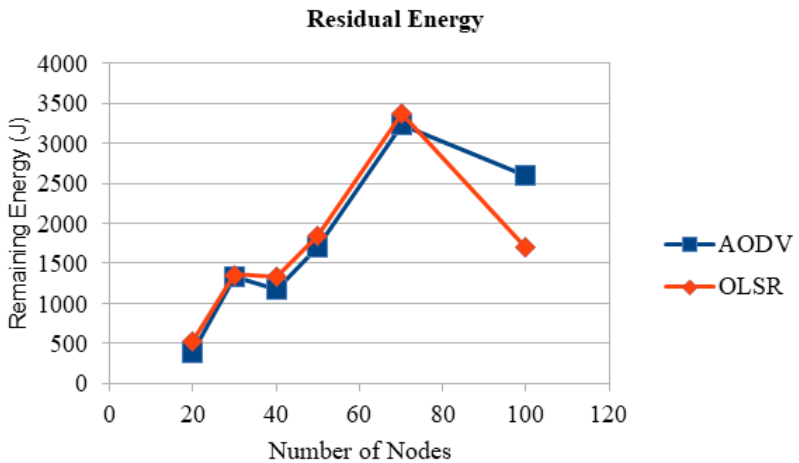

Fig. 4: Residual energy of Nodes (pause time=5 s)

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CONCLUSION AND FUTURE SCOPE

In this analysis it has been proved with the help of simulation results that OLSR outperforms AODV as it is more scalable, having always lesser end to end delay, showing better throughput, higher packet delivery ratio for different number of nodes. Searching takes lesser time as it is easier to search from routing table maintained by nodes. Energy spent by the nodes in case of OLSR can be further minimized by making it energy efficient link stable routing protocol.

CONFLICT OF INTEREST
None

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ARTICLE

METHOD FOR MODELING THE PARAMETERS OF THE INTERNAL COMBUSTION ENGINE

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ABSTRACT

This paper describes the modeling of internal combustion engines using mathematical models. Mathematical models were used for automated test of internal combustion engines (ICE) that allowed us to predict the behavior of the engine when control parameters have been changed. A description of the engine control rules implemented from a mathematical point of view. Rules are a set of restrictions on the type and location of the graph based on the values of the technological parameter from the time that is written in a mathematical form. The fixing of the possibility of these errors reduced the time spent on developing technologies and testing engines to improve the usability of automated test systems (ATS). To solve this problem, a method based on the use of nodal points was proposed. Its essence lies in the fact that the technologist does not work with the graphic images of control operations themselves, but with the nodal points of their conjugation. An algorithm for planning test technologies using this method is described. Using the method, the technologist specifies the technological parameters of engine that will be included in the newly developed test technology.

KEY WORDS
internal combustion engine, diagnostic, test, mathematical model.

INTRODUCTION

In the modern world the problems of saving fuel and energy resources become acute. Road transport consumes more than 30% of produced petroleum products [1], and fuel costs make up about 20% of the cost of any product.

The pollution of the environment is also an acute problem, and motor transport accounts for more than half of the harmful effects.

The development of modern engine is on the way to improving the economic, environmental and operational performance of engines [2]. This is primarily due to the use of electronic control systems – fuel injection and ignition control. It can significantly reduce the toxicity and energy consumption of vehicles.

In the process of car using, aging of its components and assemblies inevitably results in deterioration of its economic, ecological and effective indicators [3]. In this regard, in order to maintain the engine in good condition and to timely detect the deviation of parameters, leading to deterioration in the economic, environmental and effective performance of its work, the leading role belongs to the system of maintenance and repair, its scientific validity and excellence. At the same time, testing and diagnostics of engines is very important.

METHODS

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Due to the fact that the ICE has many technical states, in fact, in diagnosing, it is necessary to split this set into a finite number of recognizable classes of states, combining in each class states having the same physical nature [4]. For example, one class can include the state of the engine, characterized by defects in the components of the valve mechanism, the bearing units of the crankshaft and so on. This class of states is characterized not only by a single sign of the state, but also by a single method of diagnosis [5]. Based on the statistical analysis of the failures of the diagnostic object, standards for each class of technical states are formed (the values of the diagnostic parameters averaged for this class).

To create a system of diagnostic parameters and standards, diagnostic model of the object is used, in some cases facilitating the process of searching for informative parameters in the signal under investigation [6].

The final stage of the engine diagnostic system is the decision making subsystem, which estimates the technical state of the engine and its elements based on the values of the diagnostic parameters using different criteria.

The main tasks when creating a system of technical diagnostics are the choice of the diagnostic method and the developing of an algorithm for determining the technical state of engine.

The development of the method for diagnosing engines includes a group of sequential tasks: the description of the object of diagnosis by a minimum set of state parameters and diagnostic parameters; identification of diagnostic parameters most sensitive to common defects; separation of technical states into classes [7]. At the same time the tasks of measuring diagnostic parameters, ensuring the control ability of the diagnostic object are being solved.

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When developing engine diagnostic algorithms, the following approaches are applied [8]. The first is that the measured values of the parameters of the engine being diagnosed are immediately compared with the values of the same parameters measured earlier in the same engine [9]. As a result of the comparison, the deviations of the measured parameters are calculated, and all further diagnostic operations involving the appropriate mathematical models are performed with the indicated deviations.

The second approach is that the values of the parameters measured on the diagnosed engine are calculated with the help of a mathematical model of the values of other parameters not directly measurable that are compared with the values obtained previously for the same or similar models for the same engine model in the same mode, and on the basis of their analysis, diagnostic recommendations and decisions are made.

The development of the engine diagnostic system was carried out in accordance with the type of diagnosis to be performed: functional or test [10]. The system of functional diagnostics provides control over the running engine during its normal operation, evaluating it according to the diagnostic parameters [11]. In the case of a test diagnostics, the engine was subjected to artificial action to determine the operability of the assembly or part.

RESULTS AND DISCUSSIONS

As mentioned above, the program for managing technological parameters is a graph of the dependence of its value on time. This graph can be analytically described by a piecewise-defined function f(t).

Because of this, the description of rules for engine control is convenient to implement from a mathematical point of view [12]. Rules represent a number of restrictions imposed on the type and location of the graph of the dependence of the value of the technological parameter on time, which is convenient to write down in mathematical form [13].

A list of the grammatical rules of the graphic language for the description of engine testing technologies is formulated as follows:

1. The time is counted from zero to infinity, technological parameters can take only non-negative values that are not greater than some maximum allowable value and not less than some minimum allowable value:

$$D(f_i) = [0;+\infty) \quad (1)$$

where fi – function that describes the dependence of the value of the i-th technological parameter on time.

$$E(f_i) = [Y_{i\min}, Y_{i\max}], \quad (2)$$

where $Y_{i\min}$ – minimum allowed value of the i- th technological parameter,

$Y_{i\max}$ – maximum allowed value of the i-th technological parameter.

Thus, the graph of the i-th technological parameter lies in the first coordinate quarter, in the band bounded by the straight lines: $y = Y_{i\min}$ and $y = Y_{i\max}$.

2. All control programs must start at the zero point in time and end at the same time:

$$t_1 = t_2 = \ldots = t_N = 0, \quad (3)$$

where t_i – the start time of the control program of the i-th technological parameter,
N – number of technological parameters used in the test technology.

$$d_1 = d_2 = \ldots = d_N, \quad (4)$$

where d_i – duration of the control program of the i-th technological parameter.,
N – number of technological parameters used in the test technology.

3. Each time value t corresponds to a single value f(t):

$$\exists! f_i(t) \forall t \in D(f_i). \quad (5)$$

From the single-valued correspondence to each argument of only one value of the function it follows that the graph does not have "loops", ramifications and discontinuities.

4. The permissible rates of change in the values of technological parameters are related to the constructive features of the engine and are limited by physical laws:

$$\frac{df_i(t)}{dt} \geq A_{i_{re}} \; \forall t \in D(f_i), \tag{6}$$

where $A_{i_{re}}$ – maximum allowed rate of reduction of the i-th technological parameter.

$$\frac{df_i(t)}{dt} \leq A_{i_{incr}} \; \forall t \in D(f_i), \tag{7}$$

where $A_{i_{incr}}$ – maximum allowed speed of increase of the i-th technological parameter.

Rules are associated with the correct form of graphical figures of process control operations. So consider possible errors:

1. Disruption of the control operation figure of the technological operation [Fig. 1(a)].
2. Control operation figures with the opposite motion along the time axis [Fig. 1(b)].
3. Create two control operation figures for the same operation [Fig. 1(c)].
4. Branching of the control operation figure [Fig. 1(d)].

Error 1 is a gap in the continuous management of the process, which will lead to a malfunction of the system in the interval of the gap. Error 2 is the absence of physical meaning when the system is running, because the time movement is carried out in one direction. Errors 3 and 4 also lead to system failure due to ambiguous control, i.e. at the same time the same control parameter must have different values.

Removing the possibility of these errors will reduce the time spent on developing test technologies and improve the ergonomics of ATS.

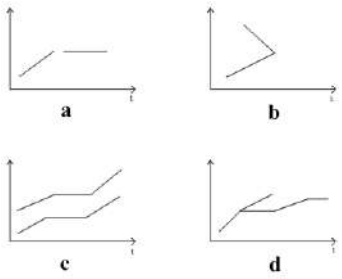

Fig. 1: Possible errors in the development of test technology.

Note that errors 1, 3, 4 arise when the figure of the technological operation is ruptured. Having eliminated the principal possibility of the appearance of a rupture of testing technology in the planning, one can get rid of errors of types 1, 3, 4.

To solve this problem, a method based on the use of nodal points was proposed. It is the fact that the technologist does not work with the graphic images of control operations themselves, but with the nodal points of their conjugation.

Adding a node to the graphic element actually means dividing it into two conjugate elements. Deleting a node means merging two adjacent elements into one. To uniquely define the control operation, it is sufficient to indicate the nodes of the corresponding graphic element. For convenience, the operation setting vectors are also linked to nodes. Thus, the process of setting the test modes is reduced to manipulating the nodes. Obviously, a technology test does not break in this case. This means that when using the node-point method, errors 1, 3, and 4 are fundamentally impossible. Error 2 is eliminated by introducing an additional rule for the movement of nodes: the abscissa of the node must always be not less than the abscissa of the left neighboring node and not greater than the abscissa of the right neighboring node. The [Fig. 2] shows the allowed interval for changing the time coordinate of the node (on the example of the technological parameter "shaft speed").

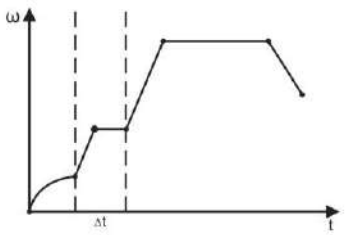

Fig. 2: The allowed interval for changing the abscissa of the node.

At the beginning of the planning the test duration, the initial and final values of all technological parameters are set. For the newly created test technology, they are formed by the one control operation for each technological parameter. The [Fig. 3] shows an example for the technological parameter "shaft speed".

These operations are mandatory, and cannot be deleted. They can only be divided into several sub-operations, the total duration of which is equal to the duration of the original obligate operations. In other words, the test technology always contains at least two nodes, which are set at the beginning of planning.

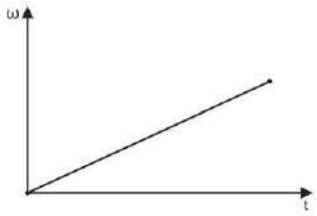

Fig. 3: Mandatory operation.

Further, the test technology is tuned in the desired way by adding and removing nodes and setting the parameters of the adjustment vectors. The [Fig. 4] shows the generated program for controlling the technological parameter on the example of shaft speed.

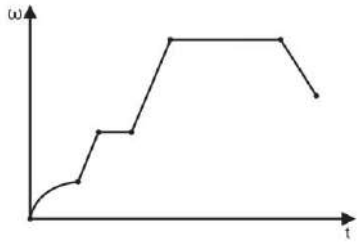

Fig. 4: Generated program for controlling the shaft speed.

The main function of the graphical interface is to convert data from internal representation to graphic form and back. The work of the ATS interface is based on the mathematical apparatus of analytic geometry. In computer memory, information about graphic elements is stored in the internal coordinate system. Its display on the display, which uses its screen coordinate system, is associated with the conversion of the internal coordinate system to the screen system. This transformation is performed by formulas (8) and (9):

$$x_s = \frac{x_{\text{int}}}{k_x} \quad (8)$$

$$y_s = h_s - \frac{y_{\text{int}}}{k_y} \quad (9)$$

where x_s – screen coordinate x,

x_{int} – internal coordinate x,

k_x – scale on the axis X,

y_s – screen coordinate y,

y_{int} – internal coordinate y,

k_y – scale on the axis Y,

h_s – distance between the origin of the screen and the internal coordinate system.

The inverse transformation is carried out by the formulas (10) and (11):

$$x_s = x_s \cdot k_x \quad (10)$$

$$y_s = (h_s - y_{\text{int}}) \cdot k_y \quad (11)$$

As it was said above, we will use graphic elements of three types: linear, exponential and harmonic.

Linear elements are straight lines and are described by the equation of a straight line passing through two points - the ends of a segment:

$$\frac{y-y_1}{y_2-y_1}=\frac{x-x_1}{x_2-x_1} \quad (12)$$

or

$$y=\frac{y_2-y_1}{x_2-x_1}\cdot x+\frac{y_1\cdot x_2-x_1\cdot y_2}{x_2-x_1} \quad (13)$$

where x_1 – abscissa of the beginning of the segment,
y_1 – ordinate of the beginning of the segment,
x_2 – abscissa of the end of the segment,
y_2 – ordinate of the end of the segment.

Exponential elements do not have a single equation. There are four types of exponential graphic elements, each of which is described by its equation. They differ from each other by increasing / decreasing and curvature of the arc (positive / negative). The [Fig. 5-6] show these four types.

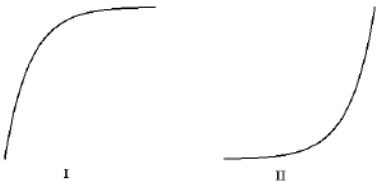

Fig. 5: Growing exponentials.

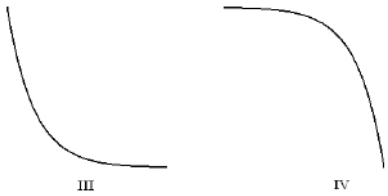

Fig. 6: Decreasing exponentials.

Graphic elements of I-IV types are described by equations (14 - 17), respectively:

$$y=a-e^{-kx+b} \quad (14)$$

$$y=a+e^{kx+b} \quad (15)$$

$$y=a+e^{-kx+b} \quad (16)$$

$$y=a-e^{kx+b} \quad (17)$$

where a and b – coefficients that affect the displacement of the graph with respect to the coordinate axes, k – coefficient that affects the curvature of the graph.

In a generalized form, formulas (14) and (15) can be written in the form of formula (18), and formulas (16) and (17) in the form (19):

$$y=a+s\cdot e^{skx+b} \quad (18)$$

$$y=a+s\cdot e^{-skx+b} \quad (19)$$

where s = ±1.

The technologist sets only s and k coefficients. The coefficients a and b are calculated by the program.

For the exponent described by equation (18) and passing through two nodes (x_1, y_1) and (x_2, y_2), the system (20) takes place:

$$\begin{cases} y_1 = a + s \cdot e^{skx_1 + b} \\ y_2 = a + s \cdot e^{skx_2 + b} \end{cases} \quad (20)$$

This is a system of two equations and two variables. We solve it with respect to a and b.

We subtract the first from the second equation:

$$y_2 - y_1 = s \cdot e^b (e^{skx_2} - e^{skx_1})$$

We express from this equation e^b :

$$e^b = \frac{y_2 - y_1}{s \cdot (e^{skx_2} - e^{skx_1})}$$

From here we can find b:

$$b = \ln \frac{y_2 - y_1}{s \cdot (e^{skx_2} - e^{skx_1})} \quad (21)$$

Knowing b, we can find a from the first equation:

$$a = y_1 - s \cdot e^{skx_1 + b} \quad (22)$$

For the exponent described by equation (19) and passing through two points (x_1, y_1) and (x_2, y_2), the system will have the following form (23):

$$\begin{cases} y_1 = a + s \cdot e^{-skx_1 + b} \\ y_2 = a + s \cdot e^{-skx_2 + b} \end{cases} \quad (23)$$

Solving it in a similar way, it can be established that the calculated formulas for a and b will have the form (24) and (25), respectively:

$$b = \ln \frac{y_1 - y_2}{s \cdot (e^{-skx_2} - e^{-skx_1})} \quad (24)$$

$$a = y_1 - s \cdot e^{-skx_1 + b} \quad (25)$$

The harmonic element is described by equation (26):

$$y = A \cdot \sin(\omega \cdot x + \varphi) + k \cdot x + b \quad (26)$$

where A – the amplitude,
ω – frequency,
φ – phase shift,
k – coefficient of slope,
b – distance from the abscissa.

In addition to the formulas for describing graphic elements, ATS uses some other formulas.

To verify that the node (x*, y*) of a neighborhood of a linear graphic element with origin at node (x_1, y_1) and end at node (x_2, y_2) belongs to formula (27):

$$|y^* - kx^* - b| < \varepsilon, \quad (27)$$

where ε – number describing the extent of the neighborhood.

To verify that the node (x*, y*) of a neighborhood of an exponential graphic element with origin at the node (x_1, y_1) and end at point (x_2, y_2) belongs to formula (28):

$$|y^* - a - s \cdot e^{skx^* + b}| < \varepsilon \quad (28)$$

where ε – number describing the extent of the neighborhood.

To verify that the node (x*,y*) of the neighborhood of the harmonic graphic element with the origin at the node (x_1, y_1) and the end at node (x_2, y_2) is used, the formula (29):

$$|y^* - A \cdot \sin(\omega x^* + \varphi) - k \cdot x^* - b| < \varepsilon \quad (29)$$

SUMMARY

[Fig. 7] shows an algorithm for planning test technologies using a method based on the use of nodal points.

The planning begins with the choice of the engine. At this stage the technologist chooses the technological parameters that will be included in the newly created test technology. This determines the choice of the mathematical model that will be used in calculating the control signal.

After that control programs for all the necessary technological parameters are created. The technologist manipulates with nodal points (adds, deletes, changes parameters). Each of its actions is checked by the system for correctness – compliance with the rules of the graphic language.

Incorrect actions by the system are not allowed. When the single-parameter control program takes the desired form, the technologist proceeds to create the next program.

The planning of the test technology is completed when the control programs for all technological parameters are created.

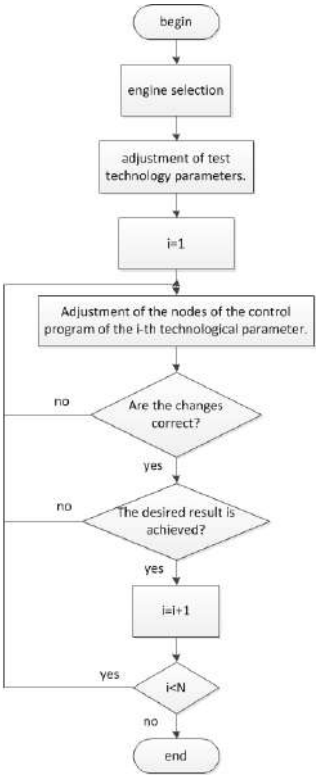

Fig. 7: Algorithm for planning testing technology.

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CONCLUSION

As a model for tuning the ICE test modes, the dependence on the engine speed versus time was taken to adjust the engine to the required test mode. In the case of obtaining a universal dependence, which will allow controlling and adjusting the obtained model, it will be possible to talk about the creation of an adaptive control system for testing ICE. The solution of this problem will allow simplify, and also qualitatively improve the level of the ICE tests.

CONFLICT OF INTEREST

There is no conflict of interest.

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FINANCIAL DISCLOSURE

None

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ARTICLE

INTERNAL COMBUSTION ENGINE FAULT SIMULATION METHOD

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ABSTRACT

This article describes methods of diagnosing of internal combustion engines (ICE). The conclusion is drawn that the majority of modern methods and ICE diagnostic devices don't solve fully a problem of determination of technical condition of the engine, often are labor-consuming and expensive. The choice of a method and mode of diagnosing of ICE on the basis of external speed characteristics is carried out for what the list of sensors and executive mechanisms of a control system of the engine is defined. The choice of a method of training of fuzzy Sugeno systems on the basis of hybrid neural networks is reasonable. The possibility of identification of difficult dependences by the systems of fuzzy sets on the basis of hybrid networks is proved. Разработаны и реализованы алгоритмы обработки информации сигналов датчиков и исполнительных механизмов системы управления для вычисления внешних скоростных характеристик. Possibilities of systems for fuzzy conclusion on identification of dependences are the basis for algorithms. Assessment of influence of external factors on the accuracy of measurements therefore it is established that the maximum error doesn't exceed 5% is carried out. Experimental studies of metrological characteristics of the diagnostic system have been carried out, which showed that the relative errors do not exceed the estimated errors. In this case, speed characteristic was determined in the entire range of engine speed.

KEY WORDS
diesel engine, fault diagnostic, test, information system, neural network.

INTRODUCTION

The estimation of the general condition of the engine is made on the effective parameters of its operation, which include the effective torque and power on the motor shaft, fuel and air consumption, ignition timing, and harmful emissions in the exhaust gases [1]. The work of systems implementing this approach is based on brake and non-brake methods.

Brake methods involve the use of special loading stands with running drums. This method was not widely used due to the high cost of equipment.

Non-brake methods are simpler and do not require the use of special braking devices [2]. In this case, the angular acceleration is measured when the engine is accelerated without an external load from the minimum stable speed to the maximum due to the sharp opening of the injection pump. This method allows carrying out diagnostics in real operating conditions, and equipping modern ICE with electronic control systems - to increase the number of controlled parameters.

The disadvantages of the systems implementing this approach are to a different degree the low accuracy associated with the need for numerical differentiation of the angular velocity variation function, the incompleteness of the parameters to be determined, and a narrow range of rotation frequencies for the characteristics obtained [3].

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In view of what has been said, the task of creating a diagnostic system that makes it possible to evaluate the basic performance of ICE over a wide range of engine speed is urgent and requires the development of original methods that go beyond existing approaches.

METHODS

The main provisions of the theory of fuzzy sets and fuzzy logic are applied. Typical membership functions and operations on fuzzy numbers are used [4]. The concepts of fuzzy and linguistic variables are considered. In this case, the fuzzy variable is determined by the triple <a, X, A>, where a - name of a fuzzy variable, X - the domain of its definition (universe), A - fuzzy set on X, describing the possible values that a fuzzy variable can take.

A generalization of a fuzzy variable is the so-called linguistic variable, defined by a tuple <p, T, X, G, M>, where

- p - name of the linguistic variable,
- T- basic term-set of a linguistic variable or the set of its values (terms), each of which is the name of a separate fuzzy variable,
- X - domain of fuzzy variables that are included in the definition of a linguistic variable,
- G - a syntactic procedure that describes the process of generating new values for a given linguistic variable,
- M – a semantic procedure that allows each new value of a given linguistic variable, obtained by procedure G, to be assigned to each meaningful content by forming the corresponding fuzzy set.

The basic configuration of the fuzzy inference system based on the rules of fuzzy products is used, in which conditions and conclusions are formulated in terms of fuzzy linguistic utterances [5].

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Thus, the problem of identifying data with fuzzy Sugeno systems with membership functions of a Gaussian type reduces mainly to the selection of the number of terms of the input variable. With an increase in the number of terms of the input variable, the errors do not increase [6]. At the same time, with a decrease in the number of terms of the input variable, the smoothing properties of the fuzzy system approximation will be strengthened [7].

The undoubted advantages of fuzzy systems to identify data can be attributed to the fact that not require special selection output system structure and the form of membership functions, unlike parametric identification methods (exponential, logarithmic, exponential, power and other techniques).

RESULTS AND DISCUSSION

To build the speed characteristic, it is enough to process the information contained in the five signals of the control system [8]. These include the signals of the crankshaft position sensor, the mass air flow, the position of the fuel pump rail, the fuel injection and ignition control systems, etc.

In the developing system, the definition of speed characteristic is based on the non-brake method. The engine is accelerated by changing the position of the fuel injection pump rail. The signals of the engine control system are continuously measured.

The choice of the diagnostic mode is reduced to providing such engine operating conditions, in which its properties are presented most fully. This mode corresponds to the mode of full fuel supply, when the fuel pump rail is opening as much as possible [9]. This is due, first of all, to the maximum wide frequency range of the engine and the maximum work of inertial forces and frictional forces. In addition, in the real conditions of the diagnosis, to ensure the permanence of the position of the rail (different from 100% of the opening of the rail) is problematic enough.

The hardware of the AIS includes a cable-splitter of the signals of the control system, a coupling device, an input module for analog signals, and a computer. To provide mobility as a computer, a portable personal computer of the "notebook" type was chosen. This makes it possible to carry out diagnostics while the vehicle is moving, when the load is the mass of the car, driven to the crankshaft via the transmission [10]. As an analog input module, an external ADC / DAC E14-440 module from L-card was selected, which was added to the State Register of measuring instruments. The module interacts with the computer via the USB bus, the ADC has a bit capacity of 14 bits, the maximum conversion frequency is 400 kHz [11]. This solution allows for diagnostics in real operating conditions. The software part manages the data collection and processing of the engine control system signals. Processing algorithms are based on the use of fuzzy inference systems as part of hybrid networks, which ensures high accuracy and repeatability of the results of experimental tests in a wide range of engine speed.

On the basis of the previously obtained knowledge base of fuzzy rules [12], we will formulate a methodology for testing and diagnosing diesel engines in accordance with GOST 18509-88 "Diesel tractors and combine harvesters. Test methods». The given standard assumes measurement of parameters of the engine in a stationary mode at a step equal to 200 min-1. The fuel consumption is selected as low as possible, which makes it possible to realize an economical operating mode, and the torque according to its characteristics will be selected to coincide with the corresponding speed.

The next stage is the presentation of this testing method in the form of images, which are formed according to the methodology for designing testing techniques for diesel engines., described at [13].
The figures for ω, MH and GT are shown in the [Fig. 1,2,3].

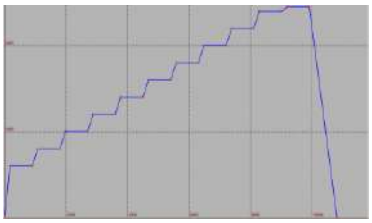

Fig. 1: The figure for the engine speed.

Fig. 2: Figure for moment of loading.

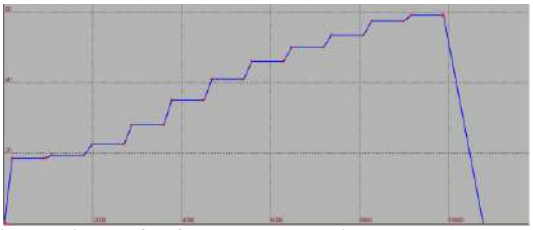

Fig. 3: Figure for fuel consumption.

The use of graphical representation of data is convenient for humans, for computer processing it is better to have numeric data. Therefore, the next step is to convert the images into a summary table of parameters.

This data is saved in the summary table of parameters [Table 1].

Table 1: Summary table of parameters

№	Test time, min.	Figure for ω, min^{-1}	Figure for M_H, Nm	Figure for G_T, kg/hour
1.	Engine start			
2.	15	600	73	18,6
3.	30	800	90	19,5
4.	45	1000	110	24
5.	60	1200	123	30
6.	75	1400	125,8	35
7.	90	1600	123	41
8.	105	1800	115	46
9.	120	2000	112,5	50
10.	135	2200	110,8	53,5
11.	150	2400	110	57,5
12.	165	2450	110	59,2
13.	180	600	73	18,6
14.	Engine stop			

At the next stage, fuzzification is carried out, that is, the conversion of values of the input variables A_i into fuzzy B_i, by linguistic variable [14]. Such transformation is in fact a kind of valuation necessary to translate the given data into subjective estimates. Linguistic variables for translating a value into fuzzy are stored in the knowledge base of fuzzy logic. The result of the work at this stage will be a converted summary table of parameters, in which instead of clear values the membership functions will be located. The result of this stage is shown in the [Fig. 4].

The next step is the formation of an approximate fuzzy result in the output block. To do this, fuzzy rules stored in the knowledge base of fuzzy logic were applied.

The next stage is defuzzification. Defuzzification means the procedure for converting fuzzy values obtained as a result of fuzzy inference into clear ones, on the basis of which it is possible to conduct engine tests. For defuzzification we use the fuzzy derivation of Sugeno. This is because it is highly accurate and easy to use this algorithm will reduce the processing time of information.

The results of fuzzy inference are control vectors in linguistic variables ω, MH and GT.
F_ω= (0; 2,99; 6,48; 11,13; 16,13; 21,1; 26; 30,98; 36; 43,53; 50);
F_{Mh}=(0; 3,04; 7,37; 12,5; 15,17; 21,43; 28, 31,25; 36; 45; 50);
F_{Gt}=(0; 1; 5,7; 10,39; 14,3; 19,32; 24,12; 28,97; 33,97; 41,11; 48).

We calculate the total result vector by three parameters ω, MH and GT based on averaging the average value and the method of ranking the characteristics. The result of the control vector over the averaged value will have the form:

F_S=(0; 2,34; 6,52; 11,34; 15,2; 20,62; 26,4; 30,4; 35,3; 43,21; 49,33).

The control vector by the method of paired comparisons will have the following form:

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F_R=(0; 2,27; 6,42; 11,2; 15,21; 20,53; 25,81; 30,31; 35,26; 43,01; 49,27).

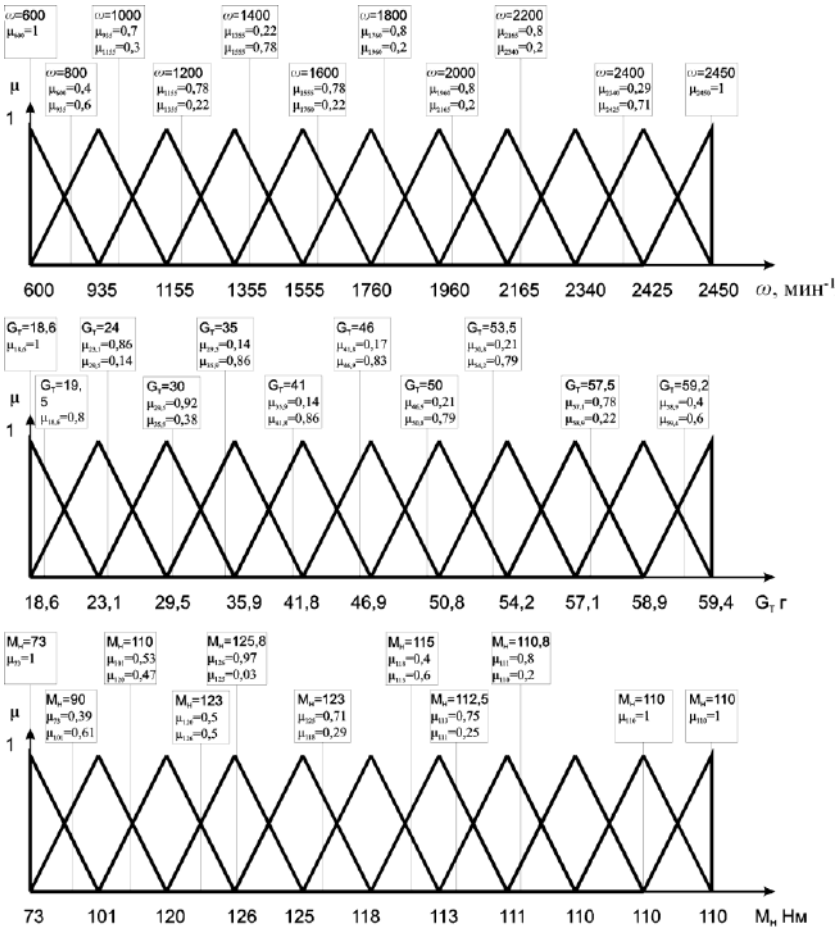

Fig. 4: Fazzification of data.

SUMMARY

Using the vector Fω, which characterizes the engine speed, we will check the degree of adequacy of the control model to the real parameters of the engine. The results of the averaged value of the error of the engine tests are shown in the [Fig. 5].

As can be seen from the figure, the maximum absolute error is 19,4 min-1, which corresponds to a relative error of 2,4% at 800 min-1, which is explained by the high non-linearity of this characteristic in this section. To this value it is necessary to add the error of the test stand, equal to 0,5%. From these values, we can conclude that the error in controlling the diesel engine based on the model as a knowledge base of fuzzy rules will not exceed 2.9%.

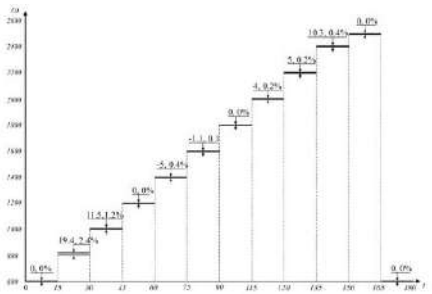

Fig. 5: Calculated and experimental data of the engine speed.

Using the resulting values of ω, MH and GT we construct speed characteristics with these parameters [Fig. 6, 7]. In these figures, [Fig. 1] indicates a calculated characteristic, and [Fig. 2] indicates an experimental characteristic. The maximum error at the moment of engine load is 3% at 1800 min-1, and the maximum error in fuel consumption is 5% at 1400 min-1.

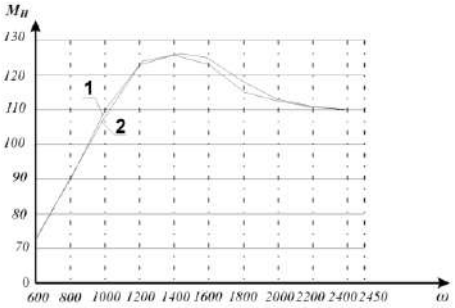

Fig. 6: Speed characteristic for engine load moment.

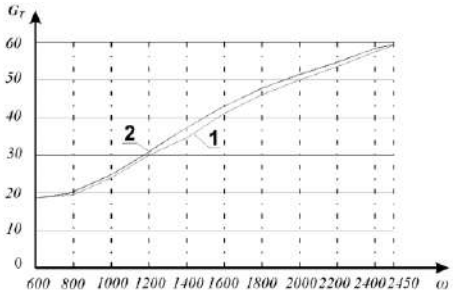

Fig. 7: Speed characteristic for fuel consumption.

Calculation of the speed characteristic for MH and GT showed that the error of control based on the model using fuzzy logic on these characteristics does not exceed five percent, which satisfies the requirements of GOST 18509-88 « Diesel tractors and combine harvesters. Methods of bench tests».

The accuracy of the methods for obtaining the resulting control vectors with concern to the three parameters ω, MH and GT, is determined using the averaging of the mean value and the ranking of the reference parameters based on the testing of diesel engines. The results of the experiment are shown in [Fig. 8].

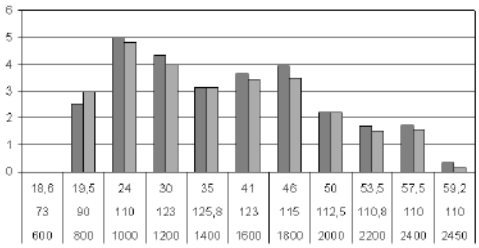

Fig. 8: The error in the methods for determining the resulting vector.

[Fig. 8] shows the relative error of the tests: dark color - by the average value, and light - by the method of paired comparisons. As can be seen from the figure, the second method is more accurate, in addition to the value of 800 min-1, which is explained by the large nonlinearity in this section of the engine speed.

CONCLUSION

As a result of the work, a hardware-algorithmic complex was developed that makes it possible to carry out experiments to obtain the speed characteristics of an internal combustion engine. This system makes it possible to carry out tests of both a working engine and an engine with various malfunctions in real operating conditions. It can be seen that the average value of the relative deviation for the tests performed does not exceed the estimated relative error.

CONFLICT OF INTEREST
There is no conflict of interest.

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None

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ARTICLE

ABSOLUTE STABILITY ANALYSIS METHOD OF THE PROBING SIGNALS GENERATOR OF PHASE-METRIC SYSTEMS OF GEODYNAMIC CONTROL

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ABSTRACT

Phase-metric method of geo electric signals registration allows eliminating multiplicative noise and, accordingly, to increase the accuracy of geo electric control due to the use of phase methods of formation of probing signals. For the reliability of the phase-metric systems of geodynamic control it is necessary to ensure the stability of the signal generators of these systems at the geo-dynamic variations of the object of control and the effects of noise. When registering small geo-dynamic changes, the level of destabilizing effects sometimes exceeds the level of useful signal by 60 dB and more, which determines the need to use nonlinear model of the signal generator. A new method based on the V.M. Popov frequency criterion and the piecewise linear approximation of the hodograph is developed to study the absolute stability of the high-order generator model with an arbitrary value of perturbing effects. On the basis of the developed method, the stability analysis of probing signal formers with different types and orders of filters is performed. Studies had shown a significant difference between the calculated boundary regulation coefficients of the generator in linear and nonlinear regime.

KEY WORDS
Phase-metric method, geodynamic monitoring of karst processes, a generator of probing signals, stability

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INTRODUCTION

The phase-metric method of geo electric data registration is used to monitor the geo dynamics of near-surface in homogeneities in cases of the need to provide increased sensitivity to special changes in the object of study. High efficiency is achieved by increasing the sensitivity of the measuring system, initial installation and operational positioning of the electrical installation by controlling the sources of probing signals [1]. Technique of applying the phase-metric method of geo electric control is that in the case of the probing signal, several sources located in the field of the object under study and the required number of vector measurement sensors of the electric field are used. Point sources form probing signals shifted in phase by a given angle relative to each other. Geodynamic variations of the object under study are determined by the displacement of fictitious sources, which leads to the dis balance of the measuring system and the registration of the corresponding signal vector in it.

For reliability of the operation of phase-metric systems of geodynamic control is necessary to ensure the stability of the signal generators of these systems with variations in the installation parameters and the effects of noise. The article [2] develops a method and algorithm for analyzing the stability of the linear model of the former based on the Nyquist frequency criterion and the algebraic Raus-Hurwitz criterion, well known in the theory of automatic control [3, 4, 5]. The linear model of the device is adequate for small impact perturbations. At the same time, when recording small geodynamic changes, the level of destabilizing effects may be 60 dB or more higher than the level of useful signal [6, 7]. This determines the need to use a nonlinear model of the signal generator and, accordingly, other methods of stability analysis. Lyapunov methods [8, 9] enables to investigate the stability of devices operating in non-linear regime. The first method is based on the Lyapunov linearization of all nonlinear blocks for a particular equilibrium position. Therefore, its application is equivalent to the construction of a linear model for the maximum deviation of variables at the inputs of each nonlinear block [10]. Thus, the first Lyapunov method allows estimating only the asymptotic stability of the nonlinear former "in the small". The second Lyapunov method [8, 10] is universal, since it is not associated with linearization of the differential equation of a nonlinear device and does not impose any special restrictions on the nature of nonlinearity. However, application of the second Lyapunov method in practice is complicated by the lack of general recommendations on the choice of Lyapunov functions [10].

The frequency criterion of absolute stability of the equilibrium position was first proposed by V.M. Popov [11]. The implementation of this criterion provides asymptotic stability of the de-vice "as a whole", "in general" (at any deviations of the influencing disturbances). Popov's criterion is also applicable to devices whose nonlinear blocks have static characteristics with areas of ambiguity [12]. Another important advantage of the Popov criterion is the simple expression, clarity and convenience of the method not only for analysis, but also for the synthesis of nonlinear inertial devices. Approximation of the amplitude-phase characteristic (hodograph) allows simplifying the application of Popov frequency criterion for the study of the stability of devices with a complex form of inertial characteristics.

It is necessary to develop a new method for studying the stability of high-order signal formers (generators), which is applicable not only in the linear mode (for small influencing disturbances, "in small"), but also in the nonlinear mode (for an arbitrary value of the influencing disturbances, "in general"), within the

framework of the computational experiment. The proposed method should combine the advantages of known algebraic and frequency criteria and the ability to study stability of the device not only for fixed values of the blocks parameters, but also when they change.

The purpose of this work is to develop a method for analyzing the absolute stability of the probing signal formers at any deviations of the influencing disturbances to ensure the reliability of the phase-metric method of geo electric control of geodynamic objects.

Phase formation of the probing signals of geodynamic control systems

Applied phase-metric method of geo electric signals registration allows to eliminate multiplicative noise and, accordingly, to increase the accuracy of geo electrical control through the use of phase methods for the formation of probing signals. Operation of phase-metric systems of geo electric control is based on the direct conversion of the useful signal into the phase of oscillation [7].

Probing signals of multipolar phase-metric systems can be represented with high accuracy either by single harmonic oscillations with defined amplitudes, frequencies and phases, or by a set of such oscillations. Thus, for the analysis of such installations, application of the model of amplitude-phase formation and transformation of signals is relevant [13, 14, 15]. The use of such a model is promising both for simplification of modeling and design of known monitoring systems and for modernization of known systems in order to increase their reliability and sensitivity by improving the quality of sounding signals formation and algorithms of their processing.

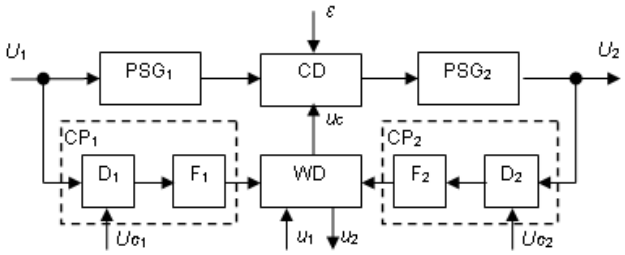


Fig. 1: Generalized PSG model.

The composition of the generalized model of the probing signal generator [PSG, Fig. 1], identical to the model [14], includes: similar to it PSG1,2, control device (CD), control paths (CP1,2) and a weight distributor (WD). Amplitude and (or) phase of the input signal of the generator is controlled in the control device (CD). Each control path consists of an amplitude and (or) phase deviation detector and a filter. Paths CP1 and CP2 implement the principle of perturbation and deviation, respectively. Values of transfer coefficients of the weight distributor determine the proportions of signal transmission from its inputs to outputs and allow to form the control and output auxiliary signals of the generator.

The scheme includes following designations: U1,2 - main input and output signals of the PSG, UG1,2 - signals of equivalent reference generators of detectors (D1,2), $u_{1,2}$ – auxiliary input and output signals, Uc - control signal, ε - destabilizing factor.

Various options for the construction of generator - with perturbation control, control by deviation and combined control (CC) – we obtain by a simple choice of values of the corresponding coefficients of the weight distributor. Further expansion of PSG1,2 allows to represent devices by different number and type of connections (direct, inverse, local, general, multi-loop). Thus, flexible structure of the generalized model [Fig. 1] allows to investigate a wide class of schemes of signal generators of electro location systems of geodynamic control, distinguishing by the number of channels (poles) and dependence between the parameters of signals in individual channels, characteristics of components, magnitude and nature of the influencing disturbances, etc.

The method of absolute stability analysis of probing signals generators with arbitrarily large forcing perturbation

According to Popov's criterion [9, 11, 10], for absolute stability of the equilibrium position of a nonlinear system with a stable linear part, the existence of a real g is sufficient, for which the condition is satisfied

$$\forall \omega \geq 0 : \mathrm{Re}\left[(1 + j\omega g)W(j\omega)\right] > -1/k \qquad (1)$$

where k is an angle of absolute stability, $W(j\omega) = \dfrac{A_1(\omega) + jA_2(\omega)}{B_1(\omega) + jB_2(\omega)}$ is the complex transfer function of the filter in the feedback circuit, and l is the order of the filter. The largest and the smallest values of k,

at which the condition (1) is satisfied, determine, respectively, the lower and up-per boundaries of the region of stable operation of the nonlinear generator.

We divide the complex transfer function of the filter $W(j\omega)$ into the real and imaginary parts:

$$W(j\omega) = W_R(\omega) + jW_I(\omega) \quad (2)$$

where $W_R(\omega) = \dfrac{A_1(\omega)B_1(\omega) + A_2(\omega)B_2(\omega)}{B_1^2(\omega) + B_2^2(\omega)}$ - real frequency characteristic of the filter F2,

$\mathrm{W}_\mathrm{I}(\omega) = \dfrac{A_2(\omega)B_1(\omega) - A_1(\omega)B_2(\omega)}{B_1^2(\omega) + B_2^2(\omega)}$ - imaginary frequency characteristic, polynomials $A_{1,2}(\omega) = \sum_{i=0}^{I} A_{1,2_i}(\omega)$, $B_{1,2}(\omega) = \sum_{i=0}^{I} B_{1,2_i}(\omega)$ are determined according to the expressions:

$$A_{1_i}(\omega) = \mathrm{Re}[A_i(j\omega)] = \alpha_{4i}\omega^{4i} - \beta_{4i+2}\omega^{4i+2},$$
$$B_{1_i}(\omega) = \mathrm{Re}[B_i(j\omega)] = \beta_{4i}\omega^{4i} - \beta_{4i+2}\omega^{4i+2},$$
$$A_{2_i}(\omega) = \mathrm{Im}[A_i(j\omega)] = \alpha_{4i+1}\omega^{4i+1} - \alpha_{4i+3}\omega^{4i+3},$$
$$B_{2_i}(\omega) = \mathrm{Im}[B_i(j\omega)] = \beta_{4i+1}\omega^{4i+1} - \beta_{4i+3}\omega^{4i+3},$$

where α_i, β_i are the filter coefficients. Separation of the transfer coefficient of filter into the real and imaginary parts allows a simple geometric interpretation of the Popov criterion.
We introduce a modified complex transfer function

$$W^*(j\omega) = W_R(\omega) + jW_I^*(\omega) \quad (3)$$

where $W_I^*(\omega) = \omega W_I(\omega)$.

By converting (1) to (3), we obtain a sufficient condition of absolute stability in the form $W_R(\omega) - gW_I^*(\omega) > -1/k$. For the boundary values of the regulation coefficient, condition takes the form of equality (the Popov equation)

$$W_R(\omega) - gW_I^*(\omega) = -1/k. \quad (4)$$

The straight line defined by equation (4) passes through the point –1/k on the real axis with a slope of 1/g.

To conduct an analytical study of the absolute stability of the PSG, it is necessary to obtain a Popov direct expression for a particular type of F2. Solution of the problem in a generalized form for an arbitrary type and order of filter is not possible. This difficulty arises due to the non-linear nature of the left side of equation (4) and the presence of two un knowns g and k. Approximation of the filter frequency characteristics based on continuous piecewise linear functions (CPLF) [14] allows one to line arise (4), to eliminate the unknown g and to conduct an analytical study of the absolute stability in general.

We set the following approximation parameters: the range of variation of the variable from ω0 to ωN, N - the maximum number of the approximation node, n, m - the current numbers of the approximation nodes. Frequency characteristics change most quickly in the region of ω small values and slowly – at large. Thus, in order to reduce error the exponential position of nodes is reasonable. Expressions of lines approximating the left side of (4) in the current nodes will take the form

$$W_{I\,m,n}^*(W_R) = g_{m,n}(W_R - b_{m,n}), \quad (5)$$

where $g_{m,n} = (W_{I\,m}^* - W_{I\,n}^*)/(W_{R\,m} - W_{R\,n})$ are angular coefficients, $W_{I\,m,n}^* = W_I^*(\omega_{m,n})$, $W_{R\,m,n} = W_R(\omega_{m,n})$,

$$b_{m,n} = W_{R\,m} - W_{I\,m,n}^* / g_{m,n} \quad (6)$$

- abscissas of the approximating straight lines.

The result is N2 coefficients bm,n. From the obtained values of abscissas it is necessary to exclude those that are located outside the range of ωn÷ωm and are "false". To do this, we introduce the inclusion CPLF

$Q_{m,n}(\vartheta) = K_\sigma \sum_{\lambda=0}^{1}\sum_{\gamma=0}^{1}(-1)^{\lambda+\gamma}\left|\vartheta + \vartheta_n - \vartheta_m(1-\gamma) - \frac{\lambda}{2K_\sigma}\right|$, where K_σ is a slope of the lateral components of inclusion function. The function takes a value of 1 if its argument takes a segment [ωn; ωm] and 0 otherwise.

The corresponding inclusion function for "false" abscissas values is equal to zero, and for the true values $Q_{m,n}(b_{m,n}) = 1$. To exclude "false" bm,n, values, it is enough to multiply (6) by $Q_{m,n}(b_{m,n})$

$$b^*_{m,n} = b_{m,n} Q_{m,n}(b_{m,n}) \ . \qquad (7)$$

We obtain the boundary values of k for each true abscissa by substituting (7) into the right part of (4)

$$\mathrm{k}_{m,n} = -1/b^*_{m,n} \qquad (8)$$

We denote N_2^{low} and N_2^{up} the lower and upper bounds of the range of N2 values, in which PSG maintains stability. I.e., the stability region is an interval $N_2^{low} \le N_2 \le N_2^{up}$.

In order to find the boundaries of the absolute stability region, it is necessary to select one negative and one positive from all the values (8), which are nearest to zero.

The lower bound of N2 is defined as the maximum of all negative values

$$\widetilde{N}_2^{low} = \max\left\{k_{m,n}\left[1 - \widetilde{q}(k_{m,n})\right]\right\}, \qquad (9)$$

where $\widetilde{q}(\vartheta) = \frac{1}{2\Delta}\left[|\vartheta + \Delta| - |\vartheta| + \Delta\right]$ - inclusion CPLF, taking value 1 when $\vartheta \ge 0$ and 0 when $\vartheta < 0$.

The multiplier $1 - \widetilde{q}(\mathrm{k}_{m,n})$ in (9) excludes positive roots.

The upper bound of N2 corresponds to the minimum of all $k_{m,n}$ positive values

$$\widetilde{N}_2^{up} = \min\left\{N_{2\mathrm{k}}\widetilde{q}(k_{m,n})\right\}. \qquad (10)$$

As an example, we can calculate the area of absolute stability of generator when low-pass filter (LPF) of the 5th order with transfer function $W(p) = 1/(1+Tp)^5$ is used as F2, where T is the time constant of the filter. In [15] the investigation of stability "in the small" is made for this filter.

The real and imaginary frequency characteristics of this filter are obtained from the expression (2) based on polynomials $A_{1,2}(\omega)$, $B_{1,2}(\omega)$. We take the time constant of the filter equal to T=1s and approximate the frequency characteristics in the range of variables $\omega_0 = 0{,}01\mathrm{c}^{-1}$, $\omega_N = 7\,\mathrm{c}^{-1}$, N=30. Of all the N2=900 abscissas (6) define the true (7). According to (9) $\widetilde{N}_2^{low} = -1{,}006$, to (10) $\widetilde{N}_2^{up} = 2{,}9$.

[Fig. 2] shows the conventional W and the modified W* hodographs of the frequency characteristic of the filter, approximated by CPLF. Abscissas of approximating lines corresponding to the boundaries of the region of absolute stability, $\widetilde{b}_{low} = -1/\widetilde{N}_2^{low} = 0{,}994$, $\widetilde{b}_{up} = -1/\widetilde{N}_2^{up} = -0{,}345$. Popov straight lines for $\widetilde{N}_2^{low,up}$, indicated in [Fig. 2] as $W^*_{I\ low,up}$ are obtained by (5).

Stability of the linear generator in accordance with [8, 10] is determined by the condition of intersection of the abscissa axis by the conventional hodograph ( ), the boundary values are equal to $N_2^{low} = -1$, $N_2^{up} = 2{,}885$, that is, stability region of the linear generator with the 5th order LPF in CP2 represents a segment $-1 \le N_2 \le 2{,}885$.

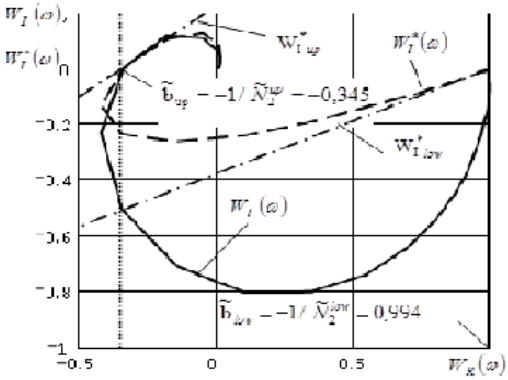


Fig. 2: Conventional W and modified W* hodographs of the 5th order low-pass filter.

From the comparison of the hodographs in [Fig. 2] it is seen that the stability region of the linear PSG and the absolute stability of the nonlinear PSG are the same. A small error of $\tilde{N}_2^{low,up}$ (less than 1%) is caused by an approximation error of frequency characteristics.

Similarly, the stability analysis of PSG with filters of other orders may be done.

In the above case with the 5th order LPF the stability regions of the device in the linear and nonlinear modes coincide. Their difference is also possible for some types of filters. As such an example, we can also calculate the region of absolute stability of the generator with a complex filter of the 4th order in the deviation regulation chain. The filter consists of series-connected integrating, inertia-integrating and oscillatory units. Transfer function of such filter is

$$W(p) = \frac{1}{p(1+Tp)(\beta + 2\xi Tp + T^2 p^2)}, \qquad (11)$$

where T is the time constant of the filter. We assume T=ξ=1, β=10.

Calculating filter coefficients α_i, β_i, we obtain the real and imaginary frequency characteristic by substitution of these coefficients in (2). Approximation of the frequency characteristics is feasible in the same range of variables $\omega_0 = 0{,}01\,\mathrm{c}^{-1}$, $\omega_N = 7\,\mathrm{c}^{-1}$, as for the 5th order LPF, the number of approximation nodes is increased to N=50 to improve accuracy. Of all N2=2500 abscissas (6), let us determine the true ones (7). According to (9) $\tilde{N}_2^{low} = -1/\infty \to 0$. Upper absolute sustainable N2 value should be received by (10): $\tilde{N}_2^{up} = 1/0{,}045 = 22{,}2$. The region of absolute stability is the interval $0 \le N_2 \le 22{,}2$.

From a comparison of the conventional and modified hodographs in [Fig. 3] it can be seen that the stable region in the linear and nonlinear regimes differ. Thus, stability "in the small" is determined by abscissa of the point at which $W_I(\omega) = 0$: $b_{up} = -0{,}034$, $N_2^{up} = 1/0{,}034 = 29{,}4$. The stability region "in small" is a segment $0 \le N_2 \le 29{,}4$. General meth-od for analyzing the stability of the device in a linear mode (with small perturbations) based on the Nyquist frequency criterion and piecewise linear approximation of the hodograph is described in [15].

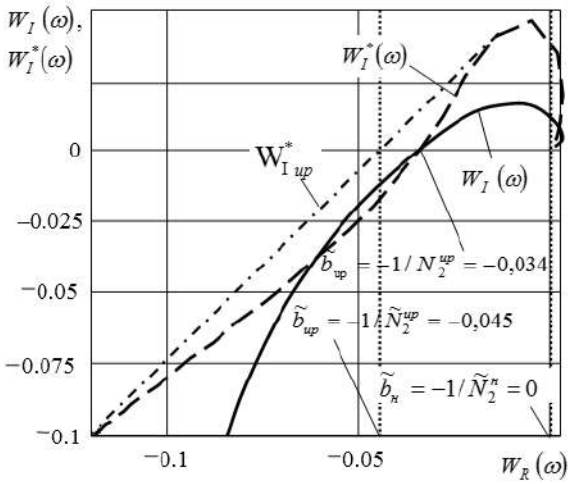
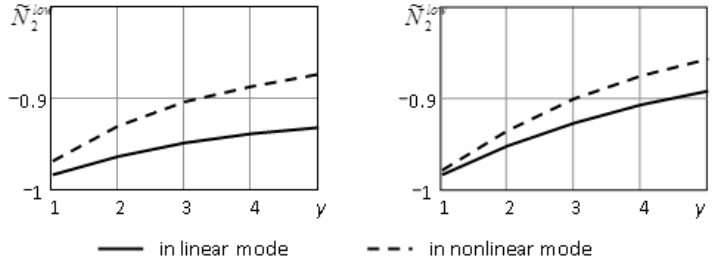
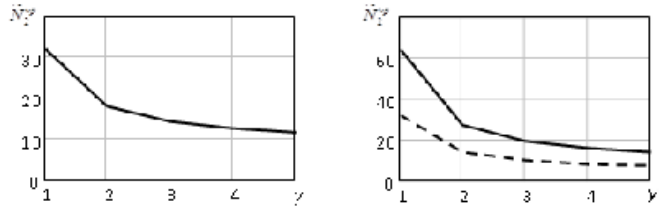


Fig. 3: Conventional and modified hodographs of the 4th order complex oscillation-integrating link.

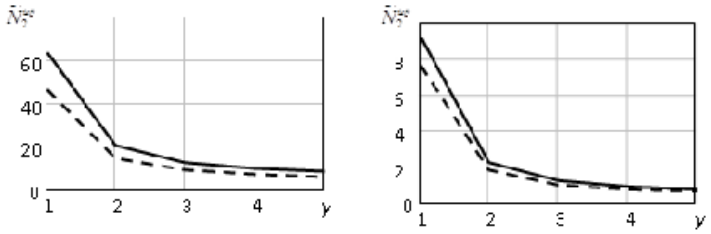
The upper limit value of N2 in the nonlinear mode is significantly less than in the linear mode (1.32 times). This imposes restrictions on the choice of parameters of feedback devices for large acting disturbances.



a) For the 4-th order NF b) for the 6-th order NF



c) For the 4-th order BPF d) for the 6-th order BPF



e) For the 8-th order BPF f) for the 10-th order BPF

Fig. 4: Dependences of the boundary stable coefficients N2 on γ in the linear and nonlinear regime for different types and orders of the filter.

In [Fig. 4] graphs of N2 stable coefficients of generator with band pass (BPF) and notch (NF) filters of different orders (4, 6, 8, 10th) are also given. Transfer functions of filters have the form:

$$M_2^{\mathrm{LPF}}(p) = 1/(1+Tp)^I \ , \ M_2^{\mathrm{HPF}}(p) = (Tp)^I/(1+Tp)^I \ ,$$

$$M_2^{\mathrm{BPF}}(p) = \mathrm{H}_{\mathrm{LPF}}(\mathrm{p})\mathrm{H}_{\mathrm{HPF}}(\mathrm{p}) = (\gamma Tp)^{0.5I}/[(1+Tp)(1+\gamma Tp)]^{0.5I} \ ,$$

$$M_2^{\mathrm{NF}}(p) = 1 - M_2^{\mathrm{BPF}}(p).$$

Here T – time constant of the link in the composition of low pass and high pass filter, γ is the ratio of time constants of HPF and LPF links in the part of the BPF and NF. When the de-vice is switched to nonlinear mode of operation, the stability area is significantly narrowed from above (2 times for the 6th order BPF at γ=1 [Fig. 4d]: $N_2^{up} = 64$ in linear mode, $\tilde{N}_2^{up} = 32$ in nonlinear mode). The results of calculation of the lower limit of absolute stability for BPF coincide with the results of calculation for the linear regime. Dependences of absolutely stable N2 values of the generator with low-pass (LPF) and high-pass (HPF) filters coincide with values for stability "in small" for any order of the filter to the 10th inclusive.

Expressions are obtained that determine the limits of the range of values of the coefficient of deviation corresponding to the stable operation of PSG "in general" (with large values of effects). Application of PSG and CPLF allows to investigate the absolute stability of devices with different type and order of filter in the feedback circuit.

CONCLUSION

The urgency of the study of absolute stability of probing signal generators to ensure the reliability of the phase-metric systems of geodynamic control at an arbitrary value of the influencing conditions (stability "in general") is noted. The method of the absolute stability analysis of high-order generators with different types of filters of control paths is developed. New approach is based on the Popov frequency criterion and the piecewise-linear approximation of the hodograph. The choice of a specific filter of the control path is carried out by simple substitution of its coefficients in the obtained expressions of the generalized PSG model. Computational experiment was conducted to analyze the stability of the PSG with different types and orders of filters: low-pass filters, high-frequency filters, band pass and notch filters from the 1st to the 10th order. Studies had shown a significant difference calculated at the boundary regulation coefficients of generator in linear and nonlinear regime.

CONFLICT OF INTEREST
There is no conflict of interest.

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None

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ARTICLE

A REVIEW ON EXISTING GREEN BUILDING RATING SYSTEM BETWEEN DIFFERENT COUNTRIES

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ABSTRACT

India and China are the developing countries while UK and USA both are the developed countries and there is a rapid increase in the construction sector. A new trend of green building gives a major emphasis in today's world. To decide whether the building is green or not many parameters are designed by the governing organization for the building to ensure the increasing practice of green building. Each country has owned its different parameters called rating system, which is different for the existing building and newly constructed building. These parameters can be estimated based on material, water efficiency, energy efficiency, health, etc. In India basically GBCI and GRIHA are followed which identify any construction as green construction based on its own parameters. USA followed the LEED standards having six different parameters with uniqueness of regional priority. In case of China, they focus on the policy of resource saving under the guidelines of ESGB while UK has the widely accepted rating system known as BREEAM which has its own nine different parameters. The present paper summarized the different aspects of existing green building rating systems used in different countries.

KEY WORDS
GRIHA, BREEAM, ESGB, LEED, Performance Evaluation, Green Buildings

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INTRODUCTION

Green building is the act of developing environment friendly and asset productive working all through its building life cycle. It incorporates arranging, planning, development, task and upkeep, redesign and so on. It is imperative towards reasonable improvement. The expansion level of contamination, the absence of water, energy sparing issues, material productive issue, arrive utilize, wellbeing solace factors, Indoor Environmental Quality (IEQ) has pushed ourselves to move from conventional working toward green building development. The significant components of a green building that we mainly see are energy and water efficiency, indoor air quality, waste and toxic reduction, environmental preferable building material, sustainable development, structural design efficiency. To move towards this green improvement, there is a need of specific criteria on which the building ought to be evaluated, that criteria are characterized by the GBRS (Green Building Rating System). Each nation has its own particular criteria that are composed of the different parameter as per the needs of the nation. In this paper, different adopted criteria for green building system of India, UK, USA and China are discussed. They are the most adaptable, acknowledged rating frameworks and that is why, they have been analyzed through the distinctive parameters.

The development in India is expanding at exceptionally quick pace that contributes much towards the economy. It is a decent activity for the nation and now there is a need to present green building ideas in this area, which can take towards economical way. Green concept in new and existing structures can help in addressing the national issues like water and energy, reduction in petroleum derivative used treatment of waste and so on. Above all, these ideas can upgrade inhabitant wellbeing, satisfaction, and prosperity. Towards this, the Green Building Council of India (GBCI) has pushed 'Green Existing Building Operation and Management Rating System (GEBOM)' to deal with the national issues in the improvement division. By adopting 'Green Existing Building Operation and Management criteria', existing structures can be prudent over the life long cycle of building. The rating program empowers the building proprietor, private engineers to apply green criteria; in order to lessen the ecological issues, which are quantifiable. Green existing structures have colossal advantages, substantial and elusive. The unmistakable advantages are diminishment in water and energy utilization. Operational reserve funds through energy and water productivity could run from 15 - 30 % [1]. The pilot form of GBCI rating framework is relevant for wide range of non-private structures including offices, IT Parks, shopping canters, air terminals, banks, and so on. Building writes, for example, industrial facility and schools will be secured under separate GBCI rating programs. The purchaser squanders created in the building can be lessened. Impalpable advantages of green existing structures incorporate improved air quality, wellbeing and higher fulfilment levels of inhabitants. GBCI has presented the credit-based framework in which credits are given on different border like site facility management, water efficiency and energy efficiency, health/comfort, and innovation. In the credit system, category levels i.e. silver, gold, platinum are evaluated and based on these acknowledgments, they are awarded best practice, outstanding, national excellence, and global leadership respectively.

Evaluation Standard for Green Building (ESGB) is assessing the green building in China. ESGB was formed in 2006 by MOHURD and overhauled in 2014 with the point of saving energy, water, material, indoor environmental quality. China is encountering quick financial improvement and urbanization. In China, the aggregate floor region of existing building is more than 40-billion-meter square. Consistently, the utilization of bond and steel is 40% of the world. As China is a nation inclined to a more catastrophic event, the future of the structures are not as much as alternate nations, almost 30 to 40 years, while in nations like USA and UK the life of a building is almost around 50 to 80 years. To advance green working in China, Evaluation Standards for Green Building or configuration codes have been issued [2]. The assessment has two principles, one for private and one for open structures. On account of China tremendous region and

differential climatic zone, it is hard to apply one national benchmark without thinking about neighbourhood circumstance. For private structures, the government ought to enhance the overall population mindfulness program with the goal that open purchaser can likewise comprehend that green building will bring a good indoor condition and prompts maintainable advancement [2]. China has presented the star rating framework (1, 2 and 3 star) which will be allot to these parameters; land, energy, water and material saving, indoor environmental quality, operation and administration.

In USA, LEED (Leadership in Energy and Environmental Design) rating system developed by USGBC (United States Green Building Council) are used to assess earth execution of a building and empower advertise change. It began in 1993 and was propelled in 1998 with the pilot variant [3]. It is additionally a credit-based framework enabling the task to gain focuses, to quicken the market towards green building. The different LEED items are LEED V3.0 - New development and Major Renovation, LEED for School, LEED for Existing Building. LEED additionally has a guaranteed rating framework in which structures are perceived. There are three-confirmation levels Silver, Gold, Platinum. For achieving them, structures must qualify factors that are sustainable sites, energy and atmosphere, water efficiency, indoor environmental quality, material and resources, innovation and development, awareness and education [4].

In United Kingdom (UK), Building Research Establishment Environmental Assessment Method (BREEAM) is the principal rating system to evaluate the building in view of certain objective esteems for various criteria. BREEAM is generally utilized for its adaptability. Building Research Establishment (BRE) propelled it in the year 1990. It surveys the nearby codes and permits application in the worldwide building. It is followed in 77 nations. So far, BREEAM has guaranteed 56,000 structures. The rating levels of BREEAM are; Unclassified, Pass, Good, Very Good, Excellent, Outstanding. These are based on, management, health and well-being, energy, transport, water, waste, materials, pollution, land use and ecology, and innovation [5]. In BREEAM, new construction comprises of 49 individual appraisal issues spreading over about nine natural classes, in addition to a 10th class called 'development'. BREEAM credits are granted on basis of that a building meets the best practice execution levels characterized by wellbeing and prosperity.

COMPARISONS OF CERTIFICATION/RATING SYSTEMS

INDIA

In India following systems to identify the green building are used

a. 'Green Existing Building Operation and Management Rating System (GEBOM) by Indian Green Building Council, known as 'GBCI-GEBOM'
b. GRIHA, Green Rating for Integrated Habitat Assessment

The details of the above are discussed below.

GBCI- GEBOM

GBCI- GEBOM is the primary rating system used in India only for existing buildings and depends on acknowledged ecological standards. The system is intended to be far-reaching in scope, and straightforward in a particular task. GBCI- GEBOM has set up a committee to monitor the evaluation system [6]. The changed involvement and callings of the individuals acquire an all-encompassing point of view during the time spent on building up the rating program. GBCI endeavors to extend green building parameters to all buildings. The rating system will ensure that it is invigorated, contemporary and empowers Indian construction standards and measures.

GBCI- GEBOM is at an extremely fundamental level proposed to address national needs of advantage assurance while giving individual fulfillment to inhabitants. The rating program uses particularly recognized Indian national standards and if subsequent are not available, legitimate worldwide standards have been considered. The highlights of GBCI- GEBOM system are as following [6].

i. The spotlight is on execution and results accomplished.
ii. Documentation necessities have been definitely lessened. Rather, it is a greater amount of confirmation like photographs and estimations.
iii. The rating can be connected to both cooled and non-ventilated structures.
iv. The rating can be intended to suit for all building in each climatic zone. Avoidances should be private for structures.
v. Water is given to higher weightage as it matter of national concern.
vi. For energy related point of views, Energy Conservation Building Code (ECBC) or Energy Performance Index (EPI) suggested by Bureau of Energy Efficiency (BEE), is the reference standard.
vii. A different module 'Health and Comfort' is incorporated, to address the wellbeing and prosperity of inhabitants in the buildings.

GBCI- GEBOM framework towards to green buildings highlights under the following classes; [6]

a. Site and facility management

i. Building materials to have at least 10% reused content, by cost.
ii. 50% of the wood materials have FSC, PEFC, or proportional accreditation.
iii. Half of waste produced (by weight or volume) on location does not go to dump.
iv. Paints and glues to have low VOC.
v. Laborers associated with the development to be given restrooms and drinking water.
vi. All machines used to have BEE 3-star or above rating.

b. Water efficiency

i. Water from sources like, bore wells, normal wells, metropolitan water is considered as consumable.
ii. On the off chance that treated wastewater/caught rainwater are being reused for all possible applications.

c. Energy Efficiency

i. EPI Method
ii. Energy Simulation Method

d. Health and Comfort

Smoking zone should be separate and smoking is not allowed outside the smoking zone. Smoking room must be straight forwardly depleted to the outside ambiance far from air admissions and building passageways.

e. Innovation
Actualize measures that are not tended to in the rating framework but rather can fundamentally lessen ecological effects. Perform past edge limits determined in credit classes of the rating system.

The rating corresponding to above mentioned factors is listed in [Table 1].

Table 1: LEED- GEBOM rating system

Site and Facility Management(Max 18 points)		
SF Mandatory Requirement 1	Green Policy	Required
SF Mandatory Requirement 2	Waste Collection & Disposal	Required
SF Credit 1	Eco-friendly Commuting Practices: 25%, 50%	4
SF Credit 2	Eco-friendly Landscaping Practices: 50%, 75%	2
SF Credit 3.1	Heat Island Reduction, Non-roof: 50%, 75%	4
SF Credit 3.2	Heat Island Reduction, Roof: 50%, 75%	4
SF Credit 4	Outdoor Light Pollution Reduction	2
SF Credit 5	Building Operations & Maintenance	2
Water Efficiency (Max 26 points)		
WE Mandatory Requirement	Water Efficient Fixtures	Required
WE Credit 1	Water Efficient Fixtures: 20%,30%,40%	6
WE Credit 2	Rain Water Harvesting: 25%, 50%	4
WE Credit 3	Waste Water Treatment, 100%	4
WE Credit 4	Waste Water Reuse, 75%, 100%	4
WE Credit 5	Water Metering	4
WE Credit 6	Turf Area: 50%, 25%	4
Energy Efficiency(Max 30 Points)		
EE Mandatory Requirement 1	Eco-friendly Refrigerants & Halons	Required
EE Mandatory Requirement 2	Minimum Energy Performance	Required
EE Credit 1	Improved Energy Performance: 10%, 12.5%, 15%, 17.5%, 20%, 22.5%, 25%	14
EE Credit 2	On site Renewable Energy: 2.5%, 5%, 7.5%	6

EE Credit 3	Off Site Renewable Energy: 25%, 50%, 75%	6
EE Credit 4	Energy Metering	4
Health and Comfort (Max 14 points)		
HC Mandatory Requirement 1	Tobacco Smoke Control	Required
HC Mandatory Requirement 2	Fresh Air Ventilation	Required
HC Credit 1	Carbon dioxide Monitoring & Control	2
HC Credit 2	Isolation of Polluting Equipment & Systems	2
HC Credit 3	Eco-friendly Housekeeping Chemicals	2
HC Credit 4	Thermal Comfort, Indoor Temperature & RH	2
HC Credit 5	Facilities for Differently Abled People	4
HC Credit 6	Occupant Well-being Facilities 2	2
Innovation Category		
INN Credit 1.1 – 1.5	Innovation Credits	10
INN Credit 2	GBCI AP	2

GRIHA

India, the main economy, is the seventh biggest nation in the world. The development business plays an essential part of the nation's economy, which is reflected in the expanding land advancement occurring in India. In the light of developing energy shortage, asset crunch, expanding ozone-depleting substance outflows, it has ended up inescapable to move to a greener development industry. The GRIHA, Simple Versatile Affordable GRIHA, what's more, GRIHA for vast advancement rating frameworks have been endeavoring to address these worries and accomplish manageability since the most recent couple of years. Albeit more than 2/3rd of the building stock in India is however, to be fabricated, the current structures are a pool of asset investment funds prepared to be tapped. Arrangements must be found for the moderately substantial quantum of the current structures in India, as there are 8700 million kWh and 74 lakh huge amounts of CO_2 sparing potential secured them. The running expenses likewise, hold a noteworthy piece of the costs in the current structures, which make the move considerably more lucrative. The GRIHA Council has built up a rating framework for existing structures. GRIHA for Existing Buildings (EB) rating is a coordinated instrument to evaluate the execution of existing structures and give reasonable arrangements while expanding the indoor solace of the inhabitants. The evaluated structures will appreciate upgraded energy and water execution and expanded warm, visual solace; eventually bringing about diminished operational, and support costs. Particularly the business structures remain to profit significantly more with the upgraded estimation of the property cost and expanded occupant maintenance of the evaluated structures. GRIHA for Existing Buildings rating is outlined with underlined targets, for example, achieving a natural disaster reduction, effortlessness in execution, the arrangement with nearby what's more, national objectives, and cost viability. The rating attempts to give answers to different typologies what's more, periods of the building taking into account the differing climatic zones of India, and incorporate RWAs and clients of territories in the procedure. The rating would be evaluated on particular areas, which are basic for a comprehensive change in the execution of the building. The parameters of GRIHA are –

i. Site parameters
ii. Maintenance & Housekeeping
iii. Energy Efficiency
iv. Water Efficiency
v. Human health and comfort
vi. Social aspects
vii. Bonus points

The certification levels of India are presented in [Table 2]

Table 2: Certification level in India

Certification Level	Points	Recognition
Certified	50-59	Best Practices
Silver	60-69	Outstanding Performance
Gold	70-79	National Excellence
Platinum	80-100	Global Leadership

CHINA

The Evaluation Standard for Green Building (ESGB) was setup by MOHURD in 2006 in China. The principal target of the models is to bring the reasonable improvement up in building part. The principles work by certifying the rating from 1 to 3 stars in view of their execution against 6 defined criteria. A new form of ESGB was presented in the year 2014. There are a few contrasts between ESGB-2006 and ESGB-2014 [Table 3].

Table 3: ESGB-2006 and ESGB-2014[2]

	ESGB-2006	ESGB-2014
Evaluation phase	Operation phase	Design phase, operation phase
Evaluation objects	Residential& public building	Civil building
Index categories	Energy, resources, environmental load& IEQ, Operation management& control the general preferences item	Energy, resources, environmental load& IEQ Operation management Construction management control & score items
Structural system	Control items & general performance	Control & score items
Evaluation method	Counting the number of provisions	Total score rate

This prompts the propel advancement in the field of innovation development. The rating is characterized by focusing on the whole of weighted scores of items, which have been already scored, and inventive things. The evaluation rates structures with an assortment of pre-essentials and credits in six classes.

i. Land saving and open air condition
ii. Energy Saving
iii. Water sparing
iv. Material Saving
v. Indoor Environmental Quality
vi. Operation and administration

a. Land Saving & Outdoor Environment

China being the most noteworthy populated nation has the lack of land all through. This prompts real issues that are the reason it advances the land sparing arrangement. ESGB 2014 advances the use of more and more open transport to limit the stopping regions. Furthermore, the ESGB 2014 that the separation between transport station and railroads station ought to be in constrained separation and as far as possible benefits of arranging space are endorsed too.

b. Energy Saving

ESGB assesses the building energy execution by assessing the parameters of warming ventilation, aerating and cooling, lightning, exhaustive usage of energy. ESGB 2014 additionally elevates to use the sustainable power source. It recommends that it is important to use the encompassing condition to decrease the building energy expenditure.

c. Water saving

Saving and reuse of water are exceptionally vital on the grounds that lone 3% of water is in the crisp frame. It's important to urge extend groups to exploit each opportunity to reduce water utilization. ESGB 2014 makes it obligatory to use the water sparing hardware, water accumulation, and green water system. ESGB 2014 additionally elevates to gather the rainwater from roof to ground. It additionally has the obligatory control for seepage arrangement of water sparing performance.

d. Materials saving

ESGB, for the most part, encourages diminishing the material utilization, urges to decrease source lessening to utilize imaginative development practices, for example, pre-assembled and configuration to dimensional development zone, in this manner limiting the materials shorts. In ESGB 2014, just a single necessity is identified with utilizing the reused materials, considerably more this thing in score things. ESGB sets a pointer to materials reusing and reusing the activity administration things, including the recuperation rate of waste and it must be over 30%. It additionally recommends controlling the transportation distance.

e. Indoor Environment Quality

The Indoor Condition could improve the profitability, expire non-attendance. ESGB 2014 puts an awesome accentuation on indoor condition quality yet considers air quality. ESGB 2014 has likewise incorporated the sound protection execution into the extent of evaluation and set the base furthest reaches of sound protection execution. China takes the air quality in the development procedure; the nature of development site condition ought to be successfully great. China has not restricted the smoking in broad daylight territories but rather has made the different rooms in air terminal and railroad station.
The certification levels in China are discussed in [Table 4].

Table 4: Certification level in China (Public building)[2]

Grade	Land saving and outdoor environment	Energy saving and energy utilization	Water saving and water resource utilization	Material saving and material resource utilization	Indoor Environment Quality	Operating Management
1 star	4	2	3	3	2	4
2 star	5	3	4	4	3	5
3 star	6	4	5	5	4	6

UNITED KINGDOM (UK)

Green building is a rising point of research in UK. The UK government has focused on green structures into a frame that concentrates upon a low carbon emission and the advantages that emerge from embracing this is the evaluation technique which is viewed as the principal of green building rating framework, proposed by BRE (Building research establishment).It was acquainted with the market in 1990 and was amended to survey workplaces in 1993. It is broadly acknowledged that all later real green building rating frameworks, for example, LEED, Green star and CASBEE are affected by BREEAM.

BREEAM is generally utilized as attributable to adaptability. It surveys neighborhood codes and conditions as well as permits applications in global structures [7,8]. Notwithstanding BREEAM empowers assessment of a structures lifecycle in view to configuration to fabricate, task and renovation. BRE gives new development, in-utilize renovation and fit-out groups and infrastructural manuals for organizers, neighborhood experts, designers and financial specialists. Accordingly, BREEAM has so far issued more than 560000 confirmations. They have expanded their design from 250000 structures in 2014 to 425000 structures in 2015 and 540000 structures in 2016.The pattern is applied to the number of countries adopting BREEAM since 1990, 50 nations in 2014, 70 nations in 2016 and more than 75 nations in 2017. BREEAM certification represents 80% of the European market of the overall industry for sustainable building confirmations. The BREEAM rating levels engage a client or other to differentiate an individual building's execution and other BREEAM evaluated structures. Each BREEAM rating level represents performance equivalent to Outstanding, Excellent, Very Good, Good, Pass [Table 5].

Table 5: Certification Level in UK

BREEAM Rating	%Score
Outstanding	85%
Excellent	70%
Very good	55%
Good	45%
Pass	30%
Unclassified	<30%

BREEAM supports innovation inside the construction business and its production network. There are two ways for grants of 'innovation credits'; i) meeting excellent performance criteria characterized inside a current BREEAM issue; ii) place an application made to BRE Global by the BREEAM. The maximum 'innovation credits' that can be granted to any building is 10. Innovation credits can be granted paying little respect to the building's BREEAM rating. Although the majority of the sustainability pillars could be evaluated by BREEAM, the ecological factor is still pre-dominant.

UNITED STATES (US)

LEED stands for leadership in energy and environmental design. It is a green building rating system governed by USGBC (United States green building board) for the improvement of reasonable structures. Its credits depend on 6 classifications; supportable locales advancement, water sparing, energy sparing, material determination, indoor air quality. The LEED rating framework has turned into the reference point for some nations. There are two forms of LEED i.e. LEED v2.2, and LEED-2009 [Table 6]. LEED v2.2 was presented in the year 2005 and another adaptation was presented in the year 2007. Since its commencement LEED v2.2 was acknowledged internationally and has licensed more than 5000 or more green building. It's a building rating framework, which is utilized from office working to high rises and to evaluate working in any of the districts. One of the primary distinctions between the LEED v2.2 and LEED-2009 is the presentation of the credits in view of provincial need credits. These focuses are not, but rather the extra focuses presented in the rating framework. Other than this LEED, rating framework has no credits based on wellbeing and solace factors. Another issue of the LEED is that it has been criticize as Performa and is more about earning points than improvement. Different parameters of LEED existing buildings are shown in [Table 7].

Table 6: Credits Assigned (LEED Points) [3]

Assessment area	LEED V2.2	LEED2009
Sustainable sites	14	26
Water efficiency	5	10
Energy& atmosphere	17	35
Material& resources	13	14
Indoor environmental quality	15	15
Innovation	5	6
Regional Priority	Not applicable	4

Table 7: LEED for Existing Building[3]

Total possible points	110
Sustainable sites	26
Water efficiency	14
Energy and atmosphere	35
Material and resources	10
Indoor environmental quality	15
Innovation in operations	6
Regional priority	4

OVERVIEW OF LEED, GBCI, BREEAM, AND ESGB

Comparisons of different systems and their weightage are listed in [Table 8] and [Table 9]. In addition, a comparative plot of different rating systems is presented in [Fig.1]. LEED and BREEAM were set up by non-benefit organization, while legislative bodies issue the GBCI and ESGB. The BREEAM is one of the greatest, oldest and most flexible rating framework covers very nearly 77 nations built up in1990 while the LEED was most adequate rating framework accepted by almost 160 nations, set up in the year 1998.Numerous nations plan their rating framework based on LEED. Each appraising framework has its own component, which contributes towards reasonable improvement. The similarity between LEED, GBCI, and BREEAM rating framework is that they all have the credits of "innovation", which prompts the expansion in the way of research of green structures. However, in case of ESGB it focuses mainly on the saving of resources. The uniqueness of LEED is that it has the credits in view of regional priority. The GBCI focuses on wellbeing and comfort issues where the entire rating framework falls behind. BREEAM has guaranteed the 561600 structures, which is seven times more than the building authorizes by LEED [5]. LEED is more straightforward than other rating frameworks yet BREEAM is stricter towards their credits. The entire framework has diverse rating levels. The BREEAM has the maximum number of credits that is the advantage thing for the sake of development.

Table 8: Comparison of Different Rating System

	LEED	BREEAM	GBCI/GRIHA	ESGB
Country	US	UK	INDIA	CHINA
Organization	USGBC	BRE	CIA	MOHURD
Flexibility	160 COUNTRY	77 COUNTRY	1 COUNTRY	1 COUNTRY
First version	1998	1990	2001	2006
Latest version	2013	2016	2013	2014
Main categories	Integrative projects, Energy& atmosphere, Location& transport, Water efficiency, Material resource, Sustainable sites, Regional priority, Innovation	Management, health well-being, Energy, Transport, Water, Material, Waste, Land use& ecology, Pollution, Innovation	Site facility management, Water efficiency, Energy efficiency, Energy efficiency, Health& Comfort, Innovation	Land saving, Outdoor environment, Energy saving, Water saving Material saving, IEQ, Operation& management
Rating Approach	ADDITIVE CREDITS	PREWEIGHTED CREDITS	ADDITIVE CREDITS	THREE STAR RATING SYSTEM
Rating Level	Certified>=40, Silver>=50, d>=60, Platinum>=80	Pass>=30, Good>=45, Very Good>=5 Excellent>=70, Outstanding>=85	Certified 50-59, Silver 60-69, Gold 70-79, Platinum 80-100	1 Star, 2 Star, 3 Star

Table 9: Weightage on different parameters

BREEAM Category	Weightage (%)	LEED Category	Weightage (%)	GBCI Category	Weightage (%)	ESGB Category	Weightage (%)
Management	12.5%	Sustainable Sites	23.6%	Site and Facility Management	18%	Land Saving and Outdoor Environment	20.8%
Health and Well Being	14.5%	Water Efficiency	12.7%	Water Efficiency	26%	Energy Saving and Energy utilization	12.5%
Energy	19.5%	Energy and Atmosphere	31.8%	Energy Efficiency	30%	Water Saving and Water Utilization	16.6%
Transport	8%	Material and Resources	9%	Health and Comfort	14%	Material Saving and Material Utilization	16.6%
Water	6%	Indoor environment Quality	13.6%	Innovation	12%	IEQ	12.5%
Materials	13%	Innovation in Operation	5.4%			Operating Management	20.8%
Waste	5%	Regional Priority	3.6%				
Land use and Ecology	10.5%						
Pollution	9.5%						
Innovation	10%						

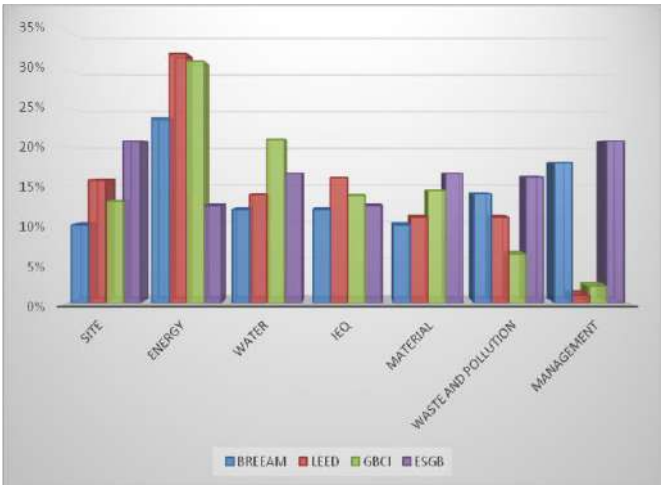

Fig. 1: Analytical comparison between credit systems of different countries.

CONCLUSIONS

To meet the objective of sustainable development, the approach of green building ought to be underlined with incredible potential so we can add to the earth too. We have to survey the execution of each significant working as indicated by green building measures for existing building. LEED-EBOM Conserving energy is not just a solitary objective for a green building. The government ought to likewise implement the engineers to get this approach, by giving sponsorships and monetary backings with the goal that we can move towards greener built environment. A building ought to be designed such that a solitary plan could meet the prerequisite and can last for a long time. Contingent upon the focuses earned according to this plan, significant remodels and retrofits can be intended to incorporate sustainability starting and have a decent LEED-EBOM Green building rating. This will decrease activity and support costs and normal impacts and can extend building adaptability, robustness and adaptability. Apportioning essentialness is not the primary reason behind retrofitting existing structures; rather the target should be to make predominant working by applying integrated building design process. In China, with the expanding urbanization and fast monetary improvement, the Chinese building business sector will in any case blast in the following a few decade and a vast number of the new building will be developed. The advancement of green building is at

starting stage, huge change must be made with the goal that reexamined norms can be better encourage for their imaginative endeavors to develop the green building. Coordinated methodologies from the perspective of every stake holder should be adopted. We can finish up by studying the above rating frameworks that each evaluating framework has its own criteria composed by the nation's needs. In India GBCI covers all the important parameters that help to move towards the green construction. There are many sub parameters are covered under the different criteria of GBCI which are discussed in this paper. Apart from this, the government of India is also laying the stress on this type of construction by providing the huge benefits in taxes that any industry has to pay. GBCI has included a point of Health & Comfort, which is unique in its own way; it covers the point for differently abled person, carbon dioxide monitoring, thermal comfort etc. that are not present in other rating system that can be counted as its merit.

CONFLICT OF INTEREST

None

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FINANCIAL DISCLOSURE

None

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ARTICLE

ENERGY EFFICIENT RELIABLE (2^NX1) MULTIPLEXER DESIGN USING QCA APPROACH

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ABSTRACT

In the fast growing VLSI technology, designing allows power utilizing tool turns into a testing task and leads to the era of Quantum-dot cellular automata (QCA). It is one of the unconventional computing stages with cutting edge technology that has the potential of achieving higher speeds, smaller size, and mainly low power consumption in comparison with CMOS technology. This paper presents an evolutionary approach to investigate and realize a modular 2^N to 1 mux. The design is done using AND & OR blocks. The proposed multiplexer is designed and simulated using the QCA Designer tool 2.0.3 in Windows XP operating system. It is observed that the designed multiplexer is efficient in terms of complexity, area, delay and cell count when compared to the previous designs.

KEY WORDS
4×1 Multiplexer, QCA Designer, Majority Gate, Inverter, Power Dissipation

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INTRODUCTION

QCA Designer is one of the good simulation tools to make exact simulation and design for quantum-dot cell automata (QCA). Complex QCA circuits can be produced utilizing QCA Designer on most standard stages. In Boolean capacity and circuit outlines multiplexer is the primary part and plays a critical part. An intuitive approach is carried out to realize a modular 2^n to 1 mux using AND & OR blocks. A basic MUX uses the basic building blocks such as AND & OR. The main objective is to design an efficient mux which has improved values in terms of cell count, complexity, area, and delay [1-6].

The data is communicated through every cell and not held. Every cell eradicates its own particular state after each cycle of the clock QCA Memory Cell. For designing in QCA, a developer must be able to combine basic utilities and then design it in the QCA Designer tool. To accomplish this simulation engines are integrated into QCA Designer. Basically there are three simulation engines in QCA Designer. The first is a digital logic simulator, which views cells as either invalid or plenarily polarized. The next is a stable state of cells within an outline which is determined by the non-linear approximation engine. The third is a quantum mechanical model of a system which depends on the estimation of two states Hamiltonian [7-9].

Due to large number of cells, experimental data cannot be provided for QCA systems which lead to a problem of implementing precise simulation. However, there are countless small QCA systems which have been developed resulting which a motivation is driven for research and implementation of various circuit designs. This research and implementation can further be used to design a specific or particular system.
The QCA cell is square formed and it comprises of four quantum dots as shown in Figure 1. The electrons possess the contrary corners in the fault free QCA cell due to columbic repulsion and gives two stable configurations logic'0' and logic'1' with polarization P = -1 and P = +1 respectively. There will be no actual discharge in capacitor as in conventional CMOS while changing state from logic'0' to logic'1' in QCA cell. There are four clock signals in the QCA designer tool. These clocks help in preventing any traffic inflow of information [10-12].

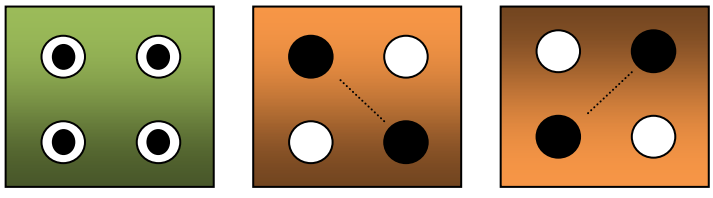

Fig. 1: QCA cell

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As seen from [Fig. 1], four quantum dots are present in a single QCA cell which is organized in a square pattern. 2 extra electrons, which always reside diagonally to each other inside a cell, by tunneling which externally, mutual electrostatic repulsive force is created between these electrons and we can get either of the two logics: logic '0' or logic '1' [13-14]. The synchronize of clock phases is done by using four different clock phases as shown in [Fig. 2].

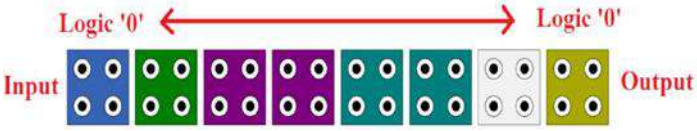


Fig. 2: Clock coding

DESIGN OF NAND & NOR GATE USING QCA

NAND gate design

NAND is one of the two universal gates. NAND is built using AND gate as shown in [Fig. 3]. By inverting the AND output, that is by arranging a cell diagonally to the AND output and keeping it as output we get the NAND gate output.

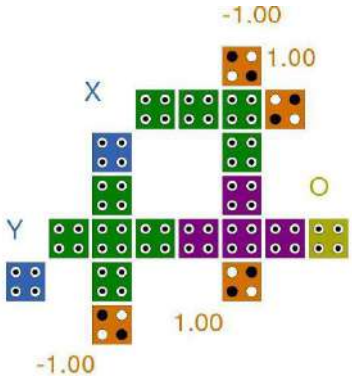


Fig. 3: Design of QCA NAND Gate in QCA Designer

NOR GATE design

NOR is one of the two universal gates. NOR is built using OR gate as shown in [Fig. 4]. By inverting the OR output, that is by arranging a cell diagonally to the OR output and keeping it as output we get the NOR gate output.

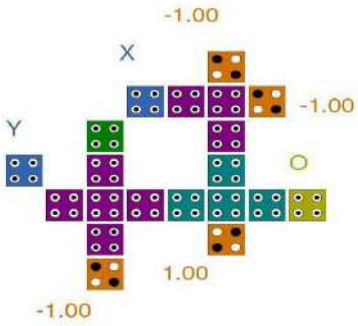


Fig. 4: Design of QCA NOR Gate in QCA Designer

QCA CLOCKING SYSTEM

There are four clock signals in the QCA Designer tool. These clocks help in preventing any traffic inflow of information. Each clock signal will be shifted by a phase of 90. This empowers the information to be pumped through the circuit in view of the dynamic locking and unlatching in cells related to different clock cycles. Using four distinct clock phases synchronization of clock phases in QCA cells is done as shown in [Fig.5].

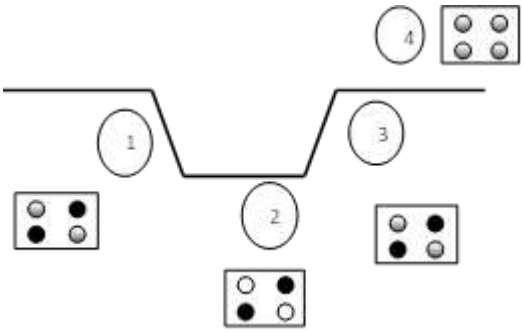
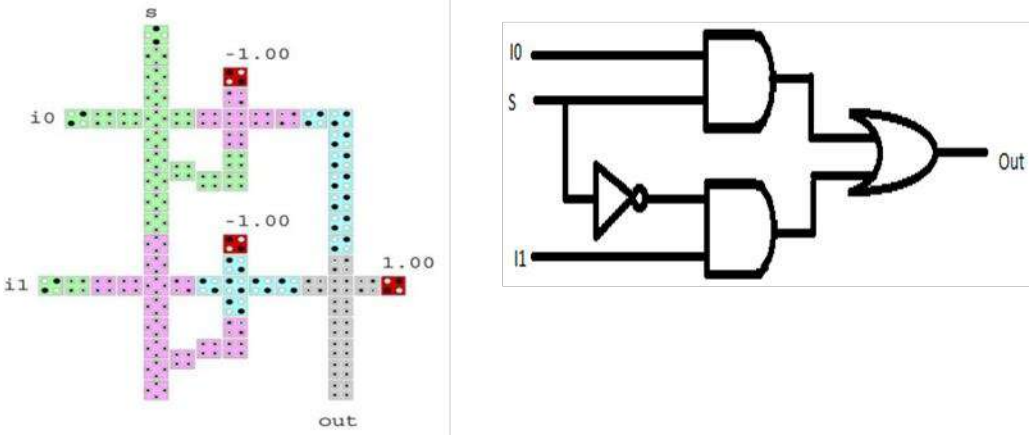


Fig. 5: Stages of the QCA clock

PROPOSED ARCHITECTURE OF MULTIPLEXERS

It can be observed from [Fig. 6] that a 2:1 mux needs three majority gates and one inverter. It can be seen that the inputs 'i0', 'i1' and 's' are put in one clock zone and the outputs are set in another clock zone. The input's' is the select line. This will make the clocking phases to pass over. [Fig. 7] shows the design of 2×1 multiplexer using QCA Designer tool.



(a) (b)

Fig. 6: (a) Existing model of 2×1 Multiplexer (MUX) (b) Symbolic representation of 2×1 multiplexer

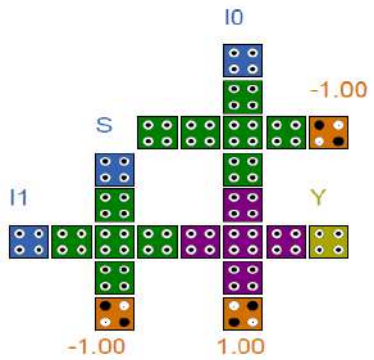


Fig. 7: 2×1 Multiplexer (MUX) design in QCA Designer

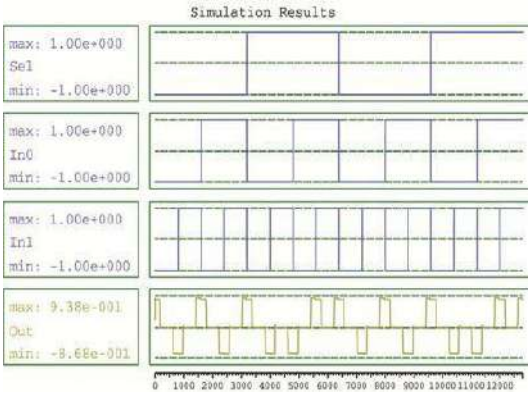


Fig. 8: Simulation results of 2×1 Multiplexer (MUX)

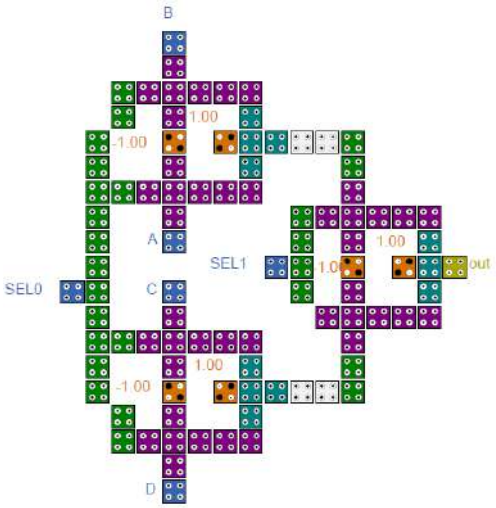


Fig. 9: 4×1 Multiplexer (MUX) design in QCA Designer

[Fig. 8] shows the simulation results of 2×1 MUX. [Fig. 9] shows the design of a 4×1 mux using QCA designer tool. It is observed from the figure that it has four data lines (i0, i1, i2, i3) and two select lines (S0 and S1) of the 4:1 mux. The proposed design uses the concept of the module used for 2:1 mux. [Fig. 10] shows the simulation results of 4×1 multiplexer [15-18].

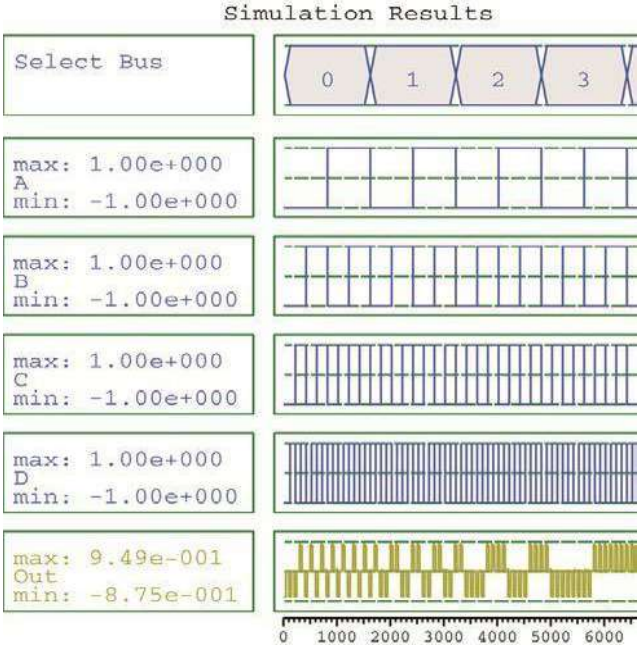


Fig. 10: Simulation results of 4×1 Multiplexer (MUX)

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CONCLUSION

This paper presents an evolutionary approach to explore and realize a modular 2^N to 1 mux. The design is prepared using the AND & OR blocks. The proposed multiplexer is designed and simulated using the QCA Designer tool 2.0.3 in Windows XP operating system. It was observed that the designed multiplexer is efficient in terms of complexity, area, delay and cell count when compared to the previous designs.

CONFLICT OF INTEREST

The authors do not have any conflict of interest.

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FINANCIAL DISCLOSURE

None

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