Online ISSN : 0975-4172
Print ISSN : 0975-4350

Global Journal

of Computer Science and Technology: E

Network, Web & Security

Highlights

Nano Sensing Network

Mobile Object-Tracking

Protocol for Wireless

Multicast Routing Protocols

Discovering Thoughts, Inventing Future

VOLUME 15 ISSUE 8 VERSION 1.0

Global Journal of Computer Science and Technology: E
Network, Web & Security

Global Journal of Computer Science and Technology: E
Network, Web & Security

Volume 15 Issue 8 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*

Sponsors: *Open Association of Research Society*
Open Scientific Standards

Publisher's Headquarters office

Global Journals Headquarters
301st Edgewater Place Suite, 100 Edgewater Dr.-Pl,
Wakefield MASSACHUSETTS, Pin: 01880,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Including by Air Parcel Charges):

For Authors:
22 USD (B/W) & 50 USD (Color)
Yearly Subscription (Personal & Institutional):
200 USD (B/W) & 250 USD (Color)

Integrated Editorial Board
(Computer Science, Engineering, Medical, Management, Natural Science, Social Science)

Dr. Bart Lambrecht
Director of Research in Accounting and FinanceProfessor of Finance
Lancaster University Management School
BA (Antwerp); MPhil, MA, PhD (Cambridge)

Dr. Carlos García Pont
Associate Professor of Marketing
IESE Business School, University of Navarra
Doctor of Philosophy (Management), Massachusetts Institute of Technology (MIT)
Master in Business Administration, IESE, University of Navarra
Degree in Industrial Engineering, Universitat Politècnica de Catalunya

Dr. Fotini Labropulu
Mathematics - Luther College
University of ReginaPh.D., M.Sc. in Mathematics
B.A. (Honors) in Mathematics
University of Windso

Dr. Lynn Lim
Reader in Business and Marketing
Roehampton University, London
BCom, PGDip, MBA (Distinction), PhD, FHEA

Dr. Mihaly Mezei
ASSOCIATE PROFESSOR
Department of Structural and Chemical Biology, Mount Sinai School of Medical Center
Ph.D., Etvs Lornd University
Postdoctoral Training,
New York University

Dr. Söhnke M. Bartram
Department of Accounting and FinanceLancaster University Management SchoolPh.D. (WHU Koblenz)
MBA/BBA (University of Saarbrücken)

Dr. Miguel Angel Ariño
Professor of Decision Sciences
IESE Business School
Barcelona, Spain (Universidad de Navarra)
CEIBS (China Europe International Business School).
Beijing, Shanghai and Shenzhen
Ph.D. in Mathematics
University of Barcelona
BA in Mathematics (Licenciatura)
University of Barcelona

Philip G. Moscoso
Technology and Operations Management
IESE Business School, University of Navarra
Ph.D in Industrial Engineering and Management, ETH Zurich
M.Sc. in Chemical Engineering, ETH Zurich

Dr. Sanjay Dixit, M.D.
Director, EP Laboratories, Philadelphia VA Medical Center
Cardiovascular Medicine - Cardiac Arrhythmia
Univ of Penn School of Medicine

Dr. Han-Xiang Deng
MD., Ph.D
Associate Professor and Research
Department Division of Neuromuscular Medicine
Davee Department of Neurology and Clinical NeuroscienceNorthwestern University
Feinberg School of Medicine

Dr. Pina C. Sanelli
Associate Professor of Public Health
Weill Cornell Medical College
Associate Attending Radiologist
NewYork-Presbyterian Hospital
MRI, MRA, CT, and CTA
Neuroradiology and Diagnostic Radiology
M.D., State University of New York at Buffalo,School of Medicine and Biomedical Sciences

Dr. Roberto Sanchez
Associate Professor
Department of Structural and Chemical Biology
Mount Sinai School of Medicine
Ph.D., The Rockefeller University

Dr. Wen-Yih Sun
Professor of Earth and Atmospheric SciencesPurdue University Director
National Center for Typhoon and Flooding Research, Taiwan
University Chair Professor
Department of Atmospheric Sciences, National Central University, Chung-Li, TaiwanUniversity Chair Professor
Institute of Environmental Engineering, National Chiao Tung University, Hsin-chu, Taiwan.Ph.D., MS The University of Chicago, Geophysical Sciences
BS National Taiwan University, Atmospheric Sciences
Associate Professor of Radiology

Dr. Michael R. Rudnick
M.D., FACP
Associate Professor of Medicine
Chief, Renal Electrolyte and Hypertension Division (PMC)
Penn Medicine, University of Pennsylvania
Presbyterian Medical Center, Philadelphia
Nephrology and Internal Medicine
Certified by the American Board of Internal Medicine

Dr. Bassey Benjamin Esu
B.Sc. Marketing; MBA Marketing; Ph.D Marketing
Lecturer, Department of Marketing, University of Calabar
Tourism Consultant, Cross River State Tourism Development Department
Co-ordinator , Sustainable Tourism Initiative, Calabar, Nigeria

Dr. Aziz M. Barbar, Ph.D.
IEEE Senior Member
Chairperson, Department of Computer Science
AUST - American University of Science & Technology
Alfred Naccash Avenue – Ashrafieh

Contents of the Issue

Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 15 Issue 8 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Spectrum Assignment Scheme based on Genetic Algorithm for Cognitive Radio Receiver

By Veena Gawde, B. K. Mishra & Rajesh Bansode
University of Mumbai, India

Abstract- Spectrum scarcity is one of the major challenges that the present world is facing. The efficient use of existing licensed spectrum is becoming most critical as growing demand of the radio spectrum. Different researches show that the use of licensed are not utilized inefficiently. It has been also shown that primary user does not use more than 60% of the licensed frequency band most of the time. There is need to find the techniques that can efficiently utilize the under-utilized licensed spectrum. One of the approaches is the use of "Cognitive Radio". This allows the radio to learn from its environment, changing certain parameters. Based on this knowledge the radio can dynamically exploit the spectrum holes in the licensed band of the spectrum. This paper focuses on the performance of spectrum allocation technique, based on popular meta-heuristics Genetics Algorithm. Analyzing the performance of this technique using Matlab achieves mean fitness of 9.41. It provides fittest channels to the cognitive user on the basis of four priority parameters (genes) viz frequency, power, BER and modulation.

Keywords: *cognitive radio, genetic algorithm, spectrum assignment, decision making, optimization.*

GJCST-E Classification : *I.3.7 I.4.1*

Strictly as per the compliance and regulations of:

Spectrum Assignment Scheme based on Genetic Algorithm for Cognitive Radio Receiver

Veena Gawde [α], B. K. Mishra [σ] & Rajesh Bansode [ρ]

Abstract- Spectrum scarcity is one of the major challenges that the present world is facing. The efficient use of existing licensed spectrum is becoming most critical as growing demand of the radio spectrum. Different researches show that the use of licensed are not utilized inefficiently. It has been also shown that primary user does not use more than 60% of the licensed frequency band most of the time. There is need to find the techniques that can efficiently utilize the under-utilized licensed spectrum. One of the approaches is the use of "Cognitive Radio". This allows the radio to learn from its environment, changing certain parameters. Based on this knowledge the radio can dynamically exploit the spectrum holes in the licensed band of the spectrum. This paper focuses on the performance of spectrum allocation technique, based on popular meta-heuristics Genetics Algorithm. Analyzing the performance of this technique using Matlab achieves mean fitness of 9.41. It provides fittest channels to the cognitive user on the basis of four priority parameters (genes) viz frequency, power, BER and modulation.

Keywords: cognitive radio, genetic algorithm, spectrum assignment, decision making, optimization.

I. Introduction

The radio spectrum is a natural resource, and used by transmitters and receivers in a communication network. In the past years, end user became service oriented which increased demand of wireless applications resulting in increased demand of bandwidth caused spectrum scarcity. The efficient use of licensed spectrum becomes a subject of recent contributions [1]. One of the leading technologies to answer the spectrum overcrowding problem is Cognitive Radio.

Simon Haykin defines Cognitive Radio, it as follows [2]: "Cognitive radio is an intelligent wireless communication system that is aware of its surrounding environment (i.e., outside world), and uses the methodology of understanding-by-building to learn from the environment and adapt its internal states to statistical variations in the incoming RF stimuli by making corresponding changes in certain operating parameters (e.g., transmit power, carrier-frequency, and modulation strategy) in real-time, with two primary objectives in mind:

- highly reliable communications whenever and wherever needed;
- efficient utilization of the radio spectrum.

The regulatory bodies focus on the operation of transmitter like FCC defines the cognitive radio as: A radio that can change its transmitter parameters based on interaction with the environment in which it operates [1]. So among all definitions it is observed that following terminologies are common "Observation", "Adaptability" and "Intelligence".

One of the most important components of the cognitive radio concept is the ability to measure, sense, learn, and be aware of the parameters related to the radio channel characteristics, availability of spectrum and power, radio's operating environment, user requirements and applications, available networks (infrastructures) and nodes, local policies and other operating restrictions. In cognitive radio terminology, primary users are defined as the users who have higher priority or legacy rights on the usage of a specific part of the spectrum. On the other hand, secondary users, which have lower priority, exploit this spectrum in such a way that they do not cause interference to primary users. Therefore, secondary users need to have cognitive radio capabilities, such as sensing the spectrum reliably to check whether it is being used by a primary user and to change the radio parameters to exploit the unused part of the spectrum.

Cognitive Radio receiver follows cognitive cycle which consists of two major parts shown in fig. 1, that are spectrum sensing and assignment [3]. Spectrum sensing is closely connected to *spectrum analysis*, which determines the characteristics of the spectrum bands that are detected through sensing. After detecting and analyzing the spectrum holes, the *spectrum decision* (or *spectrum assignment*) function selects the best available band according to some criteria [4].

The paper is structured as follows: In section II, a detailed description of challenges, issues faced an different approaches for CR spectrum assignment are given. proposed strategy that is GA for Spectrum assignment is also described. In section III, a CR decision-making process results are analyzed by matlab simulation. Finally, a conclusion is discussed.

Author α: Masters in Electronics and Telecommunication subject. Area of interest is Wireless Communication.
e-mail: veenagawde@gmail.com
Author σ: completed research work in MIMO OFDM in wireless communication. e-mail: tcet.principal@thakureducation.org

II. Spectrum Assignment

Spectrum assignment (SA) is a key mechanism that limits the interference between CR devices and licensed users, enabling a more efficient usage of the wireless spectrum. Spectrum assignment is a basic function of CRNs because it affects the normal operation of the network and is closely related to spectrum sensing, which provides information on the available spectrum. SA is responsible for assigning the most appropriate frequency bands at the interfaces of a cognitive radio device according to some criteria shown in Fig.1 that are maximize throughput, fairness, spectral effciency but at the same time, avoiding interference to primary users operating in the same geographical area.

Spectrum holes that are discovered by spectrum sensing are used as input to spectrum assignment, in order to find the optimum spectrum fragment that the SU should use according to its requirements [4], [5].

Cognitive spectrum assignment has some challenges that differentiate it from the conventional CA as shown in Fig. 2 in wireless networks. In traditional primary wireless networks, the spectrum is split among channels that have fixed central frequency and fixed bandwidth. Thus, traditional CA is the process of assigning a channel (namely the central frequency for use) to each user. In CRNs there is no standard definition for "channels". SUs can dynamically change the central frequency and the bandwidth for each transmission. As a result, the SA function for each SU should determine not only the central frequency, but also the spectrum bandwidth to be used by that SU (according its requirements), unless there is central node that selects frequencies/bandwidths for all SUs (in centralized SA). Moreover, the available frequencies and spectrum holes dynamically change with time and location. These additional challenges increase the complexity of the SA problem in CR networks [6].

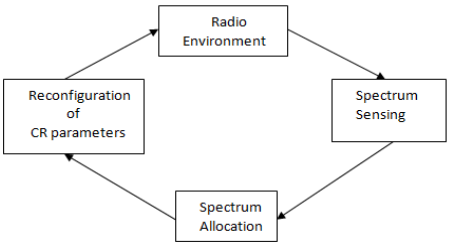


Fig.1 : Cognitive Radio Cycle

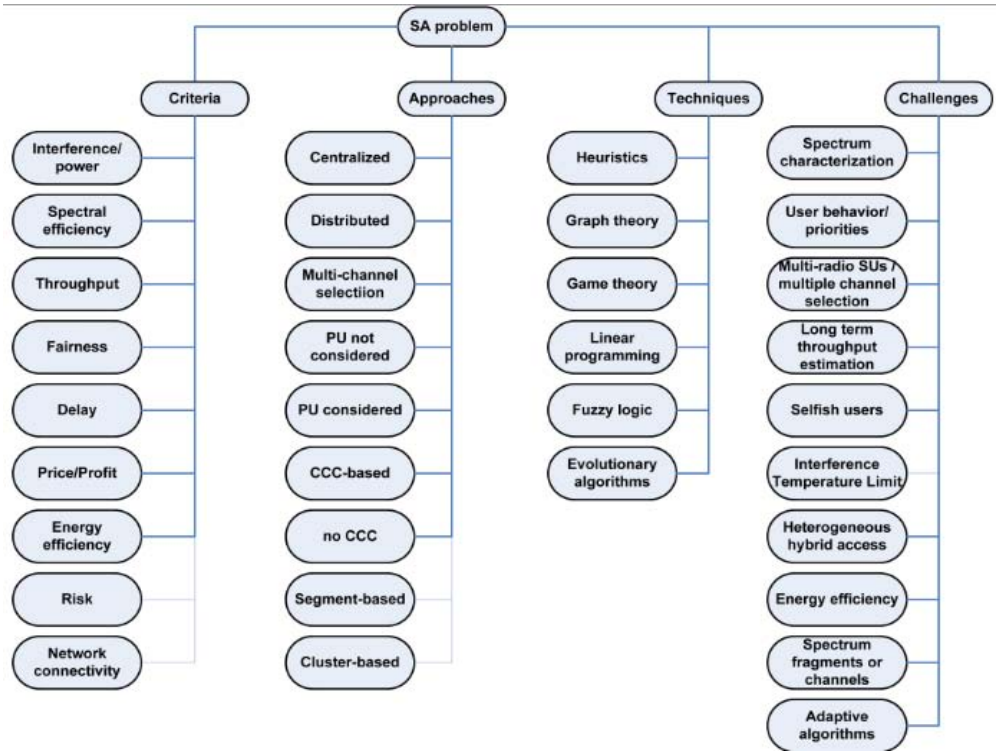


Fig.2 : Spectrum Assignment Problems

a) Introduction to Genetic Algorithm

Evolutionary algorithms are stochastic search methods that mimic natural evolution and the social behavior of species, a category of which are the Genetic Algorithms (GAs). Genetic algorithms are random search techniques used for finding optimal solutions to problems such as cognitive SA [4]. They are based on the principles of evolution and genetics and they are different from other optimization techniques because they are based on nature's notion of "survival of the fittest". This means that the "fitter" individual has higher probability to survive. To solve optimization problems, GA uses fitness functions and requires the parameters to be coded as chromosomes or finite-length strings over a finite alphabet, which are collected in groups called "populations". The populations are then divided into sets of feasible and infeasible solutions with the first being the channel assignments that satisfy the interference constraints or, in general, the requirements of the spectrum assignment [7], [8].

The procedure used in cognitive spectrum assignment based on genetic algorithms requires the definition of several parts, namely "population", "fitness function", "selection", "crossover", and "mutation". Chromosomes usually specify a possible confiict free channel assignment matrix, which is encoded in such a way to avoid redundancy of the elements. To evaluate the fitness of the chromosome, it should be mapped to the channel assignment matrix. For the initial population, the value of every bit in the chromosome is randomly generated and at each iteration, a new population is generated after applying selection, crossover and mutation functions. The evaluation of each chromosome is the objective of the optimizations, and several objective functions are used, such as maximizing throughput, fairness, etc [9].

The advantage of using GAs to solve the optimization problem of spectrum assignment in CR is that they can handle arbitrary kinds of constraints and objectives. Inefficient solutions are simply discarded by the algorithm. One major disadvantage associated with GA is that the process for finding the optimal solution is quite slow and there is always the risk of finding a local minima and not the globally optimal solution [7], [8].

b) Spectrum Assignment using genetic Algorithm

The computation of the GA starts from the assortment of the chromosomes which are randomly generated. Configurable radio parameters viz. transmit power, modulation, coding rate, symbol rate, packet size etc. represent genes of chromosomes. Size of population is taken according to number of cognitive users. Three genetic core operators which help for fittest solution are selection, crossover and mutation.

- *Crossover children* are created by combining the vectors of a pair of parents.
- *Mutation children* are created by introducing random changes, or mutations, to a single parent.
- *Stopping Criteria* depends on the number of maximum iterations and defined fitness value achieved [9].

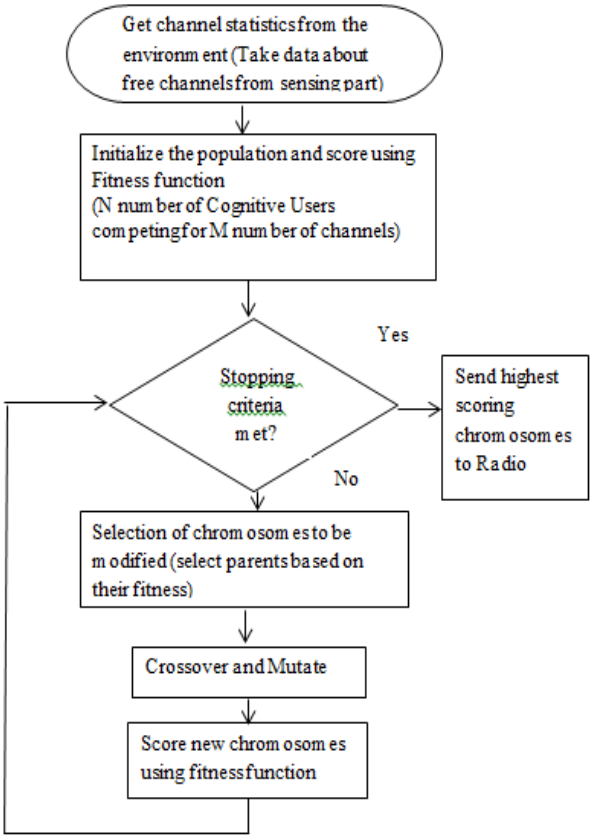


Fig.3 : Genetic Algorithm

Each primary user means a chromosome is identified by its parameters called as Genes. Four Genes are considered for implementation of this Genetic algorithm that are Frequency, Power, BER and Modulation [10].

Table.1 : Representation of chromosome structure

Order	1	2	3	4
Gene	Frequency	Power	BER	Modulation
Ranges	1-100	1-50	1-8	1-4
Bits required	7	6	4	2

Fitness is given by the following formula,

$$fi = \left[\frac{wi.\left|xi - x_i^d\right|}{x_i^d}\right] \; if \; \left|xi - x_i^d < x_i^d\right| \quad \ldots(1.1)$$

$$fi = Wi \qquad otherwise$$

The overall fitness value of chromosome F can be calculated as cumulative sum of indivisual fitness value of all the genes that is

$$F = \sum_{i=1}^{4} fi \quad \ldots\ldots \quad (1.2)$$

In [10] Fitness value in percentage can be given as,

$$Total\ fitness\ (\%) = 100\left[1 - \sum_{i=1}^{4} fi\right] \quad \ldots (1.3)$$

III. Simulation Results and Discussion

Simulation parameters used are as follows:

Population	20
Generations	100
Crossover	80%
Best Fitness	9.0896

Fitness function shown above in equation (1.1) is optimized using GA tool.

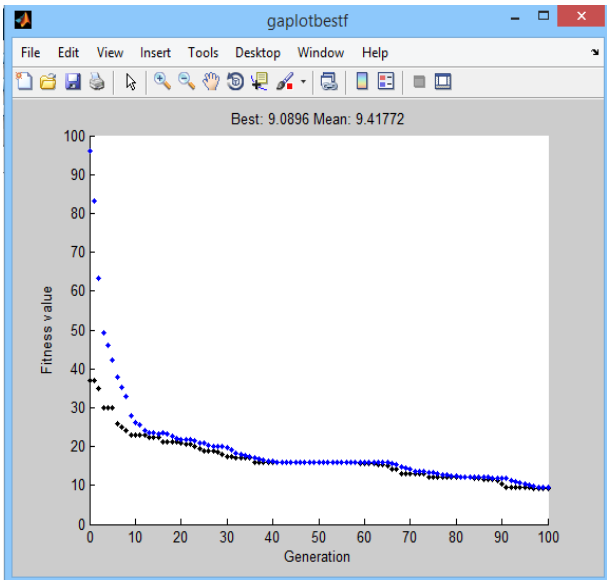


Fig. 4 : Fitness value for number of generations

The graph shown in fig 4 shows mean and best fitness value for number of generations GA is set. Here, for 100 number of generations fitness value is evaluated. As number of generations increases, mean and best value of fitness comes closer. Best value and mean value of fitness achieved by this GA is 9.0896 and 9.41772. Higher value of fitness shows more number of candidate channels are available to get occupied by cognitive users.

From parent population, child population is generated. Initially population of 20 is taken and then by crossover of 0.8 and mutation operation child population is generated. As shown in Fig. 5, Each parent population is operated by optimization tool and randomly few are mostly selected to create their child population further. Thus Crossover and mutation operators increases the population and enhances the performance of GA

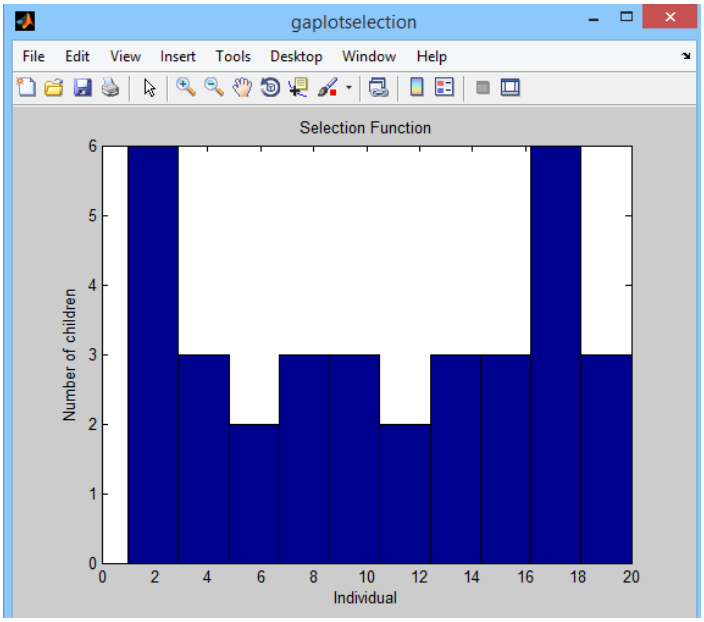


Fig. 5 : Fitness value for number of Children population generated Versus Indivisual

In this plot shown in Fig.6, Frequency is having high priority to decide selection of channel to avoid interference, power is having second priority and then BER and modulation are almost with equal priorities. As mentioned in table 1, Frequency, power, BER and

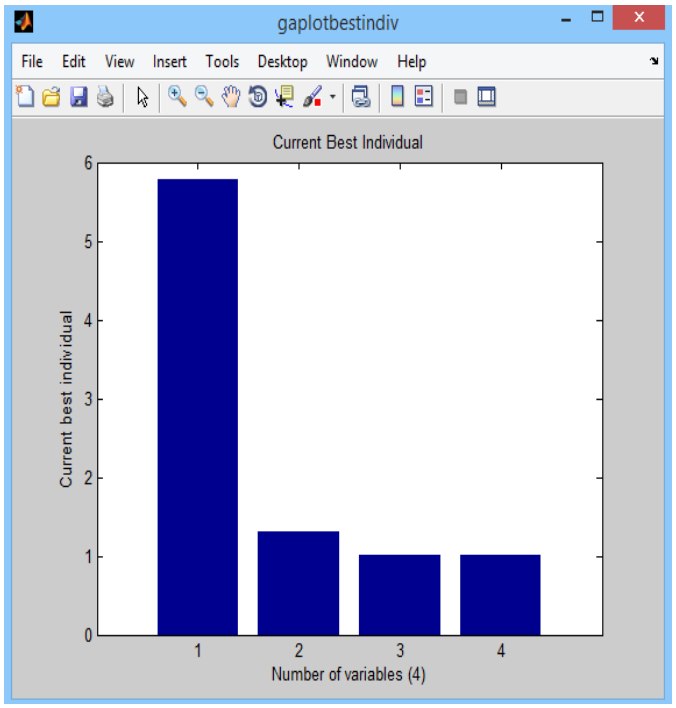


Fig. 6 : Current Best indivisual versus Number of variables

Modulation are the parameters on the basis of which channel suitability for assignment is checked.

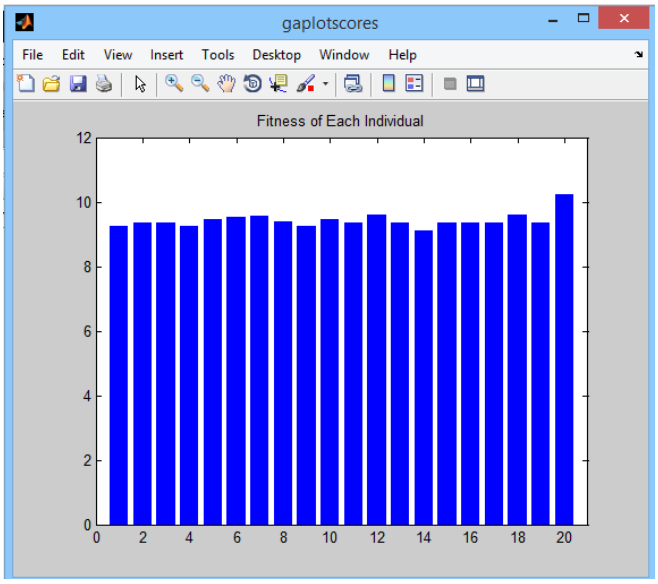


Fig. 7 : Fitness of each Indivisual

Fig. 7 shows fitness of each indivisual obtained in all iteartions of GA.

IV. Conclusion

This work shows that the fitness function of the individual parameters or genes increases with increase in number of generations, but this performance is always not linear. This performance of the G.A. is due to the existence of other genes in the chromosome structure that affect the decision-making process, to reach an optimal solution. This is for the reason that the optimal solution reached by the Genetic Algorithms may have to cooperation for an individual gene to have a better solution for another gene in the structure at the same moment and therefore obtain a better overall fitness value of the chromosomes. GA actually go for the nearby possible values for each gene along with the available pool of solutions. Also, the range for decision-making connected with each gene affects the decision-making process. A gene with a lesser range i.e. modulation gene in this case have a higher fitness value, while with a bigger range i.e. frequency gene in this case will have a worse fitness value in the optimal solution found by the GA, over the number of generations. This mean that the individual fitness values for the genes may not increase in the same manner, however the total fitness value stay almost 9.41 all through the generations and find the nearby probable best values in the existing pool of solutions .

References Références Referencias

1. J. Mitola III and G. Maguire Jr, "Cognitive radio: making software radios more personal," *Personal communication, IEEE,* vol .6, no.4, pp. 13-18, 1999.
2. S. Haykin, "Cognitive radio: brain-empowered wireless communications," *IEEE Journal on Selected Areas in communications,* vol.23, No. 2, pp.201–220, 2005.
3. Nolan, K., Doyle, L. ; S. Oh ; Cabric, D. "Cognitive radio: Ten years of experimentation and development," *IEEE Communication Magazine*, vol.49,no.3, pp.90-100, 2011.
4. B. Wang and K. Liu, "Advances in cognitive radio Networks: A Survey," *IEEE Journal of Selected Topics in Signal Processing*, Vol. 5, No. 1, Feb 2011.
5. E. Tragos, S. Zeadally, A. Fragkiadakis and V. Siris, "Spetrum assignment in Cognitive radio Networks: A comprehensive Survey," *IEEE Communications Surveys & Tutorials, 2013.*
6. L. Lu, X. Zhou, U. Onunkwo and G. Li, "Ten years research in spectrum sensing and sharing in cognitive radio," *EURASIP Journal on Wireless Communications and Networking,* 2012.
7. T. Rondeau, Bin Le, C. Rieser, "Cognitive radios with Genetic algoriths: Intelligent control of software defined radios," *Proceeding of the SDR 04 Technical Conference,* 2004.
8. Z. Zhao, Z. Peng, S.Zheng, J. Shang, " Cognitive Radio Spectrum allocation using Evolutionary algorithms," *IEEE Transactions on Wireless Communications, vol.* 8, NO. 9, 2009.
9. M. Kaur, M. Uddin and H. Verma, "Optimization of QOS parameters in cognitive radio using adaptive genetic algorithm," *International Journal of Next-Generation Networks (IJNGN), Vol.*4, No.2, June 2012.
10. S. Singh, G. Singh, V. Pathak, K. Roy, "Spectrum Management for cognitive Radio using Genetic Algorithm," *Neural and Evolutionary Computing (cs.NE), cornell University Library,*2011.

This page is intentionally left blank

Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 15 Issue 8 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Channel Sharing based Medium Access Control Protocol for Wireless Nano Sensing Network

By Md. Syful Islam Mahfuz & Suman Saha
Patuakhali Science and Technology University, Bangladesh

Abstract- Recent advancement and grown up technologies has enabled the development and implementation of low-cost, energy efficient and versatile sensor networks. Sensor networks are built up with sensors that have the ability to sense physical or environmental property. Assumption can be made that Wireless Sensing Network (WSN) is able to sense environmental conditions at Nano and gaseous level. This architecture of Wireless Sensor Network is maintained by a sub-layer named Medium Access Control Layer that provides addressing and channel access control mechanism among multiple nodes of the network and makes these nodes capable to communicate with other nodes through a shared medium. The hardware that implements the MAC is referred to as a medium access controller. This paper finds the problems in selection of cluster nodes and transmitting data and also proposes an improved MAC protocol to minimize the problem.

Keywords: *WSN, MAC protocol, terahertz communication, electromagnetic communication.*

GJCST-E Classification : *C.2.1 C.2.5*

Channel Sharing based Medium Access Control Protocol for Wireless Nano Sensing Network

Md. Syful Islam Mahfuz [α] & Suman Saha [σ]

Abstract- Recent advancement and grown up technologies has enabled the development and implementation of low-cost, energy efficient and versatile sensor networks. Sensor networks are built up with sensors that have the ability to sense physical or environmental property. Assumption can be made that Wireless Sensing Network (WSN) is able to sense environmental conditions at Nano and gaseous level. This architecture of Wireless Sensor Network is maintained by a sub-layer named Medium Access Control Layer that provides addressing and channel access control mechanism among multiple nodes of the network and makes these nodes capable to communicate with other nodes through a shared medium. The hardware that implements the MAC is referred to as a medium access controller. This paper finds the problems in selection of cluster nodes and transmitting data and also proposes an improved MAC protocol to minimize the problem.

Keywords: WSN, MAC protocol, terahertz communication, electromagnetic communication.

I. Introduction

Wireless sensor network has increasingly become a research hotspot as the technology of wireless networks become gradually matured and supported by small, micro-mobile devices. WSN consists of a several number of sensor nodes ranging from few tens to thousands and base station or sink node. Each node is capable of storing, processing and relaying the data that are sensed. When Physical Layer is used for Signal transmission and reception by nodes within the network then there must be a point to point capability among these multiple networks nodes. However, this is insufficient for several reasons. In spite of using advance channel coding algorithm error can occur in bits or packets. The factors for this type of error are variations of link quality, interference etc. And it is particularly true for wireless nano sensor network. For this reason an additional control mechanism is needed above the physical layer. This additional layer is Medium Access Control Layer or MAC Layer.

Author α: B.Sc. (Engg.) degree in Computer Science and Engineering from Patuakhali Science and Technology University, Bangladesh in 2012. Currently, he is a Lecturer of Computer Science and Engineering at Bangladesh University of Business and Technology (BUBT). His teaching and research areas include Data Mining, Wireless Transmission, Neural Network and Embedded System design. e-mail: mahfuzisl@pstu.ac.bd

Author σ: B.Sc (Engg.) degree in Computer Science and Engineering from University of Chittagong, Bangladesh in 2011. He is now serving as a Lecturer in CSE Dept. at Bangladesh University of Business and Technology (BUBT). His research interests are Data Mining, Pattern Recognition and Image Processing, Wireless Ad hoc Networks, and Algorithms. e-mail: sumancsecu04@gmail.com

II. Medium Access Control Protocol

Protocol means few rules and regulation. Network Protocol means some rules and convention for successful and efficient communication among network nodes. MAC protocol indicates some rules and convention for accessing the same channel by multiple nodes at the same time without collision for better performance and throughput. So the key task of a MAC protocol is to coordinate the process of sharing the same medium among multiple users with the objective of achieving certain performance goals.

a) Classification

1. *Centralized MAC Protocol*

In this type of Protocol the entire process is control and coordinates by a central network node. Remaining nodes are depending on this central node for accessing the channel. For example cellular network, satellite network etc.

2. *Distributed MAC Protocol*

This protocol not depended on central node for assigning channel to multiple network nodes. Instead they distributed these control mechanism among all nodes of the network.

III. MAC Issues for WSN Network

Nano network is densely populated network. These nano nodes have many construction limitation which are must be considered for designing MAC protocol. These limitations are as follows:

1. Nano devices are severely energy constraint machine because of their nano size. It is also difficult to provide energy harvesting technique to these nano devices for large energy support.
2. Due to the nano-scope dimensions of nano-devices and future nano-transistor, the expected number of transistors per nano processor might round up to the thousands [1]. Since nano network is densely populated network so large number of nano devices must be considered for designing an efficient and effective MAC protocol.
3. It is needed to build up an energy-efficient complexity-aware Medium Access Control protocol

that supports the peculiarities of nano devices in the wireless nano sensor network.

IV. Design Issues for MAC Protocol

It is known graphene is one-atom-thick planner sheet of carbon atoms that are densely packed in honeycomb crystal lattice. Graphene-based nano-antennas have already been proposed and they will make possible to overcome the scalability problem when trying to miniaturize classical antennas to the Nano scale [2]. This material exhibits many peculiar characteristics that must be considered if we use these materials to construct nano nodes for nano network. Graphene based nano devices communicate through Terahertz band [3]. Now try to clear the reasons of using Terahertz band for communication among nano nodes. Graphene has shown promising electrical, mechanical and thermal properties over transistors, flexible/transparent electronics, optical devices and now terahertz active components.

a) Terahertz Communication

Nano networks are composed of huge number of nano nodes which have limited energy to communicate. So they are communicated in such a way that they can transmit a large number of bits at a time. Terahertz band provide this facility. It theoretically supports very large bit-rates, up to several hundreds of terabits per second for distances below one meter.

- Nano nodes require a simple communication scheme for their limited energy. Since terahertz band have very large bandwidth that helps to design a very simple communication scheme for nano nodes.
- Terahertz waves can carry more information than radio/microwaves for communications devices.
- They also provide medical and biological images with higher resolution than microwaves, while offering much smaller potential harm of exposure than X-rays. Because of these reasons, terahertz band is used as communication medium for nano nodes in the nanonetwork.

b) Pulse Based Communication

- Carrier Based Communication requires high power carrier signal for communication. Nano nodes or nano devices are not capable to generate high power carrier signal due to their energy limitation. So Classical carrier Based Communication is not suitable for nano network.
- Nano nodes require more fast communication mechanism to transmit information. Several Pulse Based communications have been proposed for high speed communication system such as Impulse Radio Ultra-Wide-Band (IR-UWB). These pulse-based systems are much more energy-efficient and require less complex transceiver than classical carrier based schemes.
- Nano nodes can efficiently generate and radiated very short pulse in the nanoscale. So pulse communication scheme is more suitable than carrier based communication.

V. MAC Protocol for Electromagnetic Communication

This protocol is divided into three stages namely Selection of Master Node, Handshaking process, and Data transmission Process. [4]

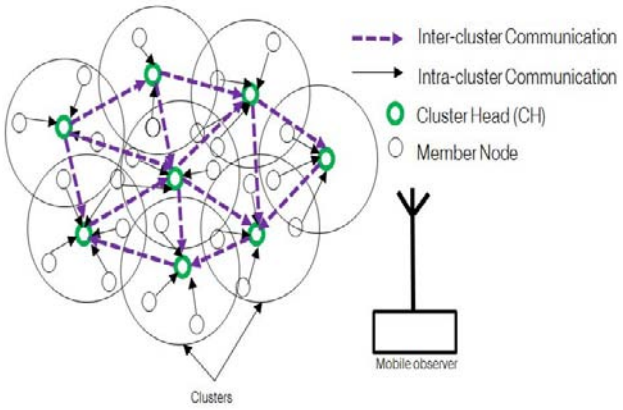


Fig.1: Clustered Nano Devices

a) Selection of Master Node

Initially, assumption is made that the nano nodes are combined to form a network. A node which is equidistant from the rest of the nodes is selected as master node among remaining nodes. Ambiguity is removed by the metric helps that were in the conventional mechanisms and lessen the possible collision.

The selection of the node M must be announced to the other nodes so as to ignite the communication. The nodes are now equally distributed and each tries to send its packets to M. It is the responsibility of the node M to allocate the channel to the requested device for a certain period of time, depend on the devices priorities or the urgent transmission of the data. However, this method works if the number of nodes in the scenario falls within 50.

If the number exceeds 50, then an alternative method is applied where the nano devices are divided into clusters. Nodes are partition into a several number of small groups called clusters for supporting data aggregation through network. A coordinator is assigned for each cluster which is defined as cluster head (CH), and member nodes. Clustering provides a two-tier hierarchy in which CHs form the higher tier while member nodes form the lower tier [5] . Figure 2 illustrates data flow in a clustered network.

The member nodes inform their data to their corresponding CHs. These data are aggregated by CHs and report them to the central base through other CHs. Because CHs often transmit data over longer distances, they waste more energy compared to member nodes of the network. In order to select energy-plentiful nodes to serve as cluster heads (CHs), the network may be re-clustered periodically and distribute the load uniformly on all the nodes. Clustering decreases channel contention besides achieving efficiency of energy. Hence, to subdue disconnected regions and distribute energy consumption across all nodes of the network periodic clustering is so important. Periodic re-clustering is also important for creating dynamic clustering of nodes and for better throughput of the network under greater load. There are two following types communication mechanism:

- Intra Cluster Communication and
- Inter Cluster Communication

An important design challenge is scheduling intra-cluster and inter-cluster transmissions. Time division multiple access (TDMA) is best for intra-cluster transmissions, Since clustering is typically employed in applications where data aggregation is performed. This is because a CH can set the TDMA schedule and inform its cluster members about it. The problem is how to prevent the TDMA intra-cluster transmissions from colliding with transmissions in neighboring clusters or with inter-cluster frames, especially when CHs communicate with each other using longer ranges.

After the selection of the master node, data is transmitted by broadcasting TDMA frame to all the nodes in the network. Here raises another scenario where few other nodes are to be added in to the network. If this happens the selection of master node is to be rescheduled by iterating the above procedure. Since the master node is repeatedly subjected to change whenever new nodes are added to the network, energy dissipation is reduced. The number of nodes to be added is also a considerable constraint to achieve scalability. If the number of additional nodes is less than 10 then the above mentioned technique can be applied if the number exceeds 10 then again we have to roll back to the Clustering mechanism which is described in detail in the above sections.

b) Handshaking Process

The handshaking process is divided in two sub stages, the handshaking request and the handshaking acknowledgment.

The handshaking request is triggered by any nano-device that has information to be transmitted and which has enough energy to complete the process. A transmitter generates a Transmission Request (TR) packet, which contains the Synchronization Trailer, the Transmitter ID, the Receiver ID, the Packet ID, the transmitting Data Symbol Rate (DSR) and the Error Detecting Code (EDC). The DSR field specifies the symbol rate that will be used to transmit the data packet. The strength of RD TS-OOK against collisions increases when different users transmit at different rates. In the PHLAME protocol, every transmitting node randomly selects a symbol rate from a set of co-prime rates, which minimizes the probability of having catastrophic collisions. The EDC field is used to detect transmission errors as a conventional checksum field. The TR packet is transmitted using a Common Coding Scheme (CCS), which specifies a predefined symbol rate and channel coding mechanism. By using the same symbol rate, catastrophic collisions might occur. However, the TR packets are very short and the EDC field should suffice to detect simple errors in the majority of cases. Finally, the transmitter waits for a timeout before trying to retransmit the TR packet when no answer is received.

The handshaking acknowledgment is triggered by the receiver of the TR packet, which uses the CCS to decode the received bit streams when listening to the channel. If a TR packet is successfully decoded, the receiver will check whether it can handle an additional incoming bit stream. In our scenario, we consider that due to the energy limitations of nano-devices after the transmission or active reception of a packet, a device needs to wait for a certain recovery time in order to restore its energy by means of energy harvesting systems. This time is much longer than the packet transmission delay and poses a major limitation to the network. If the handshake is accepted, a Transmission Confirmation (TC) packet is sent to the transmitter using the CCS. The TC packet contains the Synchronization Trailer, the Transmitter ID, the Receiver ID, the Packet ID, the transmitting Data Coding Scheme (DCS) and the Error Detecting Code. The DCS is selected by the receiver in order to guarantee a target Packet Error Rate (PER), which depends on the perceived channel quality and can be estimated from the pulse intensity or the perceived noise. In particular, the DCS determines two parameter values. First, it specifies the channel code weigh t, i.e., the average number of logical “1”s in the encoded data. By reducing the code weight, interference can be mitigated without affecting the achievable information rate. Second, the DCS specifies the order of the repetition code that will be used to protect the information.

c) Data Transmission Process

At this point, the data is transmitted at the symbol rate specified by the transmitter in the DSR field, and encoded with the weight and repetition code specified by the receiver in the DCS field. The DP contains a Synchronization Trailer, the Transmitter ID, the Receiver ID, and the useful Data. The Error Detecting Code has been removed from the packet since by using different symbol rates, catastrophic

collisions are highly unlikely, and randomly positioned error scan be fixed by means of the chosen channel coding scheme. If the DP is not detected at the receiver before a time-out, TDP out, the receiver assumes that the handshaking process failed.

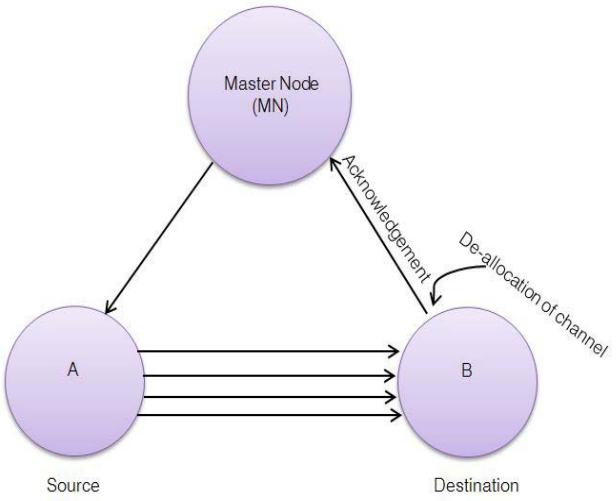


Fig. 2 : Transmission of Packets

This stage is concerned with the communication of other devices with the node M. Any node that requires the channel sends a control packet with fields containing destination address, source address, priority bit, to the node m. Priority bit number is a single bit field that represents the priority of the device. If the bit is set to 0 then the device can be scheduled sequentially. If the bit is 1, then the device has an emergency channel requirement. Scheduling of these devices is done through queuing at the master node by using Round Robin algorithm (that assumes all the devices of equal priority). After queuing, M starts allocating the channel on the FCFS basis. In some cases, if a node is to be allocated with the channel immediately then it sets it priority bit to 1 and hence the requested channel is allocated. If MN wishes to grant the channel to the node A, it first sends a REQUEST signal to the receiver B. If the receiver is free, then it sends an acknowledgement (ACK) signal to MN allowing the communication. MN in turn sends the same ACK signal to the requested device A. Hence the sender is allocated with the channel and the transmission of the packet takes place. After receiving all the packets B sends the acknowledgement to the master node indicating that the transfer is successful. In order to avoid collisions between the data packets and ACKs, the sender mentions the packet count in the first packet and receives an ACK from MN after all the packets arrive at the receiver. If the ACK is not received at the sender node within a stipulated time, indicating an error in transmission then all the packets are resent. Since the channel is allocated for transmission between two devices there will be no collisions from other nodes and hence reliability is achieved.

Energy Efficiency can be taken as a measure of the extent to which collisions are reduced. Since there are no collisions, the energy required to retransmit the packets can be eliminated totally. The other area where energy is conserved is selecting an equidistant method for the selection of master node all the nodes will require equal amount of energy to transmit the control packet. Whenever the nodes are added in to the network the master node is changed where energy dissipation is reduced. Considering all these factors energy will be saved or consumption of energy is reduced to a great extent.

d) Packet Structures

Two types of Packet structures are involved here: Control Packet, Data Packet

- *Control Packet*

Control Packet is a dummy packet, free of the data that helps in allocation of the channel to the requested device. The fields included in its structure are Destination Address, Source Address, Priority bit and Synchronization trail.

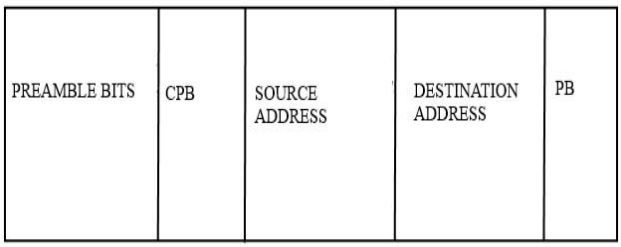


Fig. 3 : Control Packet

The preamble bits present in the packet are used for the synchronization of the Nano machines to enable communication. The conflict arises as to which address has to be mentioned in the DST ADDRESS field. Is it the master node address or the destination node address?

To resolve this, inclusion of another field known as the CPB is the Control packet bit which distinguishes the control packet from the data packet. If the packet is a control packet then the bit CPB is set to 1, otherwise the packet is taken to be a data packet. Now the packet whose bit is set to 1 will be sent to the master node thereby requesting the channel.

- *Data Packet*

Data packet structure represents the original data to be transferred with the following form the structure consists of a trail part and the data part. The data to be transferred is encoded in the data field and then transmitted.

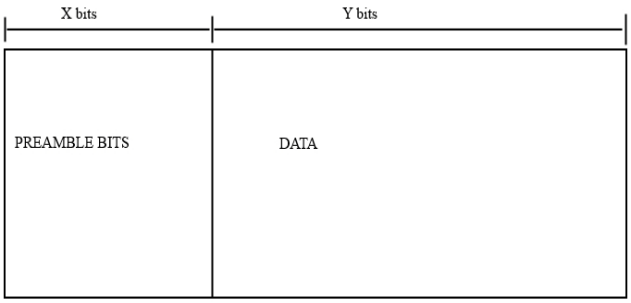


Fig . 4 : Data Packet

VI. Limitations

From previous discussion, it is learned that catastrophic collision is reduced by transmitting data from different transmitter using different transmission rate or symbol rate. This is the main limitation of this protocol. It is also known that symbol rate is selected randomly by nano devices and it is a co-prime number. So if the transmitted symbol rate is small enough then the data packet with this symbol rate journey the transmission medium long time. With high symbol rate data are transmitted more quickly through transmission medium.

Data packet with long time in transmission medium has high probability of affecting with noise and attenuation. This is a major problem of PHLAME. So a solution is been proposed for this problem that try to design a new MAC protocol for wireless Nano sensor network.

VII. Proposed Algorithm

A brief description of the above mentioned procedure is given below in the form of an algorithm:

A Nano network is formed with 'n' no. of nano nodes in it. Election of the master node is done based on the value of n. If n<50 then we use EQUIDISTANT metric method. If n>50 then clustering is applied. Protocols for inter-cluster and intra-cluster communications like HEED are employed for the selection of master node.

Now the nano device requests the master node to allocate the channel. The nano device will send a control packet to the master node. The master node will know that it is a control packet by setting the CPB to 1. Queuing is done at the master node which consists of all the nano-devices that request the allocation of channel. The queue scheduling followed here is Round Robin Scheduling. If a nano device needs the channel prior to all then the PB bit will be set to 1. After the queue of the devices, the first node in the queue will be allocated with the channel.

Now the channel is used only by the two devices that have been mentioned in the control packet. After the data transmission is completed the master node takes back the control of the channel and reallocates it to the next device on the queue.

VIII. Proposed Solution

Due to different symbol channel information may be added with more noise and attenuation. So this problem is solved by using same higher symbol rate or transmission rate. But if more than one device wants to transmit at the same time then the information from different source may overlap in transmission medium. So if the use of same symbol rate is required, then use of different channel for transmission is a must, i.e., divide the main channel into multiple channel.

In this case FHSS (Frequency Hopping Spread Spectrum) or FDM (Frequency Division Multiplexing) can be used for dividing the allocated frequency into multiple channels.

In FHSS, signals are not transmitted in one frequency channel. Same signal transmitted with different frequency channel. so if FHSS is used in nano network then signal with same symbol rate can be passed through transmission medium without high noise, attenuation and overlapping as signal transmitted in this scheme through different frequency channel with same higher symbol rate or transmission rate.

In FDM, it is possible dividing the channel into multiple channels which are used by different nano device for data transmission. Since nano network use terahertz band for operation so it can easily divide the main frequency channel into multiple channel that is enough for source station to transmit data to destination.

When one node wants to transmit data to destination node it selects one channel to transmit. In that time if there is any other node to transmit information, then it senses the channels to find any free channel. The channel which is busy to transmitting data of first node is not used to transmit data of current node. Busy channel distinguishes the node for accessing it for data transmission.

If all channels are busy to transmit data from source to destination then there is a problem if any node wants to transmit in that time. There is no free channel for transmitting data. So In this case we can use channel sharing procedure. In Channel sharing scheme one channel can be used by many sources at the same time without data overlapping. Channel which starts transmitting information first is selected as sharing channel.

IX. Conclusion

In order to maintain Medium Access Control protocol, several issues must be considered. Design issue is one of the major. Different communication process such as terahertz communication is also

considered. In this paper, the proposed solution is given based on some basic issues. The given access protocol is basically channel sharing based. So, in this scheme, one channel is allowed to be used by several sources at the same time whereas no data is overlapped. This can be an effective way to perfectly handle the MAC protocol issues.

References Références Referencias

1. Y. Li and C.-H. Hwang. Nanoscale transistors. In David L. Andrews, Gregory D. Scholes, and Gary P. Wiederrecht, editors, Comprehensive Nanoscience and Technology, pages 489 – 560. Academic Press, Amsterdam, 2011.
2. Josep Miquel Jornet and Ian F. Akyildiz. Graphene-based nano-antennas for electromagnetic nano communications in the terahertz band. In Antennas and Propagation (EuCAP), 2010 Proceedings of the Fourth European Conference on, pages 1–5, 2010.
3. J. M. Jornet and I. F. Akyildiz. Capacity of pulse-based electromagnetic nano networks in the terahertz band. submitted for conference publication, July 2010.
4. V.Srikanth, Sindhu Chaluvadi, Sandeep, Vani, Venkatesh,"Energy Efficient, Scalable and Reliable MAC Protocol for Electromagnetic Communication among Nano Devices", 2012.
5. Ossama Younis, Marwan Krunz, and Srinivasan Ramasubramanian : Node Clustering in Wireless Sensor Networks: Recent Developments and Deployment Challenges, 2006.

Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 15 Issue 8 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Mobile Object-Tracking Approach using a Combination of Fuzzy Logic and Neural Networks

By Jawdat Jamil Alshaer
Al-Balqa Applied University, Jordan

Abstract- Ability to locate a specific object in a dynamic environment has several practical applications including security surveillance, navigation and search and rescue operations. The objective of this paper is to develop an object-tracking algorithm using a combination of fuzzy logic and neural networks. The aim is to originate an algorithm that matches the history locations of an object and predicts its location when it goes offline. Determining the location of an object on specific trajectory becomes difficult if the mobile object stopped reporting its location and goes offline. Therefore, in this analytical article, a proposed approach relies on estimations from sensor data of historical movement patterns and geometric models, is fed into special Neural Network to get best accurate present or future object locations. Fuzzy logic application is used to overcome the challenge of imprecision in data. Although this approach is complex; but it can be one of the ways to be applied on large area applications with acceptable accuracy (80%) as shown by experiments.

Keywords: *neural networks, location prediction, fuzzy logic, tracking objects.*

GJCST-E Classification : *F.1.1 I.5.1*

Strictly as per the compliance and regulations of:

Mobile Object-Tracking Approach using a Combination of Fuzzy Logic and Neural Networks

Jawdat Jamil Alshaer

Abstract- Ability to locate a specific object in a dynamic environment has several practical applications including security surveillance, navigation and search and rescue operations. The objective of this paper is to develop an object-tracking algorithm using a combination of fuzzy logic and neural networks. The aim is to originate an algorithm that matches the history locations of an object and predicts its location when it goes offline. Determining the location of an object on specific trajectory becomes difficult if the mobile object stopped reporting its location and goes offline. Therefore, in this analytical article, a proposed approach relies on estimations from sensor data of historical movement patterns and geometric models, is fed into special Neural Network to get best accurate present or future object locations. Fuzzy logic application is used to overcome the challenge of imprecision in data. Although this approach is complex; but it can be one of the ways to be applied on large area applications with acceptable accuracy (80%) as shown by experiments.

Keywords: neural networks, location prediction, fuzzy logic, tracking objects.

I. Introduction

Multivariate Prediction methods and algorithms usually predicts variable value depending on pattern of time series variables, for instance: In continuous time series, variable x will instantly reports its value at time t and denoted as x(t). In other hand, In discrete time series, x will periodically reports its value in time interval t.

A variable is a value or a number that changes in increased or decreased pattern over time. There are two mainly categories of variables, independent variable and dependent variable. The independent variable and dependent variable are differing in an experiment. The independent variable is a variable that is varied or manipulated in the experiments by researchers; it refers to what is the influence during the experiment. The dependent variable is the variable that is simply measured by the researchers; it is the response that is measured. The dependent variable responses to the independent variable. It is called dependent because it depends on the independent variable. We cannot have a dependent variable without an independent variable. From these types, within the context of this article; we are interested in how location of a mobile object coordinates affects moving rate. The independent variable would be the coordinates and the dependent variable would be the speed. We can directly monitor the first and measure how they affect the speed of a mobile object. It is possible to forecast various kinds of data, in general, time series shows the changing of a value in time. The value can be impacted by also other factors rather only time. Time series represents discrete historical values and from a continuous function it can be obtained using sampling[1].

Neural networks involves using historical data and applying the neural network algorithm to predict possible future data. In this light, historical positions recorded prior to the loss of the object will be fed into the network to determine potential location in the present/future. Specifically, the backward propagation neural network model that uses historical data and applies artificial intelligence to predict likely future location of objects.

Neural network technique is particularly suitable in location prediction due to its reliance on minimal historical data to draw valuable inference. The model does not require additional data, making it less cumbersome than geometric and other models. It applies the historical data collected in a specified period and applies artificial intelligence to predict future coordinates of object location. However, as Kapitanova et al in [2] explains, applying backward propagation techniques requires heavy computation requirements and is inferior to artificial neural network models due to its low learning coefficient. In addition, the backward propagation model needs to be modified for every application.

There exist different artificial intelligence and mathematical approaches, approaches, which have been researching movement prediction of Mobile Objects(MO). Among these Markov chains, Bayesian networks, and neural networks. This paper presents and ANN-based approach. Some of the existing ANN-based approaches will be adopted and applied.

Author: Dept. of Computer Information Systems, Faculty of Information Technology. Al-Balqa Applied University, Salt, Jordan.
e-mail: Jawdat_alshaer@bau.edu.jo

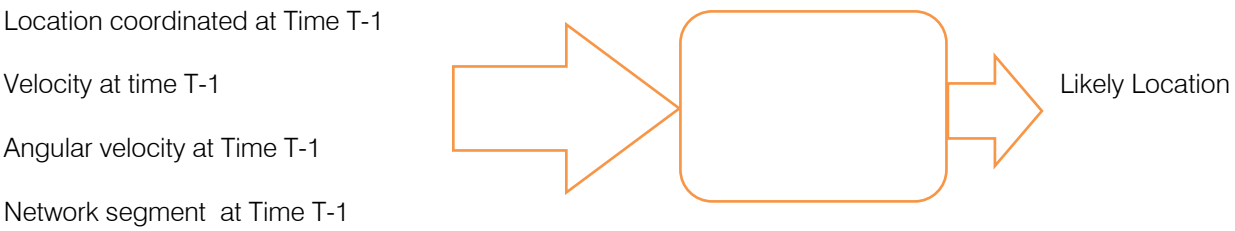
II. Related Work

To predict or forecast a future situation; learning techniques Neural Networks are obvious solution. The challenge is to construct a model using the intelligent hidden relations and transfer these techniques to work with the desired problem information.

Mozer [3] focused on Home Environments Controls by studying the environment and the actions taken by people to attempt to predict their next actions, by learning the anticipation needs. Mozer [4] uses as a predictor a feed-forward neural network with one hidden layer for anticipating the next action. In [5] , the authors have proposed user pattern learning approach neural networks to reduce location update signaling cost by increasing the intelligence of the location procedure. This approach associates to each user a list of cells where mobile is likely to be with a given probability in each time interval. The list is ranked between the most likely and the least likely place where a user may be found. When a call arrives for a mobile, it is paged sequentially in each location within the list. When a user moves between location areas in the list, no location updates are needed. However ,this will demand the storing of all possible locations of an object , which leads to huge storage mass of data in case of many objects not to mention the processing time of scanning these locations frequently. In [6], Pakyan et al, formulated a predictive trajectory model based on piecewise segments with stochastic transition and observation noises. Empirically they found that the second-order Markov model outperforms the first order Markov model. Over the range of look-ahead length from one to ten seconds, Methods were complicated and no NN was used. In [7] NN was implemented for people tracking between restricted rooms , they extracted from the presented previous results, acceptable prediction accuracy obtained using a simplified prediction process. Comparing the dynamic predictor with the static trained dynamic predictor, showing that the pre trained dynamic predictors are more efficient than the dynamic predictors. The structure of their proposed NN is extended in this article to movements of object(s) moving on the segments of trajectories. Buizza et al. [8] transformed some prediction algorithms used in branch prediction techniques of current high-performance micro-processors to handle context prediction. He proposed various context prediction techniques based on previous behavior patterns, in order to anticipate a person's next movement. The evaluation was performed by simulating the predictors with behavior patterns of people walking through a building as workload. Their simulation results show that the context predictors perform well but exhibit differences in training and retraining speed and in their ability to learn complex patterns. Petzold et al. compared these predictors with the Prediction by Partial Matching (PPM) method, and they evaluated the predictors by movement sequences of real persons within an office building reaching up to 59% accuracy in next location prediction without pre-training and, respectively, up to 98% with pre-training.

III. The Neural Prediction Approach for Location Prediction

In order to predict future mobile objects locations and trajectories, Different models can be used to capture all information about the movements of objects on linear edges of road networks, as an example is using Cellular Automation Model (CA) which was introduced in this context in [9]. Simply, The input data for the neural network can be three-dimensional coordinates on a Cartesian plane, velocity of movement and the segment of the trajectory of movement. The output of the neural networks is used to calculate the mean absolute error of the predicted value. The system should be tested using maximum observation data to determine the ideal observations to minimize mean absolute errors [10-12]. The following is an illustration of the basic working of Neural network model.



We chose a multi-layer perceptron with one hidden layer (see Fig. 1) and back-propagation learning algorithm. The input pattern to serve as input layer will consist only of the location of the mobile object and specific edges (segments); the historical pattern of movement then is simply and easily can be used to derive the velocity and direction of movement, simplifying the input layer will save computing cost, which is of particular interest for mobile (energy restrictions) or fast moving (real_time restrictions) applications. The first step of constructing the input and

the output of the NN is to divide the MO trajectory into segments[13]

IV. Modelling Trajectory as Segments

A moving object trajectory is a series of straight trajectory segments which can be generated, with perturbation of noise[13], any trajectory segment, is an element in a set where the next segment is following the previous one constructing a network of moving segments. As shown in Teble 1. This piecewise segment model will enhance the modelling of coordinates to capture precisely the movement during the reporting position intervals. The trajectory is modelled by joining together multiple segments, where one segment is only dependent on the location and speed of previous segment. Segments related to the road network are only a fraction of the complete Trajectories, Trajectory can be Highway, Cycle way, Track type, Junction. These four Trajectories can have a lot of different values. However, only key-value pairs from Table 1 (only one tag specific for certain group is listed) are used for road networks[14].

Table 1 : Different segments of road networks

Key	Value	Element	Description	Map display	Photo
highway	motorway		A restricted access major divided highway, normally with 2 or more running lanes plus emergency hard shoulder. Equivalent to the Freeway, Autobahn, etc...		
cycleway	lane		A lane is a route that lies within the roadway.		
tracktype	grade1		Solid. Usually a paved or heavily compacted hardcore surface.		
junction	roundabout		Roundabout. This automatically implies oneway=yes, the oneway direction is defined by the sequential ordering of nodes within the Way.		

In order to predict future mobile objects trajectories, We modelled the movements of objects on linear edges using Cellular Automation Model (CA). The movement patterns (on edges) are represented by one dimensional possible locations (cells) , which can be either empty or occupied by objects .

V. Deriving the Data Set for the Neural Network

The movement pattern M is recorded periodically in time stamp T by: location p; the direction (angel) and the velocity of the movement v. these parameters of movement were used to simulate mobile objects movements on selected road edges , and the resulted locations and segments were fed as training data to the NN by calculating future trajectories of MO on movement patterns on networks or random plain.

Precisely, if a mobile object moves continuously and periodically reports its location , then Mp1 represents the distance in terms of the number of cells travelled on particular segment (d, r1) of the Mobile Movement (MM) during period of time unit T1 ; Mp2 is the distance is travelled on particular segment during period of time unit T2, then T3 and so constructing periodically (every Time sized windows) pattern on specific trajectory . For example : Mp={Mp1,Mp2,…, Mpn} and Mp1=(10,1) means the desired object was located at distance 10 on trajectory segment 1, Mp2=(70,1) means: the object location is 70 cells on segment 1 if the time interval is 30 seconds then the implicitly indication of average velocity of 2.0 unit/second.

Dividing the set of Mp movements onto subsets, the first subset will be used as input in the training mode while the rest subset will be the desired

output. Applying this procedure with the generated data sets in the analytical simulation represents the trained and output sets. The architecture of the NN is adopted from[7].

VI. The Neural Network Architecture

Multi-layer perceptron with multi-hidden layers using activation function and back-propagation learning algorithm was used to construct the neural network. This model has two inputs (location and segment). And has two output neurons [7] , figure 1.

a) The hidden layer

1. Create network and feed-forward with inputs,

MP_i = Mp, Mp + 1, Mp + 2 hidden units and Mpo output units.

2. Initialize all network weights

$$W_{i,j}^{1} \quad , \qquad i = \overline{1, Mp},$$

$$j = \overline{1 + Mp_i} \text{ and } W_{i,j}^{2} \ , \qquad i = \overline{1 + Mp} \ , j = \overline{1, Mpo} \ \in \left[{}^{-2}/_{Mp}, \ {}^{2}/_{Mp} \right]$$

3. while $E(\bar{W}) - {}^{1}/_{2} \sum_{k \ in \ Mpo} (t_k - o_k)^2 \leq T \ (threshold) \ do$

- Input the instance $\bar{X}$ to the network and compute the output $\bar{O}$.

$$\bar{O} = \bar{X}.\overline{W^1}.\overline{W^2}$$

- For each network output unit k , $k - \overline{n1, Mpo}$ calculate its error term δ_k

$$. \ \delta_k - O_k(1 - O_k)(t_k - O_k)$$

- For each hidden unit h , $h - 1, MP_i$ calculate its error term

$$\delta_h = O_h(1 - O_h) \sum_{k \ \epsilon \ MPO} W_{k,h}^{2}. \ \delta_k$$

- Update each network weight $W_{i,j}$

$$W_{i,j} = W_{i,j} + \Delta W_{i,j}$$

$$\Delta W_{i,j} = \alpha - \delta_i - X_{i,j} \ where \ \alpha \ is \ the \ learning \ step$$

The weights will be randomly initialized in the interval $\left[\frac{-2}{Mp}, \frac{2}{Mp}\right]$, where Mp is the number of neurons in the input layer. For better results we will codify the input data with -1 and 1 and we'll use the following activation function:

$$F(X) = \frac{2}{(1 + e^{-x})} - 1$$

We will vary the number of neurons in the hidden layer (Mp cells). We will try first Mp, Mp + 1, Mp + 2 where Mp is the number of neurons in the input layer as in, then by experiments we find the best configuration.

b) The neural network's training

For the training/learning process we used the well-known Back-Propagation Algorithm from [15] showed in figure 1, and adapted as below :

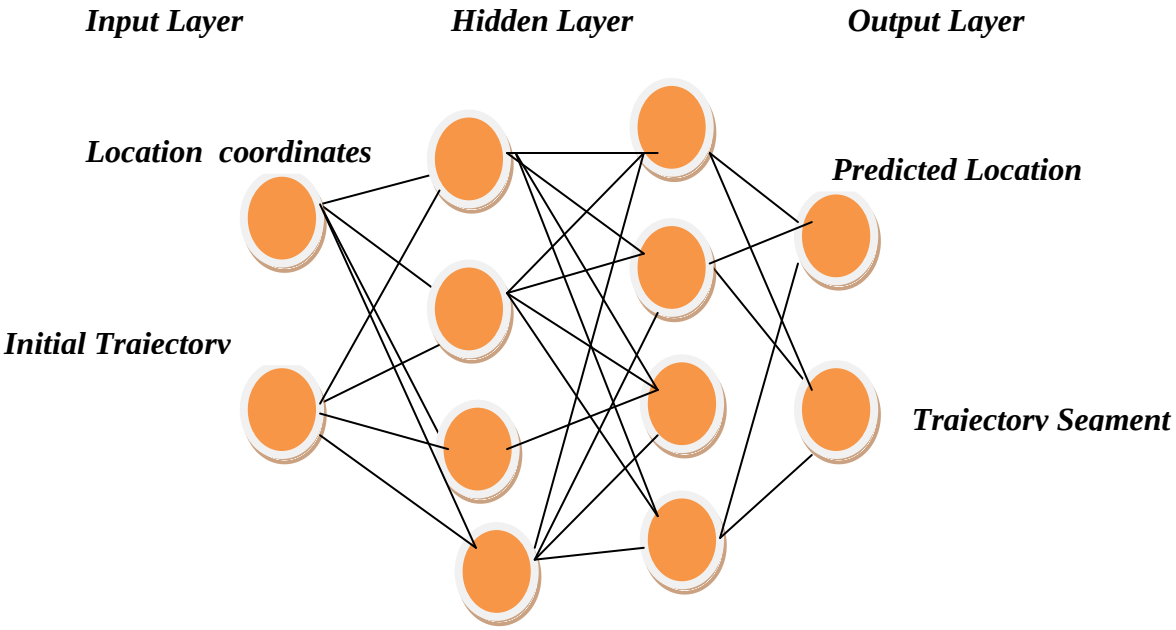


Figure 1 : The neural network's structure

VII. The Simulator and the Experimental Results

To evaluate the proposed approach, ANN methodologies (Multi Layer Perceptorn) are adopted. Simulation was developed on MAT LAB simulation environment. The proposed techniques was simulated on Pentium Core Due Processor 3 GHz CPU, 2 GB based RAM and 300 GB storage capacity based Personal Computer. Using the mathematical relationship, the model (MLP) was applied to predict the location management of the cellular network. we generated test sets of 70 randomly sampled locations and 20 trajectories segments , as was done in [6]. For each pattern in the test sets, 70 predictions were generated using the proposed NN model. The Experiment results is shown in figure 2. Cumulative distribution function plots of NN prediction patterns compared to the ground simulated trajectories. Repeating the experience with dynamic training, shows that the NN make predictions closer to the analytical simulated locations.

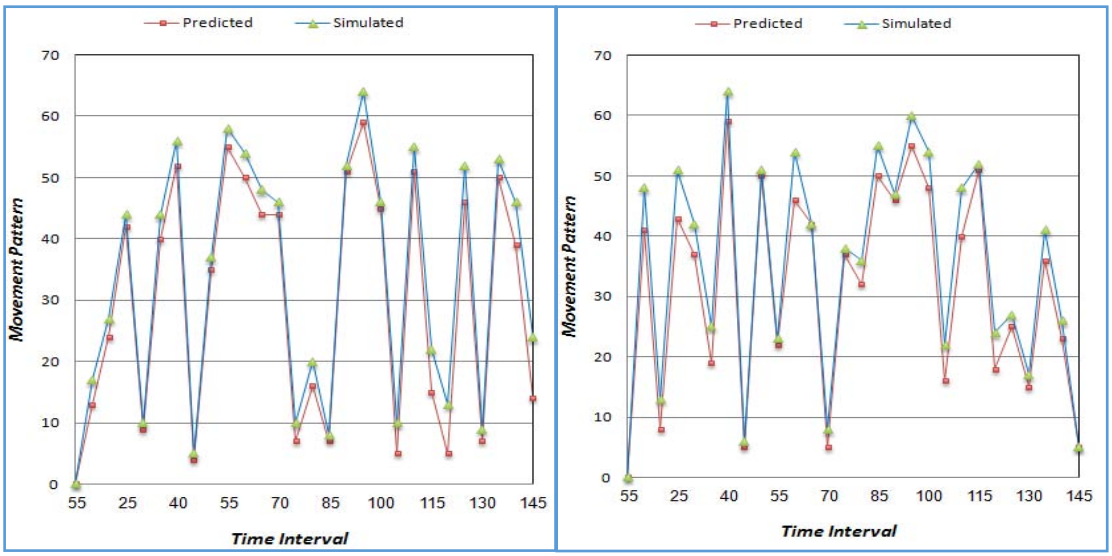


Figure 2 : Evaluation on randomly generated dataset

As to evaluation of accuracy the predictor is fed with a pattern sequence in every time stamp and predicts the next movement. The time intervals was divided into predefined size. The accuracy measure shown in the chart is then calculated for each interval as follows[16]:

Accuracy = Number of correct prediction / Time interval size

Thus the accuracy is the number of correct predictions over the number of time steps, that is, over the total number predictions in that window. The number of time intervals is varied for comparison ease. Figure 4. shows charts of accuracy over time with dynamic training.

VIII. Using the Fuzzy Logic

Neural network models are efficient when historical data is accurate and precise. However, in large-scale object location assignments, it is often impossible to collect precise coordinates along the object's trajectory. This calls for application of fuzzy logic to overcome the challenge of imprecision in data[17]. Fuzzy logic can tolerate input of unreliable and imprecise data. It is also more intuitive compared to ordinary probability theory besides being easier to use. However, it requires more memory to store the rule-base especially when there are several variables[11] .

The rule base consist of IF (condition), Then (consequence) statements. The objective of the detection algorithm is to reduce incidences of false object detection. Fuzzy logic can accommodate data from several sensors and can augment them with the rule-base to minimize such false detections over time. A simple object detection rule would be as follows.

IF *Time 1*(first input location, Segment) AND*Time 2* (second input location,segment), And *Velocity* is (first reading location differences), THEN Object is (widely defined location).

Fig. 4 shows charts of accuracy over time with dynamic training.

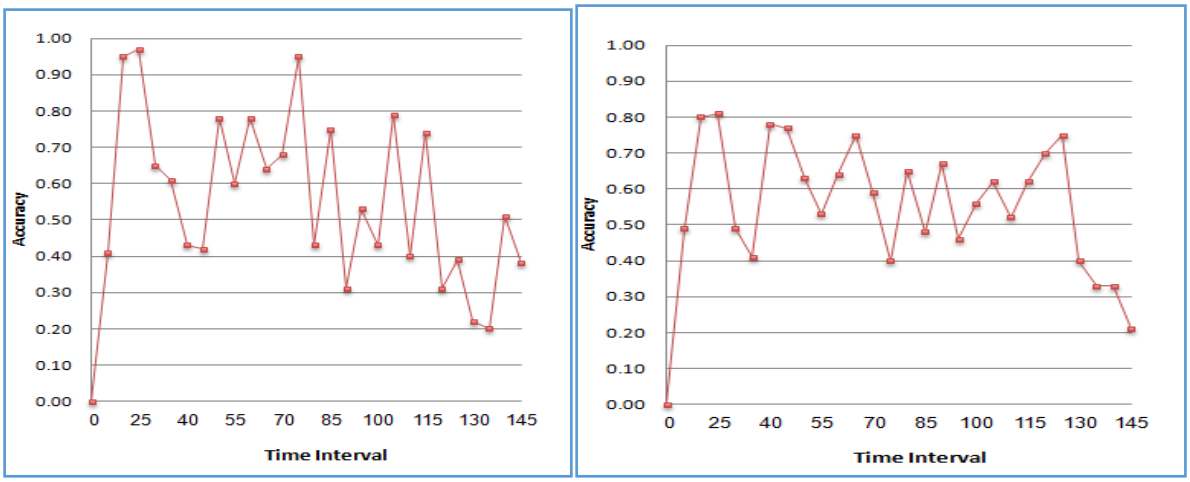


Figure 3 : The predictive Accuracy of the NN model is measured by the number of correct predictions over the number of time resulting in less accuracy for large window time intervals

IX. Conclusion

Multi-layer perceptron with multi-hidden layers Neural Network for locating mobile objects was constructed, the movement patterns of the mobile objects were simplified and derived from the movement coordinates, direction, velocity and time. This approach relies on estimations from sensor data of historical movement patterns and geometric models, the resulted data is used to dynamic training of special Neural Network producing accurate predicted mobile objects locations up to 80%. Fuzzy logic application is used to overcome the challenge of imprecision in data.

References Références Referencias

1. L. Al-Matarneh, " Development of Temperature-based Weather Forecasting Models Using Neural Networks and Fuzzy Logic" ,J. Alshaer, A. Sheta2, S. Bani-Ahmad1, and I.Al-oqily3, International Journal of Multimedia an d Ubiquitous Engineering Vol. 9, No. 12 (2014), pp. 343-366, http://dx.doi.org/10.14257/ijmue.2014.9.12.31
2. K. Kapitanova et al., "Using fuzzy logic for robust event detection in wireless sensor networks", Ad HocNetw. (2011), doi:10.1016/j.adhoc.2011.06.008
3. Mozer M. C., The Neural Network House: An Environment that Adapts to its Inhabitants, Proceedings of the AAAI Spring Symposium on Intelligent Environment, Menlo Park, California, 1998.
4. Mozer M. C., Lessons from an adaptive house, Smart Environments: Technology, Protocols, and Applications, J. Wiley & Sons, 2004.
5. JV Subramanian, " Implementation of Artificial Neural Network for Mobile Movement Prediction" , MAK Sadiq - Indian Journal of Science and Technology, Vol. 7, No. 6 (2014), pp. 858–863.
6. P. Pakyan, "Learning and Predicting Moving Object Trajectory: a piecewise trajectory segment approach" , C. Hebert, Technical Report, the

School of Computer Science at Research Showcase @ CMU , research-showcase@andrew.cmu.edu.
7. L. Vintan, " Person Movement Prediction Using Neural Network", Arpad Gellert, Jan Petzold, Theo Ungere, Technical Report, Institute of Computer Science, University of Augsburg, April 2004.
8. R. Buizza, Accuracy and potential economic value of categorical and probabilistic forecasts of discrete events‖, American Meteorological Society, vol. 129, no. 9, (2001), pp. 2329–2345.
9. Nagel K, Schreckenberg M. " A cellular automaton model for freeway traffic". In Journal Physique 1992; I 2. Pp 2221-2229.
10. Henver, S. March, J. Park and S. Ram, ―Design Science in Information Systems Research‖, MIS Quarterly, vol. 28, no. 1, (2004), pp. 75-105.
11. Aggarwal C, Agrawal D. " Nearest Neighbor Indexing of Nonlinear Trajectories". In PODS, 2003; 252-259.
12. C. R. Kothari, ―Research Methodology‖, Methods and Techniques, Delhi: (2nd Ed), Wiley Eastern Limited, (1990).
13. P. Pakyan, "Learning and Predicting Moving Object Trajectory: A Piecewise Trajectory Segment Approach", Patrick Choi , Martial Hebert , Technical Report , School of Computer Science at Research Showcase @ CMU, Research Showcase @ CMU., research-showcase@andrew.cmu.edu.
14. Wiki, OpenStreetMap (2014). "Available online: http://wiki.openstreetmap.org/wiki", Data_working_ group (accessed on 5 August 2014).
15. Mitchell T., Machine Learning, McGraw-Hill, 1997.
16. T. Mikluščák, " Person Movement Prediction Using Artificial Neural Networks With Dynamic Training On A Fixed-Size Training Data Set", Tomáš Mikluščák, Michal Gregor, Applied Computer Science, vol. 7,2011,pp. 33-46
17. V. Vaishnavi and B. Kuechler, "Design research in Information Systems", Mendeley Journal, vol. 48, no. 2, (2007), pp. 133-140.

This page is intentionally left blank

Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 15 Issue 8 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Performance Evaluation of Spatial Multiplexing MIMO-OFDM System using MMSE Detection under Frequency Selective Rayleigh Channel

By Namrata Maharaja, Dr. B. K. Mishra & Rajesh Bansode
Thakur College of Engineering and Technology, India

Abstract- MIMO-OFDM (Multiple Input Multiple Output-Orthogonal Frequency Division Multiplexing) is a very promising technology providing high throughput and range without additional bandwidth or transmit power by using many antennas at transmitter and receiver eliminating Inter-Symbol-Interference (ISI).The capacities of MIMO-OFDM systems can be fully utilized by low complex and optimal signal detection scheme. The receiver's detector is supposed to maximize the Signal to interference plus noise (SINR) by cancelling the spatial interference and should separate the transmitted signals. Minimum Mean Square Error (MMSE) detector is near optimal and less complex. The performance of the proposed system is analyzed using MMSE under flat and frequency selective Rayleigh channel environment, different number of antenna configurations and various modulation techniques to provide an optimum solution.

Keywords: MIMO-OFDM, spatial multiplexing, ZF, MMSE, rayleigh channel, flat and frequency selective.

GJCST-E Classification : C.2.5

Strictly as per the compliance and regulations of:

Performance Evaluation of Spatial Multiplexing MIMO-OFDM System using MMSE Detection under Frequency Selective Rayleigh Channel

Namrata Maharaja [α], Dr. B. K. Mishra [σ] & Rajesh Bansode [ρ]

Abstract- MIMO-OFDM (Multiple Input Multiple Output-Orthogonal Frequency Division Multiplexing) is a very promising technology providing high throughput and range without additional bandwidth or transmit power by using many antennas at transmitter and receiver eliminating Inter-Symbol-Interference (ISI).The capacities of MIMO-OFDM systems can be fully utilized by low complex and optimal signal detection scheme. The receiver's detector is supposed to maximize the Signal to interference plus noise (SINR) by cancelling the spatial interference and should separate the transmitted signals. Minimum Mean Square Error (MMSE) detector is near optimal and less complex. The performance of the proposed system is analyzed using MMSE under flat and frequency selective Rayleigh channel environment, different number of antenna configurations and various modulation techniques to provide an optimum solution.

Keywords: MIMO-OFDM, spatial multiplexing, ZF, MMSE, rayleigh channel, flat and frequency selective.

I. Introduction

High data rate wireless communications, nearing 1Gb/s speed in 100MHz of bandwidth is trending in WLANs and home audio/visual networks. Research are directed at designing systems that are capable of handling high data rates while maintaining sufficient BER performance without increasing the bandwidth. MIMO combined with OFDM system is the best solution for this. MIMO systems use array of multiple antennas and take benefit of multipath effects of the propagation instead of combating it [1]. OFDM can transform frequency selective MIMO channels into a set of parallel frequency flat MIMO channels, thus decreases receiver complexity. Parallel increase in performance and spectral efficiency of MIMO systems is not achievable with all the available signal detection schemes as their associated computational complexity increases exponentially with the number of antennas. MMSE is a low complexity scheme giving sub-optimal performance [5]. Evaluation of such system under Rayleigh flat and frequency selective channel for various digital modulation techniques is performed to present an optimum solution and achieve high data rates.

Author α σ ρ : Thakur College of Engineering and Technology, Mumbai, India. e-mails: mankad.namrata@gmail.com tcet.principal@thakureducation.org, rajesh.bansode1977@gmail.com

II. Mimo System Model

MIMO system consists of majorly three components, the transmitter, channel and receiver as shown in Fig.1. It uses multiple antennas at both the ends of the wireless links, all operating at same frequency at same time.

$$r = Hs + n \quad (1)$$

Where, r is received signal vector, H is $N_r \times N_t$ channel matrix, s is transmitted vector and n is Gaussian noise vector. MIMO encoder uses Space time processing technique which has generally has two aims; one is to increase the data rate and next is to achieve maximum possible diversity. The space time processing techniques are: Space time coding and Spatial Multiplexing. The paper focuses on the use of Spatial Multiplexing MIMO which allows higher throughput, diversity gain and interference reduction. It also fulfils the requirement by offering high data rate through spatial multiplexing gain and improved link reliability due to antenna diversity gain [6].

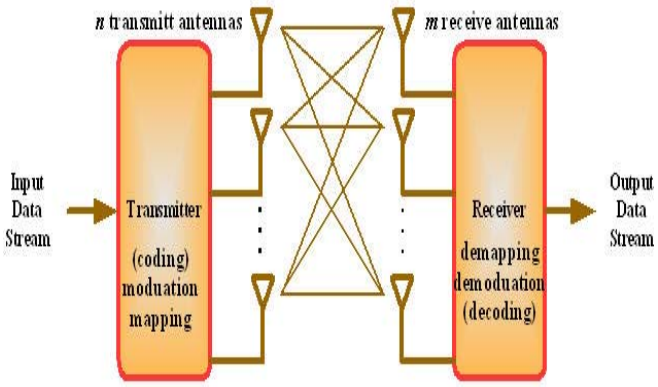


Fig. 1: MIMO system

a) Spatial Multiplexing

Spatial multiplexing is a transmission method to send several different data bits in streams through an independent spatial channel from each of the multiple transmit antennas to achieve the greater throughput at higher SNR values [7]. If the transmitter is provided with Nt antennas and the receiver has Nr antennas, the maximum spatial multiplexing order (the number of streams) is,

$$Ns = \min(Nt, Nr) \quad (2)$$

Therefore, the space dimension is reused, or multiplexed, more than once.

III. OFDM

OFDM is a special form of multicarrier modulation (MCM) with closely spaced subcarriers overlapping spectra as shown in Fig 2. MCM works on the principle of transmitting data by dividing the stream into several bit streams, each of which has a much lower bit rate, and by using these sub-streams to modulate several carriers [8].

The information data is mapped into symbols, distributed and sent over the N sub-channels, one symbol per channel. To have minimum interference, the carrier frequencies must be chosen carefully. Orthogonal FDM's spread spectrum technique distributes the data over a large number of carriers that are spaced apart at perfect frequencies. This spacing provides the "Orthogonality" which prevents demodulators from viewing frequencies other than their own. With the find of FFT/IFFT it became possible to generate OFDM using the digital domain for orthogonality of sub carriers. In OFDM, an N complex-valued data symbol modulates N orthogonal carriers using the IFFT forming. The transmitted OFDM signal multiplexes N low-rate data streams, each experiencing an almost flat fading channel when transmitted.

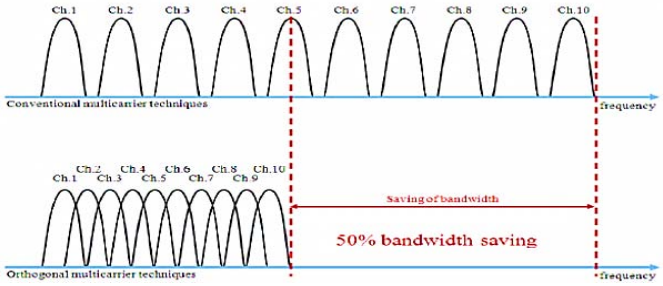


Fig. 2 : OFDM Subcarriers

IV. MIMO-OFDM

A combination of MIMO and OFDM has been considered as a potential technology for high speed data wireless transmission networks such as WLAN, 3GPP, LTE & WiMAX. The Spatial Multiplexing(SM) can significantly increase channel capacity by simultaneously transmitting multiple independent streams with same data rates and power level [10]. Other side the OFDM technology can efficiently utilize the spectrum and eliminate the effect of multipath fading. All the blocks of OFDM like, FFT, IFFT and CP when applied to every single transmit and receive antennas (MIMO) makes it MIMO-OFDM.

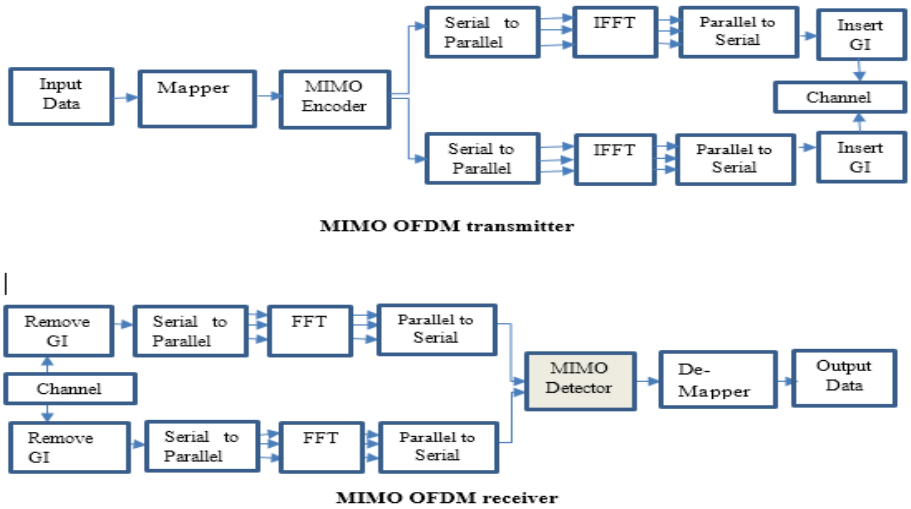


Fig. 3 : MIMO-OFDM system block diagram

The IEEE 802.11n WLAN standard is used to design the base system [11]. This standard includes MIMO- OFDM as a compulsory feature to enhance data rate. Initial target was to achieve data rates in excess of 100 Mb/s. However, current WLAN devices based on 802.11n Draft 2.0 are capable of achieving throughput up to 300 Mb/s utilizing two spatial streams in a 40 MHz channel in the 5 GHz band [12].

The proposed system shown in Fig 3 includes the available modulation schemes like QPSK, 16-QAM and 64-QAM and is designed for basic 2×2 antenna configuration which is extended up to 8×8 Here, the MIMO techniques adopted includes Open-loop MIMO

(OL-MIMO) techniques which do not require channel state information (CSI) at the transmitter. MMSE detection has primarily been considered so as to minimize the complexity associated with MIMO detection while ensuring reasonably good performance.

V. Linear Detection

a) Zero forcing(ZF) detector

The ZF is a linear detection technique, which inverse the frequency response of received signal, the inverse is taken for the restoration of signal after the channel. The estimation of strongest transmitted signal is obtained by nulling out the weaker transmit signal. Considering 2x 2 MIMO channel,

$$y = Hx + n \quad (3)$$

Where, Y=Received Symbol Matrix., H=Channel matrix, X=Transmitted symbol Matrix, N=Noise Matrix. To solve for *x*, we need to find a matrix *W* which satisfies$WH = I$, The Zero Forcing (ZF) detector for meeting this constraint is given by,

$$W = (H^H)^{-1}H^H \quad (4)$$

Where, W=Equalization Matrix and H=Channel Matrix. This matrix is known as the Pseudo inverse for a general m x n matrix. [13]-[14]. Theoretically ZF sounds efficient but in practical situations, it is very susceptible to noise as the inverse of the received noise is also applied to the signal since the channel response includes noise as depicted.

b) Minimum Mean Square Error(MMSE) detector

MMSE equalizer minimizes the mean –square error between the output of the equalizer and the transmitted symbol, which is a stochastic gradient algorithm with low complexity. This approach tries to find a coefficient *W* which minimizes the criterion,

$$E\left\{[W_{y-x}][W_{y-x}]^H\right\} \quad (5)$$

To solve for *x*, we need to find a matrix *W* which satisfies WH= I. The Minimum Mean Square Error (MMSE) detector for meeting this constraint is given by

$$W = [(H^H + N_0 I)^{-1}H^H] \quad (6)$$

The MMSE detector considers the noise variance when inverting the channel matrix. Instead of removing ISI completely, an MMSE equalizer allows some residual ISI to minimize the overall distortion. Most of the finite tap equalizers are designed to minimize the mean square error performance metric but MMSE directly minimizes the bit error rate [7]-[17].

VI. Fading Channels

In recent years, theoretical and practical investigations have shown that it is possible to realize enormous channel capacities, far in excess of the point-to-point capacity given by the Shannon-Hartley law, if the environment is sufficient multipath. The majority of work to date on this area has assumed flat sub-channels composing the MIMO channel. As the aim of MIMO systems is often to increase the data transmission rate of a communication system, a wideband and hence highly time-dispersive model would be more appropriate. To properly exploit this environment to realize these capacity increases, the MIMO channel must be equalized so that the performance of any system attempting to harness the multipath diversity can do so while maintaining a satisfactory BER performance. Assuming that the response of the MIMO channel is known at the receiver, a method to create a suitable equalizer is to analytically invert the frequency selective, or time-dispersive.

a) Rayleigh Flat Fading

Flat fading channels can be approximated by Rayleigh distribution if there is no line of sight which means when there is no direct path between transmitter and receiver. The received signal can be simplified as ,

$$r(t) = s(t) * h(t) + n(t) \quad (7)$$

where, h(t) is the random channel matrix having Rayleigh distribution and n(t) is the additive white Gaussian noise. The Rayleigh distribution is basically the magnitude of the sum of two equal independent orthogonal Gaussian random variables and the probability density function (pdf) given by:

$$p(r) = \frac{r}{\sigma 2} e^{\frac{r2}{2\sigma 2}} \quad 0 \leq r \leq \infty \quad (8)$$

where, σ^2 is the time-average power of received signal [18]-[19]

b) Rayleigh Frequency Selective Fading

Frequency-selective fading can be viewed in the frequency domain, although in the time domain, it is called multipath delay spread. The simplest measure of multipath is the overall time span of path delays from the first pulse to arrive at the receiver to the last pulse to arrive at the receiver. When viewed in the frequency domain, a channel is referred to as frequency-selective if $f_0 < 1/Ts = W$, where the symbol rate, $1/Ts$ is nominally taken to be equal to the signal bandwidth *W*. Flat fading degradation occurs whenever $f_0 > W$. Here, all of the signal's spectral components will be affected by the channel in a similar manner (e.g., fading or no fading). In order to avoid ISI distortion caused by frequency-selective fading, the channel must be made to exhibit flat fading by ensuring that the coherence bandwidth exceeds the signalling rate. Narrowband channel belongs to flat fading channels, where all the frequency components of the transmitted signal behave similarly. For wideband signal, the signal bandwidth, Ws, may be significantly higher than the coherence bandwidth. Consequently, two frequency components separated by a frequency of the coherence bandwidth or beyond may behave significantly differently. Hence, wideband

channels are typically frequency-selective fading channel [18]-[19].

VII. Results & Discussions

a) Performance under flat and frequency selective Rayleigh Channels

A 2×2 MIMO-OFDM uncoded system is considered with QPSK modulation under flat fading Rayleigh channel and the performance of ZF and MMSE detectors are compared in terms of BER Vs Eb/No.

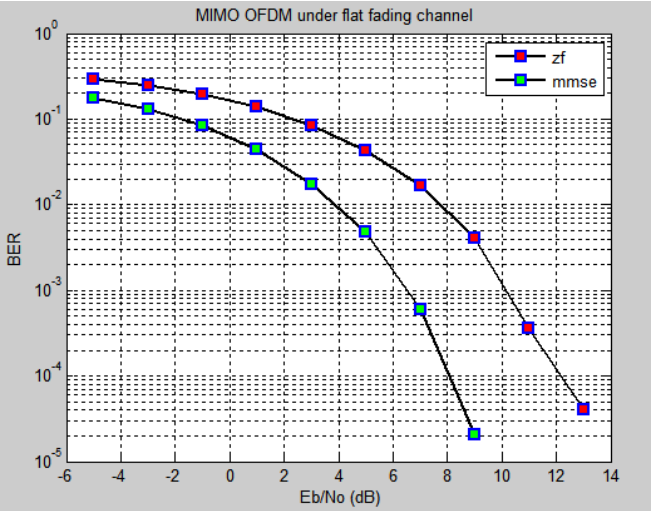


Fig.4 : ZF & MMSE under flat fading Rayleigh channel

At SNR of 7dB, the target of 10^{-3} BER is achieved using MMSE detector and the same is achieved at the SNR of 10 dB with ZF detector as shown in Fig.3. The MMSE detector considers the noise variance when inverting the channel matrix thus it has a better estimate to that of the ZF, which amplifies the channel noise. Thus, by suppressing both the interference as well as the noise components MMSE is a superior receiver than ZF which only suppresses the interference components. OFDM divides a communications channel into a number of equally spaced frequency bands called a subcarrier which carries a portion of the desired information and is transmitted in each band. OFDM converts a wide band frequency selective channels in to multiple flat channels. Here, the channel used is Rayleigh flat fading channels. Hence, the performance is better of the MIMO-OFDM system close to as in AWGN channel.

For the same input scenario, the performance of the system is evaluated under Rayleigh Frequency Selective Channel. An M×N uncorrelated Rayleigh channel with uniformly distributed 6 taps over the channel length L=85 is considered.

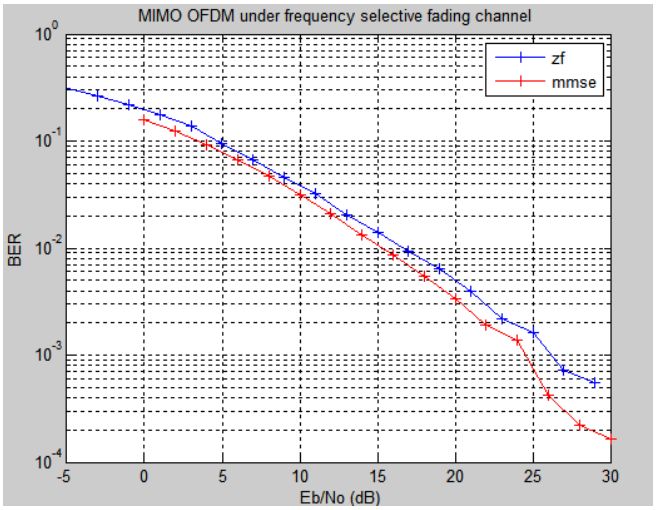


Fig.5 : ZF & MMSE under frequency selective Rayleigh fading channel

System capacity could be linearly increased with the number of antennas when the system is operating over flat fading channels. In real situations, multipath propagation usually occurs and causes the MIMO channels to be frequency selective. OFDM transforms the frequency-selective fading channels into parallel flat fading sub channels. MIMO OFDM significantly simplifies MIMO baseband receiver processing by eliminating the need for a complex MIMO equalizer. The performance of MMSE receiver though degrades under frequency selective channel as compared to flat fading channel. At SNR of 24dB, the target of 10^{-3} BER is achieved using MMSE detector and the same is achieved at the SNR of 27 dB with ZF detector as shown in Fig.3. In this case also, MMSE performs better than ZF.

b) Performance with various modulation schemes

For 2×2 configuration, the performance of ZF and MMSE is checked under various modulation techniques, such as, QPSK, 16-QAM and 64-QAM for Rayleigh flat and frequency selective channel for target of 10^{-3} BER.

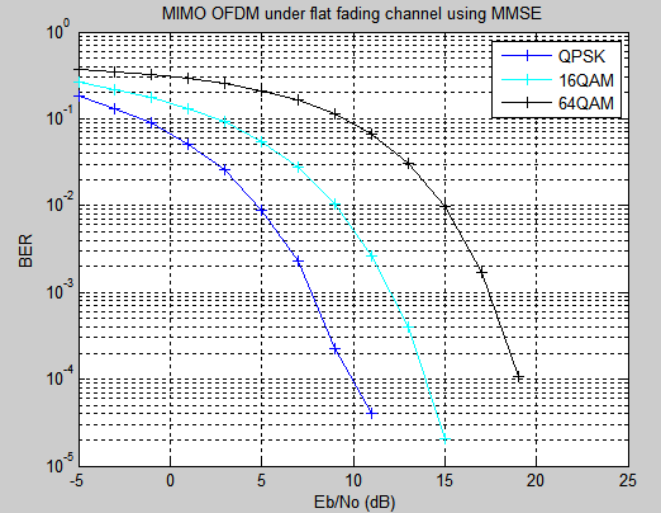


Fig. 6 : MMSE performance for different modulation schemes under flat fading Rayleigh Channel

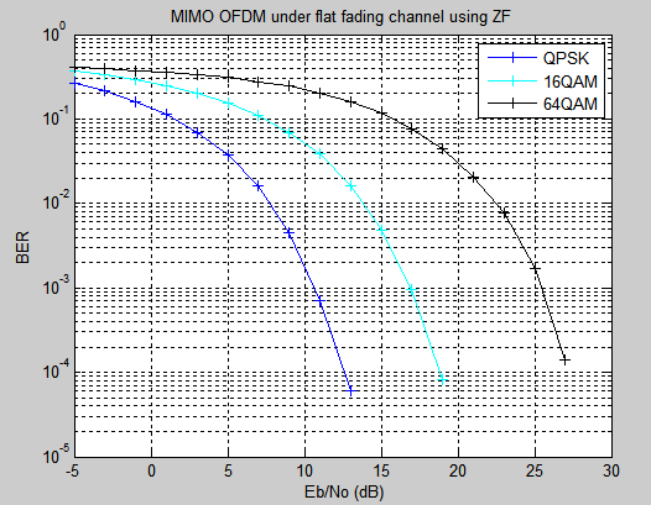


Fig. 7 : ZF performance for different modulation schemes under flat fading Rayleigh Channel

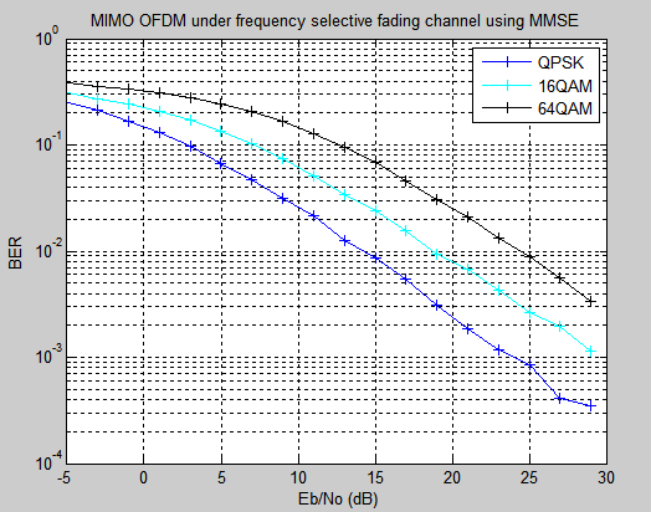


Fig. 8 : MMSE performance for different modulation schemes under frequency selective Rayleigh Channel

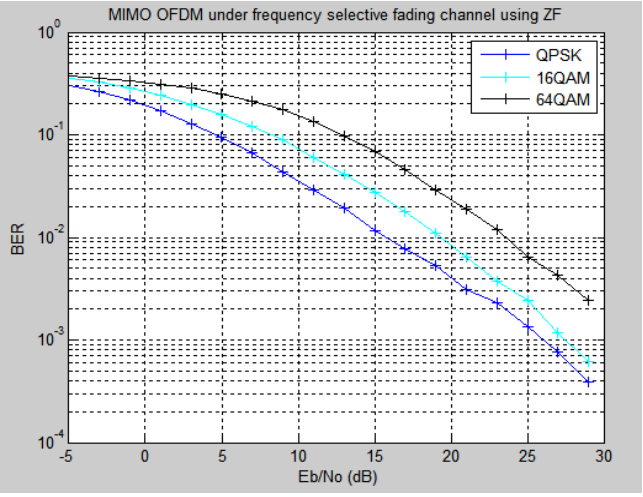


Fig.9 : ZF performance for different modulation schemes under frequency selective Rayleigh fading Channel

Under QPSK modulation, lowest BER is achieved and 64-QAM the highest. BER increases as the order of the modulation order i.e. M increases. This increase is due to the fact that as the value of M increases distances between constellation points decreases which in turn makes the detection of the signal corresponding to the constellation point much tougher The solution to this problem is to increase the value of the SNR so, that the effect of the distortions introduced by the channel will also goes on decreasing, as a result of this, the BER will also decreases at higher values of the SNR for high order modulations

In all the cases though, the performance of MMSE is better than ZF.

At 10^{-3} BER	Rayleigh Flat Fading (ZF)	Rayleigh Flat Fading (MMSE)	Rayleigh Frequency Selective (ZF)	Rayleigh Frequency Selective (MMSE)
Modulation Scheme	SNR in dB	SNR in dB	SNR in dB	SNR in dB
QPSK	11	7	26	24
16-QAM	16.5	11.5	27.5	29
64-QAM	26	17	33	31

Table.1 : MMSE and ZF performance for different modulation schemes under frequency selective and flat Rayleigh Channel

a) Performance with different antenna configurations

From basic 2 × 2, the antennas configuration at the transmitter and receiver is increased equally to 4 × 4 and 8 × 8 sizes and the performance in terms of BER Vs SNR is evaluated for MMSE detector using QPSK and 64-QAM modulation.

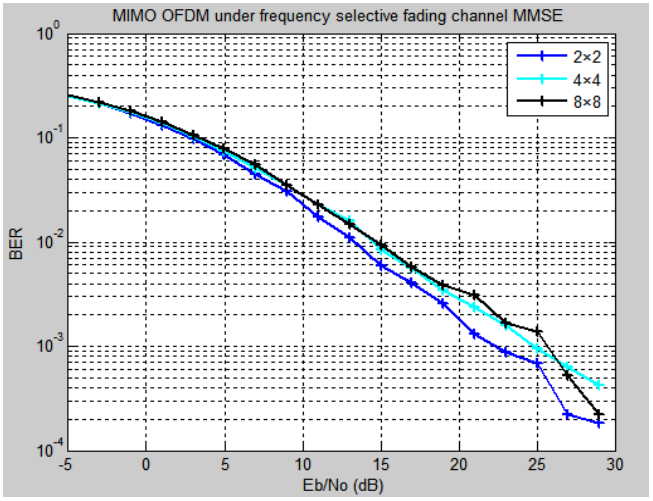


Fig. 10 : Performance for different antenna configurations using QPSK modulation with MMSE

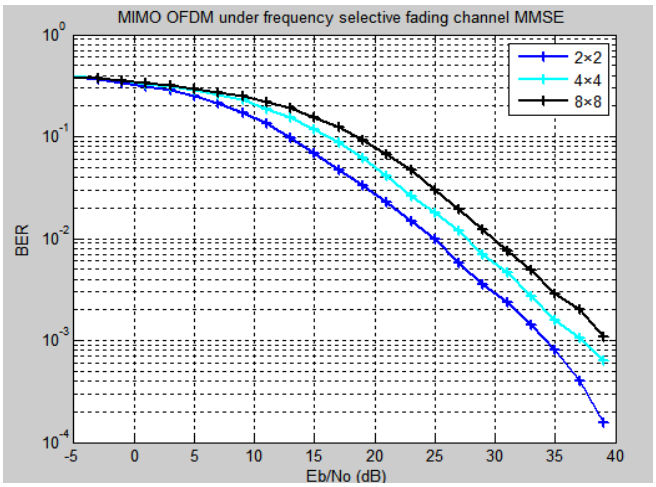


Fig. 11: Performance for different antenna configurations using 64-QAM modulation with MMSE

Figure 11 depicts that if antenna configurations are increased from 2×2 to 4×4 and similarly from 4×4to 8×8, an increment in SNR (dB) of around 2 dB is required to achieve same amount of BER. Thus the spectral efficiency gets doubled in case of MIMO SM technique at the expense of small amount of increment in SNR (0 to 3db). With higher antenna configuration, higher channel capacity is achieved with a small expense of SNR. This is the benefit of spatial multiplexing and spatial multiplexing detectors

VIII. Conclusion

MIMO-OFDM spatial multiplexing is a promising solution to achieve high data rates and robust communication for future wireless systems. The performance of Minimum Mean Square Error (MMSE) detector is near optimal and of low complexity to achieve good SINR (signal-to-interference-plus noise) ratio. Among linear receivers, performance of MMSE is better than ZF by 3 dB in all conditions. BER of 10^{-3} is achieved at 7 dB SNR under Rayleigh flat fading environment and 24 dB under Rayleigh frequency selective environment. In real-world scenarios, MIMO channels undergoes frequency selective fading, so the performance of a system and its detector is very important to be evaluated under frequency selective channel condition. Using MMSE as a detector and QPSK as a modulation scheme, minimum BER and best performance is achieved. Increasing the modulation order will increase the BER but at the same time it will increase the capacity. Using MMSE with 64-QAM gives maximum throughput than other modulation techniques. Increasing the antenna configuration from 2×2 to 4×4 to 8×8, an increment in SNR (dB) of around 2 dB is required to achieve same amount of BER but at the same time spectral efficiency is enhanced due to multiplexing gain thus leads to an increased channel capacity.

References Références Referencias

1. A. J. Paulraj, D. A. Gore, R. U. Nabar and H. Bolcskei, "An Overview of MIMO Communications—A Key to Gigabit Wireless", *Proc. IEEE*, vol. 92, pp. 198-218, Feb. 2004.
2. A. Lozano and N. Jindal, "Transmit diversity Vs Spatial Multiplexing in Modern MIMO Systems", *IEEE Trans. on Wireless Comm.*, vol. 9, pp.186-197, Jan. 2010.
3. A. G. Gravalos, M. G. Hadjinicolaou and N Qiang "Performance Analysis of IEEE 802.11n under different STBC rates using 64 QAM", presented at the *IEEE International Symposium on Wireless* Pervasive Computing, San Juan, Feb 5-7, 2007.
4. M. Jiang and L. Hanzo, "Multiuser MIMO-OFDM for next generation Wireless Systems—A Key to Gigabit Wireless", *Proc. IEEE*, vol. 95, pp. 1430-1469, Jul. 2007.
5. Y. S. Cho, J. Kim, W. Y. Yang, C. G. Kang, *MIMO OFDM Wireless Communication with Matlab.* Singapore: John Wiley and Sons, 2010
6. N. T. Hieu, N. T. Tu, A. N. Duc and B. H. Phu (2013 August). FPGA Design and Implementation of MIMO-OFDM SDM Systems for High Speed Wireless Communications Networks. *International Journal of Research in Wireless Systems*. vol. 2, pp. 26-33.
7. J. Penketh and M. Collados, "Performance and Implementation Complexity of Receiver Algorithms for MIMO-OFDM Based Wireless LAN Systems", in *IEEE Int. Symp. Personal, Indoor and Mobile Radio Communications*, 2004, vol. 3, pp.1522-1526.
8. Y. Chen, J. Zhang and D. Jayalath, "Multiband-OFDM UWB vs IEEE802.11n: System Level Design Considerations" in *IEEE Conf. Vehicular Technology,* Melbourne, Australia, 2006, pp. 1972-1976.

9. P. Samundiswary and S. Kuriakose, "BER Analysis Of MIMO-OFDM using V-Blast System For Different Modulation Schemes", in *IEEE Int. Conf. Computing Communications and Network Technologies*, Coimbatore, 2012, pp. 1-6.
10. I. Medvedev, B. A. Bjerke, R. Walton, J. Ketchum, "A Comparison of MIMO Receiver Structures for 802.11n WLAN- Performance and Complexity", in *IEEE Int. Symp. Personal, Indoor and Mobile Radio Communications*, Helsinki, 2006, pp.1-5.
11. S. Lee, J. Lee and S. C. Park, "Performance and complexity comparison of the Schemes to increase data rate in MIMO-OFDM with various Decoding Schemes", in *Asia Pacific Conf. Communications*, Busan, 2006, pp.1-4.
12. R. V. Nee, V. K Jones, G. Avater, A. V. Zelst, J. Gardener and G. Stelle. (2006, June). The 802.11n MIMO-OFDM standard for Wilress LAN and beyond. *Springer International Journal on Wireless Personal Communications*. vol.37. pp.445-453.
13. R. Pierre and F. Hoefel, "IEEE 802.11n: Om Performance with MMSE and OSIC Spatial Division Multiplexing Transceivers", in *IEEE Int. Symp. Wireless Communication Systems*, Paris, 2012, pp.376-380.
14. W. Zhang, X. Ma, B. Gestner, D. Anderson. (2009, Feb 10). Designing Low complexity Equalizer for Wireless Syatems. *IEEE Communication Mag*. pp. 56-62.
15. C. Michalke, E. Zimmermann and G. Fettweis, "Linear MIMO Receivers vs. Tree Search Detection: A performance Comparison Overview", in *IEEE Int. Symp. Personal, Indoor and Mobile Radio Communication*, Helsinki, 2006, pp.1-7.
16. A. Zanella, M. Chiani and M. Z. Win, "MMSE Reception and Successive Interference Cancellation for MIMO Systems With High Spectral Efficiency", *IEEE Trans. Wireless Comm.*, vol. 4, pp. 1244-1253, May. 2005.
17. E. Suikkanen, J. Ketonen and M. Juntti, "Detection and channel estimation in 8×8 MIMO-OFDM", in *IEEE Int. Conf. Personal, Cognitive Radio Oriented Wireless Networks and Communications*, Oulu, 2014, pp. 299-304.
18. J. G. Proakis, Digital Communications. McGraw Hill series in electrical and computer engg.,1995
19. T. S. Rappaport, Wireless Communications, Principles and Practice, Pearson Edu., vol.1, 2002

Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 15 Issue 8 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

A Comparitive Study on Location based Multicast Routing Protocols of WSN:HGMR,HRPM,GMR

By Kanchan Verma
Punjab Institute of Technology Kapurthala Punjab, India

Abstract- Wireless sensor network comprises of a set of sensor nodes that communicate among each other using wireless links and work in an open and distributed manner due to which wireless sensor networks are highly prone to attacks. This is difficult to determine the position of the sensor nodes; therefore the sensor network protocols must inculcate self-organizing competence. Location awareness is one of the important concern in WSN because for a network mostly data collection is grounded on location, so this is imperative for all the nodes to know their position whenever it is required and it is also helpful in calculating the distance between two particular nodes to deal with energy consumption issues. This paper focuses on the three location based routing multicast protocols: HGMR, HRMP, GMR and their comparison is done on the basis of different metrics like latency, PDP, encoding overhead etc.

Keywords: wsn(wireless sensor network);loaction based multicast routing protocols; hgmr(hierarchical geographic multicast routing); gmr(geographic multicast routing); hrpm(hierarchical rendezvous point multicast); pdp(average packet delivery ratio); normalized encoding overhead(neo); avergae delivery latency.

GJCST-E Classification : C.2.2

Strictly as per the compliance and regulations of:

A Comparitive Study on Location based Multicast Routing Protocols of WSN:HGMR,HRPM,GMR

Kanchan Verma

Abstract- Wireless sensor network comprises of a set of sensor nodes that communicate among each other using wireless links and work in an open and distributed manner due to which wireless sensor networks are highly prone to attacks. This is difficult to determine the position of the sensor nodes; therefore the sensor network protocols must inculcate self-organizing competence. Location awareness is one of the important concern in WSN because for a network mostly data collection is grounded on location, so this is imperative for all the nodes to know their position whenever it is required and it is also helpful in calculating the distance between two particular nodes to deal with energy consumption issues. This paper focuses on the three location based routing multicast protocols: HGMR, HRMP, GMR and their comparison is done on the basis of different metrics like latency, PDP, encoding overhead etc.

Keywords: wsn(wireless sensor network);loaction based multicast routing protocols; hgmr(hierarchical geographic multicast routing); gmr(geographic multicast routing); hrpm(hierarchical rendezvous point multicast); pdp(average packet delivery ratio); normalized encoding overhead(neo); avergae delivery latency.

I. Introduction

WSN offers an umpteen number [4] of applications in areas such as traffic monitoring, habitat monitoring, pollution monitoring robotic exploration, and many more. The sensor nodes need to be inexpensive, small, limited computation and communication, less energy resources. Sensors know their position using GPS or other virtual position systems moreover sensors share their information with their neighbors and then messages are delivered to the nodes which are located out of their radio range and sometimes single sensors need to send data to multiple destinations and to run these applications the use of multicast communication is required. Multicasting is a technique used in order to deliver messages efficiently from a source to a set of destinations to carry activities such as task assignments, code update and targeted queries, therefore multicasting is salutary to maintain as the energy is limited available in WSN networks. Multicasting protocols focus on minimizing the consumption of network resources by taking the advantage of the fact that some parts of the paths from the source to destinations can be shared by multiple destinations. WSN is characterized by its topological changes due to node failure or duty cycle operations and these characteristics make localized routing algorithms more appropriate for sensor networks. Localized algorithms do not need to know the entire topology in order to take routing decisions as comparative to that of centralized ones in which too much overhead is introduced.

Author: Computer science and engineering Punjab Technical University (PTU main campus) Kapurthala Punjab, India.
e-mail: Kanchanverma252@gmail.com

II. Routing Protocols in WSN

[4] Routing in wireless sensor networks differ from traditional wireless communication network (MANET) as the number of sensor nodes in wireless sensor networks can be several orders of magnitude which is higher than that in MANET, sensor node do not have any unique ID, [17]sensor nodes are cheaper than nodes in MANET,[16] power resources of sensor nodes should be very limited, sensor nodes are more limited in their computation and communication capabilities than MANETs, moreover sensor nodes are prone to failures. Therefore there is no infrastructure, sensor nodes may fail, wireless links are unreliable, and routing protocols have to meet strict energy saving requirements [17] so, it is imperative to study routing protocols for wireless sensor networks. The routing protocols proposed for WSN are classified into four main categories as,

- Data centric protocols. [12] These are those protocols which are query based and to reduce the repeated transmission, these protocols depend on the naming of data of interest.
- Hierarchical protocols. These are those protocols in which the sensors in the network are divided into different clusters [7]. It is an efficient way to reduce energy consumption within a cluster by introducing data aggregation and fusion to decrease the number of transmitted messages to the base station.
- Location based protocols. These protocols utilize the position information of nodes to relay data to the destinations. On the basis of the incoming signal strength the distance between the neighboring nodes is estimated [5]. Here the region which is to be sensed is known in advance using the location of

sensors and therefore the query generated will be diffused only to that particular region which will significantly estimate the number of transmissions.

- Energy efficient protocols. These protocols are to balance the energy consumption in the network as they are energy efficient as they utilize the power in an effective manner and consume less energy [17].

a) Unicast and multicast routing protocols

Earlier we have unicast routing protocols which were not that much efficient in terms of energy consumption, encoding overhead and many more.[4] The overhead in a WSN is to be kept low due to limited battery, storage capacity, bandwidth and processing power of sensor nodes so an efficient multicast mechanism is required to attenuate the overall consumption of resources in the network and to obtain this efficiently we need to send as limited copies as possible of each datagram to reach all the destinations. Multicasting is used with those sensors which are required to deliver the same data to the number of sinks whose position is known in advance; moreover from one sink we can multicast the same packets to other sinks with the help of sensors from the network.

b) Location based multicast routing protocols

Earlier Position based multicast routing protocols were used because of their application potential in networks with demanding requirements. These protocols route decisions with the use of location information. Among all the position based protocols the geographic approach is the one which seize the attention mostly due to umpteen advantages. [13]The geographic routing is one of the debonair ways to forward packets from source to destination in a demanding environment without having wastage of network resources or creating any hindrance in the network design, so it is used in high number of applications including number of areas such as industry, home ,health, environment, military and commerce .The location based routing protocols are based on dealing with location information to guide routing discovery and maintenance as well as data forwarding, permitting directional transmission of the information and evading information flooding in the whole network. It mainly focuses on calculating the distance between the two particular nodes so that energy consumption can be estimated. There are number of location based approaches which deal with the location information in order to send the data packets from one node to another so that the data reaches in an efficient way in many terms or metrics. Nowadays the use of wireless networks is mushroomed drastically and the main concern is the deteriorated non rechargeable battery power of sensor nodes so it is salutary to have energy saving optimization in WSN. [15]There are two protocols which were earlier proposed to optimize two orthogonal aspects of location based multicast protocols: [12] GMR which ameliorates the forwarding efficiency of packets by elevating the multicast advantages. HRPM deteriorates the encoding overhead by constructing a hierarchy at virtually no maintenance cost via the use of geographic hashing. The HGMR assimilates the key design of GMR and HRPM and optimizes them for WSN by providing both forwarding efficiency as well as scalability to large scale networks.

These protocols are analyzed as,

i. *Geographic multicast routing protocol*

[3] Geographic multicast routing protocol was proposed by Juan A.Sanchez, Pedro M.Ruiz and Ivan Stojmenovic. [11] It is fully distributed and operates in a localized manner in tree formation. This is a Geocasting based protocol. Here each packet carries the ID's of multicast destinations and then forward it to each of the destination independently in a greedy manner. Those destinations which share the same next hop will go along the same way in the hop-by-hop forwarding in GMR. Path sharing will help to reduce total tree cost for reaching different destinations. Each packet is forwarded in a hop-by-hop manner until it reaches its intended or desired destination.

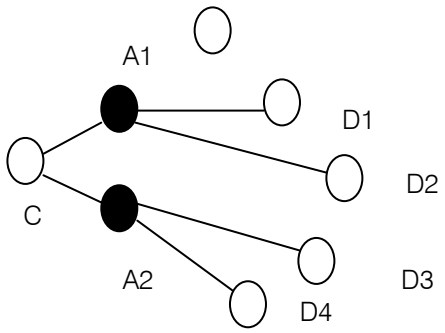


Figure 1: Fowarding Node Selection In Gmr [15] [18]

As earlier centralized membership management is done at the multicast root, but in GMR it is done along the multicast tree to send a data packet down the multiple branch of the multicast tree using one broadcast transmission.

Advantages [14]:

- Bandwidth utilization is provided to minimize the total number of transmissions for accomplishing a multicast task.
- GMR protocol is an energy inefficient protocol and it exhibits high delay during communication.

Disadvantages [15] [18][22]:

- Scalability issues are there for large scale networks.
- Too much encoding overhead.
- Energy consumption is limited to the nodes on the routing paths as for every data delivery same paths are created.
- In GMR there are more destinations so more complex is the evaluation, as the cost and the

progress need to evaluate for every subset of destinations at every hop.

ii. *Hierarchical Rendezvous Point Multicast*

[19] Hierarchical Rendezvous Point Multicast was introduced by Saumitra M.Das, Himabindu Pucha and Y.Charlie. [13] It reduces encoding overhead of location based multicast protocols by constructing a hierarchy by dividing the network into multicast groups and then into subgroups, then further each subgroup is restrained by its coordinator which is known as access point (AP).. This protocol uses the concept of mobile geographic hashing to reduce the maintenance of AP (access point) and RP (rendezvous point) nodes at virtually no maintenance cost. The need for this protocol is to construct and maintain hierarchy to have low encoding overhead. HRPM is designed to work for multicast communication and for HRPM there is no need to take care of cost factors like in GMR protocol.

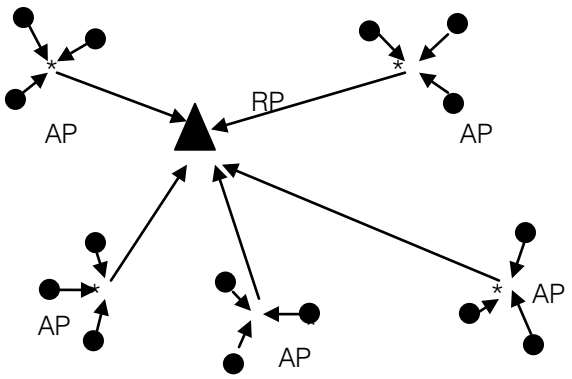


Figure 2 : Group Management In Hrpm [2]

Advantages [13] [19]:

- Reduced encoding overhead and delay is less.
- Scalable protocol and its performance do not decrease due to any change in network size or node density.

Disadvantages [19][2]:

- Consumes a lot of energy and therefore inefficient in terms of packet transmission as at each node along the source→APs (access point) or the AP→Member tree.
- Packet unicast to more than one neighbor node which consumes bandwidth.

iii. *Hierarchical Geographic Multicast Routing (HGMR)*

Hierarchical Geographic Multicast Routing Protocol was proposed by Dimitrios Koutson, Sumitra Das, Charlie Hu. and Ivan Stojmenovic [19]. HGMR put together the GMR and HRPM protocol [3]. It includes hierarchical decomposition of a multicast group into subgroups of manageable size which results in reduced encoding overhead using HRPM concept of mobile geographic hashing and within each subgroup it uses GMR concept. [7] Here the source builds an overlay tree, the source→to→AP tree and another overlay tree as AP→to →member tree. To transmit data packets from source the unicast based forwarding strategy of HRPM is used to propagate data packets to each AP along the source→to→AP overlay tree and in case of constructing an AP→to →member overlay tree in each cell. [8] Here local multicast scheme is used to forward a data packet along multiple branches of the multicast tree in one transmission. Hence it combines the high forward efficiency of GMR with low encoding overhead of HRPM.

[13] The need is to design such a protocol which provides scalability as well as forwarding efficiency.

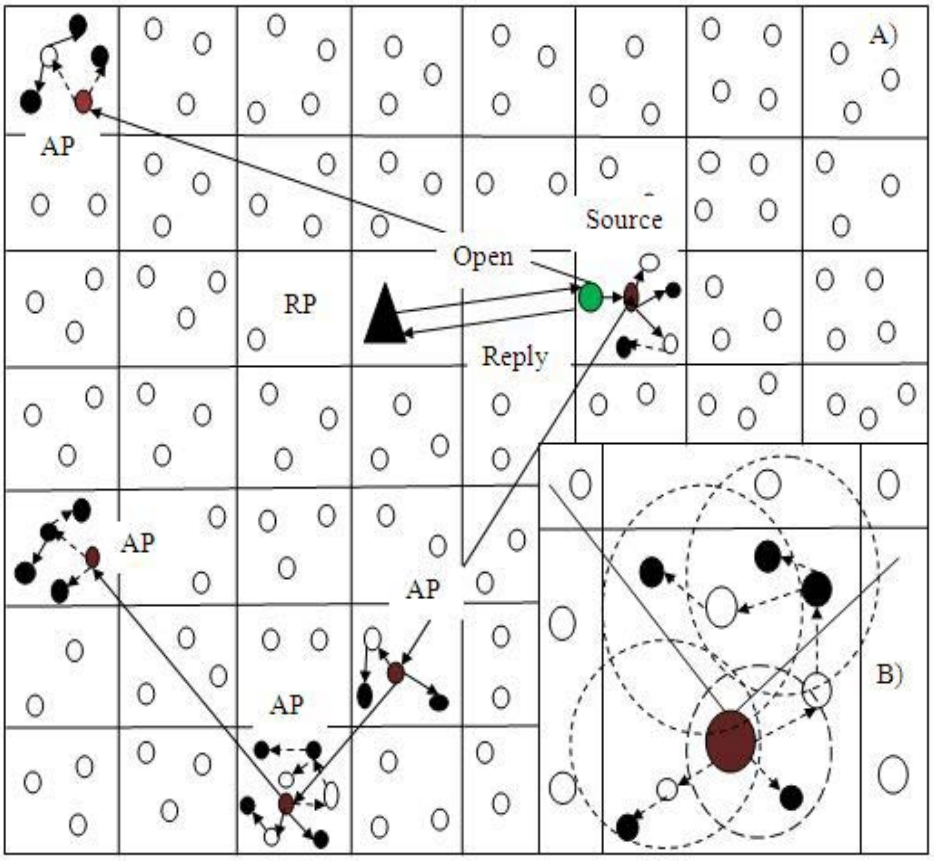
Advantages [7] [19]:

- Energy efficient and encoding efficient protocol as it provides higher forwarding efficiency which utilizes multicast advantages as concept of GMR is used in HGMR.
- Scalability is improved as it has low overhead hierarchical decomposition which is the concept of HRPM.
- Less delay as compared to GMR and HRPM.

Disadvantages [19]:

- Packets may be corrupted due to noise or the receiver may be unable to decode them due to low SNR and it increases with the packet size.
- Simple network partition may not achieve the optimal routing path from the root node to multicast group members.
- Here the routing data efficiency can be low because the data packets are always sent from the upper APs to lower APs without considering that lower APs may be closer to the source than upper APs.

Figure 3 : Data delivery in HGMR



III. Comparison on Different Metrics

There are four main measurable metrics [4] to evaluate the effectiveness of these three protocols for data forwarding.

1. **Packet Delivery Ratio (PDR).** It is the ratio of number of data packets delivered to a multicast group member divided by the number of data packet transmitted by the [1] source which is averaged over all multicast group members. It is of the amenities because in the realistic environment there is packet loss.
2. **Average Delivery Latency (Delay).** delivery ratio is calculated over all multicast packets delivered to all receivers. It inculcates all possible delays which are [8] caused by queuing at the interface queues, propagation, transfer time and back off at MAC layer when the channel is busy.
3. Data transmission of packets. The total number of packets delivered [1] from the source to the destination is the measure of the efficiency of the multicast path selected.
4. **Network encoding overhead.** Total number of encoding bytes transmitted at every hop to the total number of data bytes transmitted at every hop. Here the encoding bytes are the bytes used in each data packet to encode the information required by each protocol.
5. **Forwarding cost**. The total number of data packet transmissions divided by the total number of packets received by all the multicast members. It gives the average number of transmissions required per delivered packet. In an ideal environment, the number of data received (denominator) is same for all protocols, and hence this metric degenerates to be the same as the total number of transmissions. In a realistic environment, the PDR is different for each protocol, and hence this metric combined with the total number of transmissions gives a better picture of the forwarding efficiency of each protocol.

Earlier by Dimitrios Koutsonikolas et al. the simulation of these existing protocols is done using Glomosim simulator but here in this papers simulation is done using MATLAB and on the basis of the results the comparison table is drawn.

Table 1 : Comparison Of Location Based Multicast Protocols In Wsn[1]

S.No	Protocol / Metrics	GMR	HRPM	HGMR
1.	Data transmission	Very Less (200,000)	High (322,000)	Less or same as GMR (200,000)
2.	PDR	Low (60%)	(high) 82%	(very high) 83%
3.	latency	Highest (0.068 sec)	average (0.054 sec)	lowest (0.053 sec)
4.	FC	low (1.1)	high (1.5)	lowest (0.8)
6.	NEO	high (38%)	low (14%)	Average (16%)

Table 2 : Comparative Study Of Location Based Multicast Protocols In Wsn[14][1]

Protocol name	year	author	approach	advantages	Disadvantages
GMR	2006	Juan A.Sanchez,Pedro M.Ruiz and Ivan stojmen	Geocast based approach to optimize cost over progress ratio	Bandwidth utilization proper and forward efficiency is provided	Scalability issues for large scale network, too much encoding overhead
HRPM	2007	Saumitra M.Das,Himabindu Pucha,Y.charlie	reduces encoding overhead of location based multicast protocols by constructing a hierarchy	Reduced encoding overhead, scalable protocol, delay less than GMR	Inefficient in terms of packet transmission, consumes a lot of energy so inefficient
HGMR	2010	Dimitrios Koutsonikolas,Saumitra Das,Charlie Hu .and Ivan Stojmenovic	Combined together GMR and HGMR	Less delay than GMR and HGMR, efficient routing with the help of multicast groups	Load balancing problem, do not achieve optimal routing path, routing data efficiency can be low

Comparison of location based protocols is done on the basis of the four performance metrics. Among all the three location based protocols HGMR, HRPM and GMR, HGMR shows better performance, as it is combination of the GMR and HRPM protocols.

IV. Conclusion

Location based routing in sensor networks has captivated a lot of attraction in the recent years. In this paper we have summarized recent research results on three location based protocols HGMR, HRPM and GMR.As our study revels, that out of all these three routing protocols HGMR performs better. Although many routing protocols have been proposed for sensor networks, many issues still remain to be addressed.

References Références Referencias

1. Dimitrios Koutsonikolas ,Saumitra M. Das,Y. Charlie Hu and Ivan Stojmenovic, "Hierarchical geographic multicast routing for wireless sensor networks" Wireless Network (2010),pp.449–466.
2. Xuxun Liu, "A Survey on Clustering Routing Protocols in Wireless Sensor Networks" Sensors 2012, pp.11113-11153.
3. Gulbadan Sikander, Mohammad Haseeb Zafar, Ahmad Raza, Muhammad Inayatullah Babar, Sahibzada Ali Mahmud, and Gul Muhammad Khan, " A Survey of Cluster-based Routing Schemes for Wireless Sensor Networks" Smart Computing Review, vol. 3, no. 4, August 2013,pp.
4. Juan A. Sanchez, Pedro M. Ruiz, Member, IEEE, Jennifer Liu, and Ivan stojmenovic ,"Bandwidth-

Efficient Geographic Multicast Routing Protocol for Wireless Sensor Networks" IEEE sensors journal, vol. 7, no. 5, may 2007,pp.627-636.

5. Jennifer Yick,Biswanath Mukherjee,Dipak Ghosal, "wireless sensor network survey",computer networks 52(2008),pp.2292-2330.
6. Deepak Goyal,Malay Ranjan Tripathy,"Routing protocols in wireless sensor network:A survey",second international conference on advanced computing and communication technologies(2012),pp.474-480.
7. Juan A. Sanchez, PedroM. Ruiz, Ivan Stojmenovic, "GMR: Geographic Multicast Routing for wireless sensor networks",IEEE SECON 2006,pp.20-29.
8. Dimitrios Koutsonikolas,Saumitra Das,Y.Charlie Hu and Ivan Stojmenovic, "Hierarcchical Geographic multicast routing for wireless sensor networks",IEEE conference on sensor tecchnologiesand applications2007,IEEE computer society,pp.347-354.
9. Changle Li,Hanxiao Zhang,Binbin Hao and Jiandong Li,"survey on routing protocols for large scale wireless sensor networks",sensor 2011,11,pp.3498-3528.
10. Dachee Kim,Sejun Song and Back-Young Choi, "Energy-efficient adaptive geosource multicast routing for wireless sensor networks",journal of sensors,volume 2013,pp.1-13.
11. Rama Sundari Battula,O.S. Khanna,"Geographic routing protocols for wireless sensor networks:A review",IJEIT,volume 2,issue 12,June 2013,pp.39-42.
12. M.A.Khan,M.Ahsan,G.A shah,Muhammad Sher," Multicast routing protocols in wireless sensor networks(WSN's)",journal of computing volume 4,issue 9,september 2012,ISSN,pp.9-17.
13. Asar Ali,Zeeshan Akbar,"evaluation of AODVand DSR routing protocols protocols of wireless sensor networks for monitoring applications",Master's Degree thesis,october 2009,pp.1-44.
14. Das, S. M., Pucha, H., & Hu, Y. C. (2007), "*Distributed hashing for scalable multicast in wireless ad hoc network*", IEEE TPDS, pp. 445–487.

Global Journal of Computer Science and Technology: E
Network, Web & Security
Volume 15 Issue 8 Version 1.0 Year 2015
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

PAPR Reduction using PTS-PSO Technique for 16×16 MIMO-OFDM Systems with 16-QAM

By Jayati Das & Rajesh Bansode
Mumbai University, India

Abstract- In this paper, it is proposed that a particle swarm optimization (PSO) based partial transmit sequence (PTS) technique is used so that least Peak-to-Average Power Ratio(PAPR) is achieved in Multiple Input Multiple Output- Orthogonal Frequency Division Multiplexin gsystems (MIMO-OFDM). Our approach is to apply PSO based PTS on each antenna of the system helping to find the optimal phase factors, which is a straightforward method to achieve minimum PAPR in this system. PSO based PTS algorithm when applied to MIMO-OFDM systems with a wide range of phase factors, results in high performance after simulation. The results PAPR achieved for 16X16 MIMO-OFDM systems without PTS using 16-QAM is 15.8dB whereas with PTS the PAPR achieved is 7.1 dB therefore overall reductions PAPR with and without PTS is 8.7 dB. Similarly PAPR achieved for 16X16 MIMO-OFDM systems without PTS-PSO using 16-QAM is 15.8 dB whereas with PTS-PSO the PAPR achieved is 3.6 dB therefore overall reductions PAPR with and without PTS is 12.2 dB. The final reduction in PAPR resulted as 8.7 dB and 12.2 dB respectively.

Keywords: *MIMO-OFDM, PTS, PSO, PAPR, CCDF.*

GJCST-E Classification : *C.2.1*

Strictly as per the compliance and regulations of:

PAPR Reduction using PTS-PSO Technique for 16×16 MIMO-OFDM Systems with 16-QAM

Jayati Das [α] & Rajesh Bansode [σ]

Abstract- In this paper, it is proposed that a particle swarm optimization (PSO) based partial transmit sequence (PTS) technique is used so that least Peak-to-Average Power Ratio(PAPR) is achieved in Multiple Input Multiple Output-Orthogonal Frequency Division Multiplexin gsystems (MIMO-OFDM). Our approach is to apply PSO based PTS on each antenna of the system helping to find the optimal phase factors, which is a straightforward method to achieve minimum PAPR in this system. PSO based PTS algorithm when applied to MIMO-OFDM systems with a wide range of phase factors, results in high performance after simulation. The results PAPR achieved for 16X16 MIMO-OFDM systems without PTS using 16-QAM is 15.8dB whereas with PTS the PAPR achieved is 7.1 dB therefore overall reductions PAPR with and without PTS is 8.7 dB. Similarly PAPR achieved for 16X16 MIMO-OFDM systems without PTS-PSO using 16-QAM is 15.8 dB whereas with PTS-PSO the PAPR achieved is 3.6 dB therefore overall reductions PAPR with and without PTS is 12.2 dB. The final reduction in PAPR resulted as 8.7 dB and 12.2 dB respectively.

Keywords: MIMO-OFDM, PTS, PSO, PAPR, CCDF.

I. Introduction

Multiple antennas used at the transmitter and receiver in the wireless communication system known as MIMO These schemes are highly considered to improve the range and performance of an overall system. Therefore, the use of multiple antenna permits to transmit and receive simultaneously by eliminating the multipath effect. MIMO allows higher throughput, diversity gain having increased spectral efficiency and interference reduction [1]. It offers high data rateandimproved link reliability due to antenna diversity gain through spatial multiplexing gain. Orthogonal frequency division multiplexing (OFDM) is a multicarrier modulation technique, which decreases the effect of the noise and interferences, MIMO technique can be used in conjunction with OFDM to increase the diversity gain and/or the system capacity by exploiting spatial domain [2].

The best feature of MIMO- OFDM is to provide high data rate for wireless communications. However, fortransmitted signal high peak-to average power ratio (PAPR) is a major drawback of the OFDM scheme [3]. Since MIMO-OFDM system is based on OFDM, it also faces the same issue. The high power amplifier (HPA) causes this high PAPR which is sensitive to nonlinear distortion. The nonlinear distortion generates inter-symbol interference (ISI) and inter-modulation, which increases the bit error rate.

Many techniques have been proposed in the literature to effectively address the high PAPR in OFDM systems. These approaches include the clipping techniques (that employ clipping or nonlinear saturation around the peaks to reduce PAPR) [4], coding techniques, and probabilistic (scrambling) techniques.
Particle swarm optimization (PSO) is effective in optimizing difficult multidimensional discontinuous problems in a variety of fields. Main goal of PSO is to find in the field the location with the highest density of particles. Without any knowledge of the field a priori, the search begins in random locations with random velocities looking for particles. While a fundamental to use PTS is data blocks are divided into non overlapping sub-block with independent rotation factor. With lowest amplitude this rotation factor generates time domain data. The fundamental idea of this technique is sub-dividing the original OFDM symbol data into sub-data being transmitted through the sub-blocks which are then multiplied by the weighing value which has been differed by the phase rotation factor until choosing the optimum value which has low PAPR.

In this paper, a thorough study of PAPR Reduction in MIMO-OFDM using PTS is done. There by applying a straight forward technique this is implemented by applying PTS algorithm on each of the system's antennas [5]. This technique is called Independent PTS (IPTS).

The rest of this paper is organized as follows. In section II, describesproposed system architecture which is subdivided as Peak to Average power Ratio, Partial Transmit Sequence, Particle swarm optimization and PSO based PTS algorithm. The simulation results of the PSO based PTS MIMO-OFDM algorithm are presented and discussed in section III. Hence concluding the paper,

II. System Architecture

In day to day increasing need of high-speed wireless communication, OFDM can be applied to transform frequency selective MIMO channel into parallel MIMO channels, in multipath fading environment

Author α: Masters in Electronics and Telecommunication subject. Area of interest is Wireless Communication.
e-mail: dasjayatid@gmail.com
Author σ: is currently an Associate Professor pursuing Ph.D. in wireless Communication.
e-mail: rajesh.bansode1977@gmail.com

by reducing the complexity of the receiver also high data rate robust transmission can be achieved. At the transmitting end, a number of transmission antennas are used. To space-time coding an input data bit stream is supplied, then modulated by OFDM and finally fed to antennas for sending out radiation.Before recovery of the original signal is made at the receiving end, in-coming signals from transmitting end are fed into a signal detector and processed MIMO system with a transmit array of $M_T$antennas and a receive array of $M_R$antennas [6].

Problem of high PAPR a disadvantage in OFDM is discussed along with in depth knowledge of PAPR, how it causes problem in existing OFDM along with its outcome. For reduction of this problem at first OFDM is generated by choosing the spectrum requisite based on the input data, and modulation scheme used. Same data is assigned to transmit for each carrier to be produced. The required phase and amplitude of them are calculated based on the modulation scheme [7]. Using an Inverse Fourier Transform (IFT) requisite spectrum is achieved and then converted back to its time domain signal. The peak value of the system is very high as compared to the average of the complete system due to presence of large number of modulatedsub- carriers in an OFDM. This ratio of the peak to average power value is termed as Peak-to Average Power Ratio.

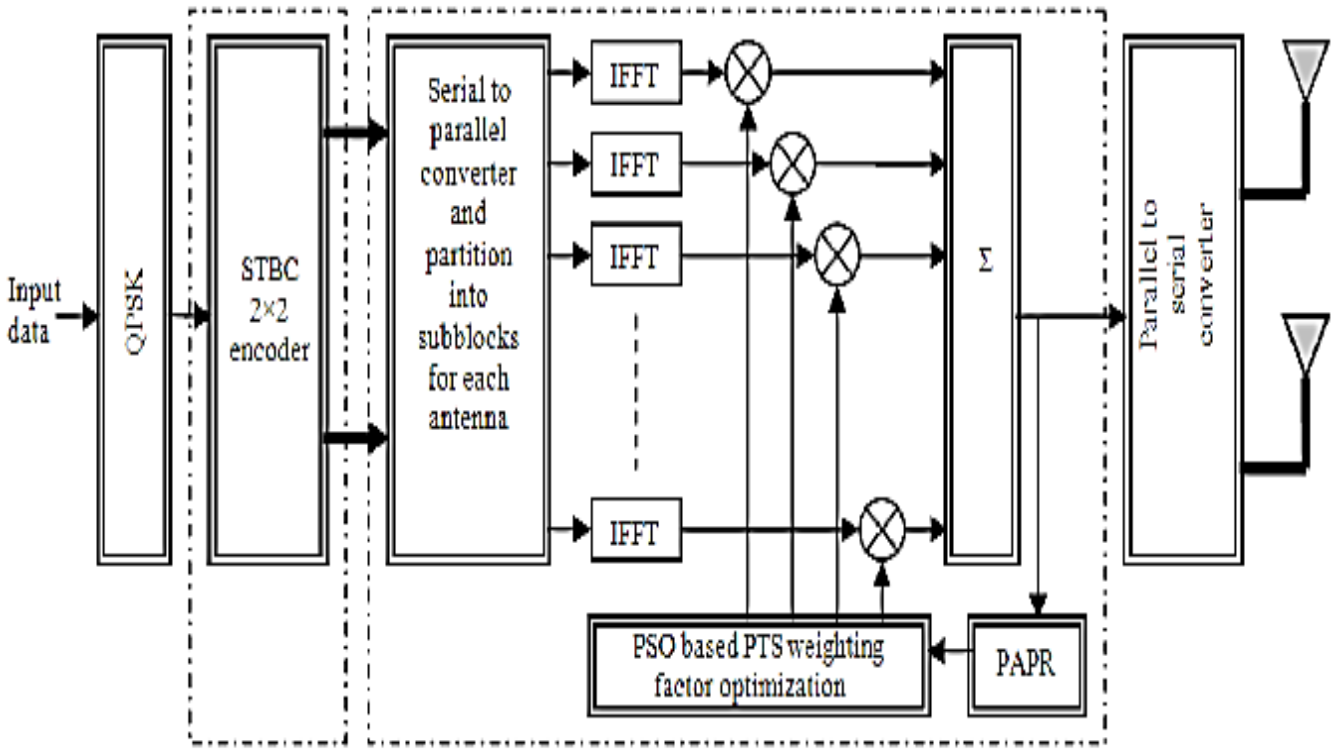


Fig.1: PAPR reduction technique by using PSO based PTS weighing factor

a) Peak to Average Power Ratio

OFDM signal show very high Peak to average power ratio. A high PAPR can cause the complexity increased of the analog-to-digital converter (A/D) and digital-to-analog converter (D/A). Therefore, Radio frequency amplifier (RF) can decrease the efficiency and it can operate in non-linear region which damaging the performance of communication system. In OFDM system, an input data block of length N can be written as $X = [X_0, X_1 \dots\dots, X_{N-1}]_T$,and each symbol modulating one of a set of subcarrier$\{f_n, n = 0,1, \dots\dots, N-1\}$. The N subcarriers are selected to be orthogonal. The datablock of the OFDM symbol is given by

$$x(n) = \frac{1}{\sqrt{N}} \sum_{i=0}^{N-1} X_i e^{\frac{j2\pi ni}{N}}, \qquad 0 \le n \le N-1 \qquad (1)$$

PAPR of the OFDM signals defined as ratio between maximum power and the average power during the OFDM signal. Then the Peak to Average Power Ratio is expressed as:

$$PAPR = \frac{\max_{0 \le t \le NT} |x(t)|^2}{1/NT \int_0^{NT} |x(t)|^2 dt} \qquad (2)$$

The large PAPR is reduced as value of$max|x(t)|$ decreased. The PAPR problems are arising by calculation of four sinusoidal signals with different frequency and phase shift logically.

Another major factor used in PAPR is Complementary Cumulative Distribution Function (CCDF), which is used to measure efficiency of PAPR technique. The Crest Factor (CF) is defined as the square root of PAPR.

$$Crest\ Factor\ =\ \sqrt{PAPR} \qquad (3)$$

The CCDF expression of the PAPR of OFDM signals can be written as

$$CCDF\ =\ max_{0\le T\le NT}\frac{|x(t)|}{E[|x(t)|]} \qquad (4)$$

$E[|x(t)|]$is the average power. In several cases, the large PAPR can be decreased by reducing the value of maximum signal power for the reason that the large value of average power causes interference. There are several techniques to reduced PAPR, and is subdivided into two groups as signal scrambling techniques and signal distortion techniques. These can be further subdivided into many techniques such as clipping, peak windowing and peak cancellation.

b) Partial Transmit Sequence

Partial Transmit Sequence is a distortion less technique based on scrambling rotations to group of subcarriers. PTS is based on the same principle as Selected Mapping (SLM), but gives better performance than SLM. The basic concept of PTS technique is the input data block is portioned into disjoint sub-blocks. The sub-carriers which are transmitted through the sub-blocks are multiplied by weighing value of the phase rotation vector for those sub blocks [8]. The phase rotation vector is very carefully chosen such that the PAPR value is minimized. PTS is highly successful in PAPR reduction and efficient redundancy utilization; on other hand a considerable computational complexity is required to search with respect to high-dimensional vector space along with necessary transmission of side information (SI) to the receiver are challenges for a practical implementation. The complexity issue has been formulated such that the search problem of PTS is a combinatorial optimization (CO) problem

c) Particle Swarm Optimization

PSO is a population-based globalised optimization technique which supported the social manners of bird flocking looking for food. The particle is called the population members which are mass-less and volume-less. All particles represent an explanation of high-dimensional space; its current position and its best position create by its region. The velocity update and position value has two primary operators of PSO technique. The language used to discuss the PSO follows from the analogy of particles in a swarm.

d) Particle Swarm optimization based PTS Algorithm

PSO as an optimizer is used to solve the phase factor problem, which is shown as PSO process block in Fig below. In PSO algorithm solution space of the problem is called particles, which is φ_k in the PTS based PSO scheme [9]. By moving the particles around in the search-space, the optimal solution of the phase problem will be reached. During the movement of the particles, each particle is characterized by two parameters: position and velocity [10]. The PSO algorithm evaluates particles with fitness value, which is PAPR the objective function. A solution space is randomly generated, which is a matrix of size$S \times K$where *S* is the number of particles and *K* is the number of disjoint sub-block [11]. In other words, the solution space is a matrix its rows are$\varphi_1, \varphi_2, \varphi_3 \dots\dots\dots \varphi_k$.

Since the PSO is an iterative algorithm, in the i^{th}iteration each particle can be described by its positionvector $Y_{SK}^t = y_{S1}^t, y_{S2}^t, y_{S3}^t, \dots\dots\dots y_{Sk}^t$ and velocityvector is given as$V_{SK}^t = v_{S1}^t, v_{S2}^t, v_{S3}^t, \dots\dots\dots v_{Sk}^t$, where $s \in [1, S]$ and $Y_{SK}^t \in R$ where Rdenotes the domain of the objective function. The PSO algorithm searches the solution space for the optimum solution by using iteration process.

Each particle updates itself in every iteration by tracking two best positions. These are called the local best position, which is the best solution this particle achieved$p_{sk} = p_{s1}, p_{s2}, p_{s3}, p_{s4}, \dots . p_{sk}$ and the global best position can be given as

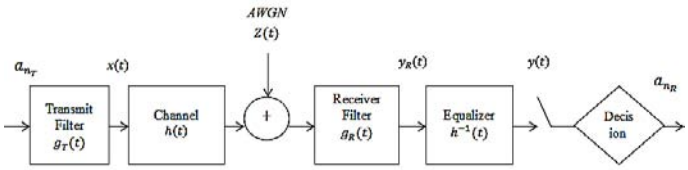


Fig. 2 : PAPR reduction technique by using PSO based PTS weighing factor

$p_{sk}^g = p_{s1}^g, p_{s2}^g, p_{s3}^g, p_{s4}^g, \dots\dots p_{sk}^g$ which the best position is obtained so far by any particle in the whole swarm. The updating process of the position and velocity of each particle can be expressed as

$$V_{SK}^{t+1} = wV_{SK}^t + c_1 r_1 (p_{sk}^t - Y_{SK}^t) + c_1 r_1 ((p_{sk}^t)^g - Y_{SK}^t)$$

$$\boldsymbol{Y}_{SK}^{t+1} = \boldsymbol{Y}_{SK}^t + \boldsymbol{V}_{SK}^t \qquad (5)$$

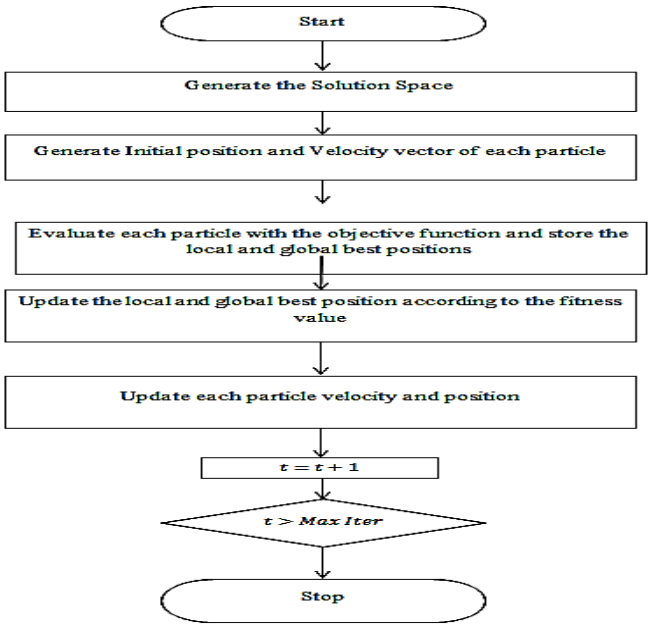


Fig. 3 : PSO-PTS Algorithm

Where c_1 and c_2 are the acceleration terms [12]. The constant r_1 and r_2 are uniform distribution random numbers in the range of [0, 1]; **w** is the inertia factor.

III. Simulation ResultAnd Discussion

Complementary Cumulative Distribution Function (CCDF) of PAPR is calculated by generating 2000 random OFDM frames. The constant acceleration $c_1 = c_2 = 2$and the inertia factor w is calculated by using

$$w = (w_{max} - w_{min}) \times \frac{Itr_{max} - Itr_{min}}{Itr_{max}} + w_{min} \qquad (6)$$

Fig.4. below shows CCDF of PAPR for PSO-PTS MIMO-OFDM (16×16) is compared with the original PAPR MIMO-OFDM. The PAPR of PSO-PTS MIMO-OFDM signal exceeds 3.6 dB is 10^{-6} while with the same PAPR of the PTS MIMO-OFDM system exceeds 7.1 dB and the PAPR of the original MIMO-OFDM system exceeds 15.8 dB The further study gives us the knowledge of reduction in PAPR is calculated as difference of MIMO-OFDM PAPR value without PTS to that of PAPR value of MIMO-OFDM with PTS.

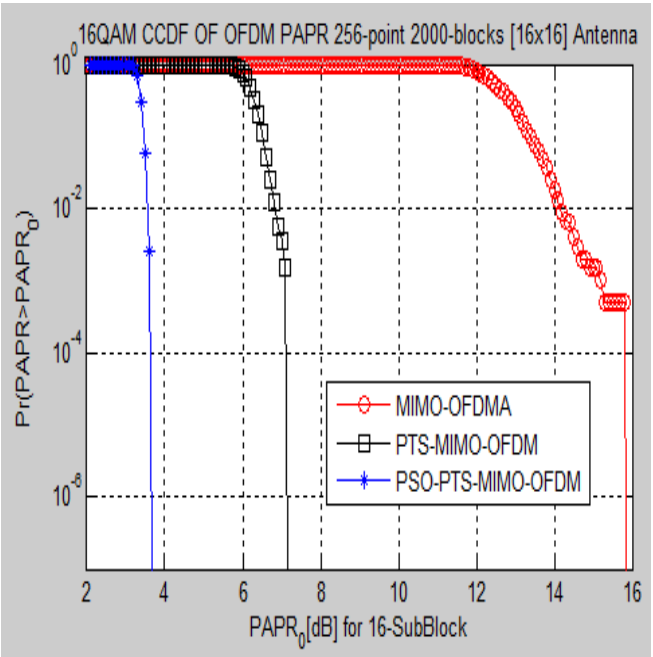


Fig. 4 : CCDF vs. PAPR for PSO-PTS MIMO (16×16)

Table 1: CCDF vs. PAPR for PSO-PTS MIMO

Condition	PAPR(dB)	CCDF	Parameter
MIMO-OFDM	15.8	10^{-6}	2000blocks,16 × 16,16 QAM,256 Carrier
PTS MIMO-OFDM	7.1		
PTS-PSO MIMO-OFDM	3.6		

For simplicity adjacent portioning technique is used. By increasing the number of sub-blocks of PTS-PSO MIMO-OFDM system, the performance of the system is enhanced. The CCDF of PAPR exceeds the PTS-PSO MIMO- OFDM when K = {4, 8, 16} is shown in Fig.5. PAPR of 3.6 dB is achieved for CCDF 10^{-6} when K = 16; PAPR of 3.8 dB is achieved for CCDF 10^{-6} when K = 8, and PAPR OF 4.4 dB is achieved for CCDF 10^{-6} when K = 4

Table 2 : CCDF vs. PAPR (Sub Blocks)

Sub-Blocks	PAPR(dB)	CCDF	Parameter
K=16	3.6	10^{-6}	2000blocks,16 × 16,16 QAM,256 Carrier
K=8	3.8		
K=4	4.4		

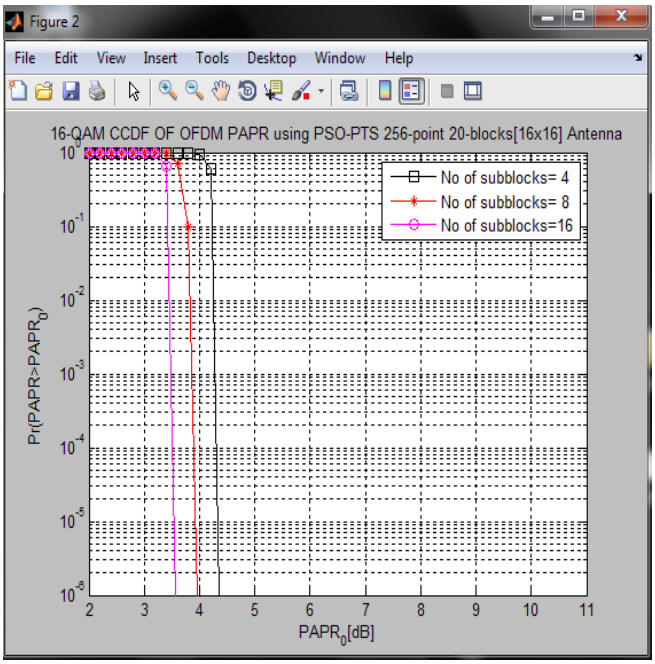


Fig. 5 : CCDF vs. PAPR for PSO-PTS MIMO (Sub-Blocks) (16×16)

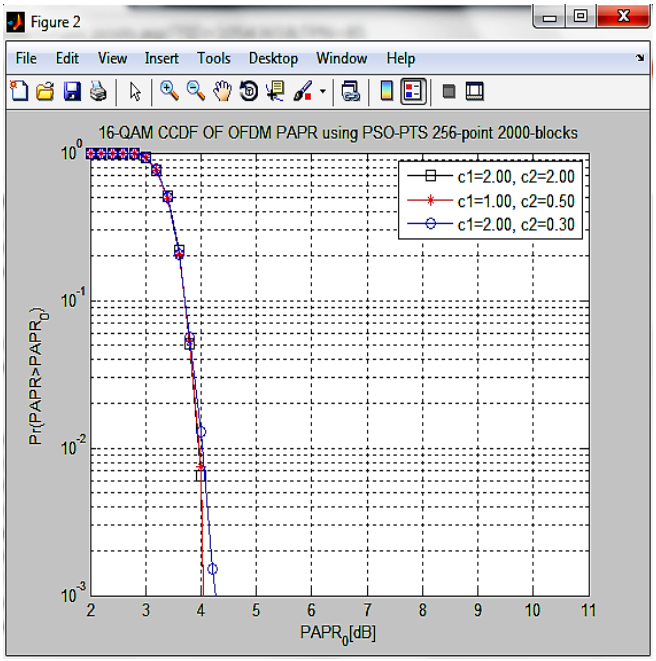


*Fig.6.*CCDF vs. PAPR for PSO-PTS MIMO (Acceleration Constant) (16×16)

The performance of PSO-PTS is analyzed for different constants accelerations are used. The probability that the PAPR exceeds 3.4 dB is 0.01 when $c_1 = c_2 = 2$ and exceeds 3.435dB is 0.0099 when $c_1 = c_2 =$

0.3. It can be noted from the graph that $c_1 = c_2 = 2$ is slightly better performance than other combinations.

Table. 3 : CCDF vs. PAPR (Acceleration Constant)

Sub Carrier	Acceleration Constant	PAPR (dB)	Probability	Parameter
256	$c_1 = c_2 = 2$	3.4	0.01	2000blocks(2k bits),16×16,16 QAM,256 Carrier
	$c_1 = c_2 = 0.3$	3.435	0.0099	

IV. Conclusion

In this paper, the PAPR of MIMO-OFDM systems using PSO algorithm is studied. The performance of the system is evaluated by calculating the CCDF. Applying PSO-PTS algorithm on MIMO-OFDM PAPR achieved for 16X16 MIMO-OFDM systems without PTS using 16-QAM is 15.8dB whereas with PTS the PAPR achieved is 7 dB hence reductions PAPR with and without PTS is 8.7 dB. Similarly PAPR achieved for 16X16 MIMO-OFDM systems without PTS-PSO using 16-QAM is 15.8 dB whereas with PTS-PSO the PAPR achieved is 3.6 dB therefore reductions PAPR with and without PTS is 12.2 dBby choosing the phase factors with high degrees of freedom the number of needed particles is low and the performance of PSO algorithm is enhanced. Performance of PSO-PTS had been analyzed for various Sub-Block and best PAPR is found for Sub-Block K=16 and is 3.6dB. And for acceleration constant the probability calculation is best found for $c_1 = c_2 = 2$ with PAPR exceeding 3.4dB at probability of 0.01. The complexity of the search is low since the number of particles is also kept low. The system modeled had 16 Transmitting and Receiver antenna.

References Références Referencias

1. S.H.Han and J.H. Lee, "An overview of peak-to average power ratio reduction techniques for multicarrier transmission." *IEEE Wireless Communications*, vol.12, pp. 56-65, 2005.. DOI: 10.1109/MWC.2005.1421929
2. A.M. Mazin and G.V. Crosby, "Reducing the Peak to Average Power Ratio of MIMO-OFDM systems,"*International Journal of Computer Networks & communications* (IJCNC), vol.5, no.3, pp.33-51,May 2013.DOI: 10.5121/ijcnc.2013.5303
3. J.H. Wen, S.H. Lee, Y.F.Huang and H.L. Hung, "A suboptimal PTS algorithm based on particle swarm optimization technique for PAPR reduction in OFDM systems," *Eurasip J. Wireless Communications. Network,* vol.8, *Dec* 2008. DOI: 10.1155/2008 /601346.
4. H.L.Hung, Y.F.Huang, C.M.Yeh, T.H.Tan, "Performance of particle swarm optimization techniques on PAPR reduction for OFDM systems," *IEEE International Conference on systems, Man and cybernetics* (SMC 2008), pp.2390-2395, 2008. DOI: 10.1109/ICSMC.2008.4811652
5. O.-J. Kwon and Y.-H. Ha, "Multi-carrier pap reduction method using sub-optimal PTS with threshold," *IEEE Transactions on Broadcasting*, vol. 49, pp. 232 – 236, June 2003.
6. W. -C. Liu, "Design of a multiband CPW-FED monopole antenna using a particle swarm optimization approach," in *IEEE Transactions on Antennas and Propagation*, vol. 53, pp. 3273 – 3279, Oct. 2005.
7. M. Clerc and J. Kennedy, "The particle swarm—explosion, stability, and convergence in a multidimensional complex space," *IEEE Transactions on Evolutionary Computation*, vol. 6,no. 1, pp. 58–73, 2002.
8. J. Kennedy and R. C. Eberhart,"Particle swarm optimization," in*Proc.IEEE Conf. Neural Networks IV, Piscataway,* NJ, 1995
9. H. Bolcskei, D. Gesbert, and A. J. Paulraj,"On the capacity of OFDM-based spatial multiplexing systems, "*IEEE Trans. Communi.*, vol. 50, no. 2, pp. 225-234, Feb.2002.
10. G. L. Stüber, J.R. Barry, S W Mclaughlin, Y.E Li, and M. Ann Ingram, "Broadband MIMO-OFDM Wireless Communications," *IEEE Communications Magazine*, vol. 92, no. 2, pp. 271–294, Feb 2004.
11. N.T.Hieu, S.W.Kim and H.G.Ryu , "PAPR Reduction of the low complexity phase weighting method in OFDM Communication system," *IEEE Transactions on Consumer Electronics*, vol. 51,no. 3, pp. 776–782,Aug 2005. DOI: 10.1109/TCE.2005.1510483.
12. P.Mukunthan and P.Dananjayan, —Modified PTS with FECs for PAPR reduction in MIMO-OFDM system with different sub blocks and subcarriersǁ, *International Journal of Computer Science Issues*, vol. 8, Issue 4, no.2, July 2011.

Global Journals Inc. (US) Guidelines Handbook 2015

www.GlobalJournals.org

FELLOW OF ASSOCIATION OF RESEARCH SOCIETY IN COMPUTING (FARSC)

Global Journals Incorporate (USA) is accredited by Open Association of Research Society (OARS), U.S.A and in turn, awards "FARSC" title to individuals. The 'FARSC' title is accorded to a selected professional after the approval of the Editor-in-Chief/Editorial Board Members/Dean.

- The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

FARSC accrediting is an honor. It authenticates your research activities. After recognition as FARSC, you can add 'FARSC' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, and Visiting Card etc.

The following benefits can be availed by you only for next three years from the date of certification:

FARSC designated members are entitled to avail a 40% discount while publishing their research papers (of a single author) with Global Journals Incorporation (USA), if the same is accepted by Editorial Board/Peer Reviewers. If you are a main author or co-author in case of multiple authors, you will be entitled to avail discount of 10%.

Once FARSC title is accorded, the Fellow is authorized to organize a symposium/seminar/conference on behalf of Global Journal Incorporation (USA).The Fellow can also participate in conference/seminar/symposium organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent.

You may join as member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. In addition, it is also desirable that you should organize seminar/symposium/conference at least once.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The FARSC can go through standards of OARS. You can also play vital role if you have any suggestions so that proper amendment can take place to improve the same for the benefit of entire research community.

As FARSC, you will be given a renowned, secure and free professional email address with 100 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.

The FARSC will be eligible for a free application of standardization of their researches. Standardization of research will be subject to acceptability within stipulated norms as the next step after publishing in a journal. We shall depute a team of specialized research professionals who will render their services for elevating your researches to next higher level, which is worldwide open standardization.

The FARSC member can apply for grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A. Once you are designated as FARSC, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria. After certification of all your credentials by OARS, they will be published on your Fellow Profile link on website https://associationofresearch.org which will be helpful to upgrade the dignity.

The FARSC members can avail the benefits of free research podcasting in Global Research Radio with their research documents. After publishing the work, (including published elsewhere worldwide with proper authorization) you can upload your research paper with your recorded voice or you can utilize chargeable services of our professional RJs to record your paper in their voice on request.

The FARSC member also entitled to get the benefits of free research podcasting of their research documents through video clips. We can also streamline your conference videos and display your slides/ online slides and online research video clips at reasonable charges, on request.

The FARSC is eligible to earn from sales proceeds of his/her researches/reference/review Books or literature, while publishing with Global Journals. The FARSC can decide whether he/she would like to publish his/her research in a closed manner. In this case, whenever readers purchase that individual research paper for reading, maximum 60% of its profit earned as royalty by Global Journals, will be credited to his/her bank account. The entire entitled amount will be credited to his/her bank account exceeding limit of minimum fixed balance. There is no minimum time limit for collection. The FARSC member can decide its price and we can help in making the right decision.

The FARSC member is eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get remuneration of 15% of author fees, taken from the author of a respective paper. After reviewing 5 or more papers you can request to transfer the amount to your bank account.

MEMBER OF ASSOCIATION OF RESEARCH SOCIETY IN COMPUTING (MARSC)

The ' MARSC ' title is accorded to a selected professional after the approval of the Editor-in-Chief / Editorial Board Members/Dean.
The “MARSC” is a dignified ornament which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., MARSC or William Walldroff, M.S., MARSC.

MARSC accrediting is an honor. It authenticates your research activities. After becoming MARSC, you can add 'MARSC' title with your name as you use this recognition as additional suffix to your status. This will definitely enhance and add more value and repute to your name. You may use it on your professional Counseling Materials such as CV, Resume, Visiting Card and Name Plate etc.

The following benefitscan be availed by you only for next three years from the date of certification.

MARSC designated members are entitled to avail a 25% discount while publishing their research papers (of a single author) in Global Journals Inc., if the same is accepted by our Editorial Board and Peer Reviewers. If you are a main author or co-author of a group of authors, you will get discount of 10%.

As MARSC, you will be given a renowned, secure and free professional email address with 30 GB of space e.g. johnhall@globaljournals.org. This will include Webmail, Spam Assassin, Email Forwarders, Auto-Responders, Email Delivery Route tracing, etc.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

The MARSC member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

Once you are designated as MARSC, you may send us a scanned copy of all of your credentials. OARS will verify, grade and certify them. This will be based on your academic records, quality of research papers published by you, and some more criteria.

It is mandatory to read all terms and conditions carefully.

AUXILIARY MEMBERSHIPS

Institutional Fellow of Open Association of Research Society (USA)-OARS (USA)

Global Journals Incorporation (USA) is accredited by Open Association of Research Society, U.S.A (OARS) and in turn, affiliates research institutions as "Institutional Fellow of Open Association of Research Society" (IFOARS).

The "FARSC" is a dignified title which is accorded to a person's name viz. Dr. John E. Hall, Ph.D., FARSC or William Walldroff, M.S., FARSC.

The IFOARS institution is entitled to form a Board comprised of one Chairperson and three to five board members preferably from different streams. The Board will be recognized as "Institutional Board of Open Association of Research Society"-(IBOARS).

The Institute will be entitled to following benefits:

The IBOARS can initially review research papers of their institute and recommend them to publish with respective journal of Global Journals. It can also review the papers of other institutions after obtaining our consent. The second review will be done by peer reviewer of Global Journals Incorporation (USA) The Board is at liberty to appoint a peer reviewer with the approval of chairperson after consulting us.

The author fees of such paper may be waived off up to 40%.

The Global Journals Incorporation (USA) at its discretion can also refer double blind peer reviewed paper at their end to the board for the verification and to get recommendation for final stage of acceptance of publication.

The IBOARS can organize symposium/seminar/conference in their country on behalf of Global Journals Incorporation (USA)-OARS (USA). The terms and conditions can be discussed separately.

The Board can also play vital role by exploring and giving valuable suggestions regarding the Standards of "Open Association of Research Society, U.S.A (OARS)" so that proper amendment can take place for the benefit of entire research community. We shall provide details of particular standard only on receipt of request from the Board.

The board members can also join us as Individual Fellow with 40% discount on total fees applicable to Individual Fellow. They will be entitled to avail all the benefits as declared. Please visit Individual Fellow-sub menu of GlobalJournals.org to have more relevant details.

We shall provide you intimation regarding launching of e-version of journal of your stream time to time. This may be utilized in your library for the enrichment of knowledge of your students as well as it can also be helpful for the concerned faculty members.

After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

Open Association of Research Society (US)/ Global Journals Incorporation (USA), as described in Corporate Statements, are educational, research publishing and professional membership organizations. Achieving our individual Fellow or Associate status is based mainly on meeting stated educational research requirements.

Disbursement of 40% Royalty earned through Global Journals : Researcher = 50%, Peer Reviewer = 37.50%, Institution = 12.50% E.g. Out of 40%, the 20% benefit should be passed on to researcher, 15 % benefit towards remuneration should be given to a reviewer and remaining 5% is to be retained by the institution.

We shall provide print version of 12 issues of any three journals [as per your requirement] out of our 38 journals worth $ 2376 USD.

Other:

The individual Fellow and Associate designations accredited by Open Association of Research Society (US) credentials signify guarantees following achievements:

- The professional accredited with Fellow honor, is entitled to various benefits viz. name, fame, honor, regular flow of income, secured bright future, social status etc.

- In addition to above, if one is single author, then entitled to 40% discount on publishing research paper and can get 10%discount if one is co-author or main author among group of authors.
- The Fellow can organize symposium/seminar/conference on behalf of Global Journals Incorporation (USA) and he/she can also attend the same organized by other institutes on behalf of Global Journals.
- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
- Fellow can also join as paid peer reviewer and earn 15% remuneration of author charges and can also get an opportunity to join as member of the Editorial Board of Global Journals Incorporation (USA)
- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

"

- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

Process of submission of Research Paper

The Area or field of specialization may or may not be of any category as mentioned in 'Scope of Journal' menu of the GlobalJournals.org website. There are 37 Research Journal categorized with Six parental Journals GJCST, GJMR, GJRE, GJMBR, GJSFR, GJHSS. For Authors should prefer the mentioned categories. There are three widely used systems UDC, DDC and LCC. The details are available as 'Knowledge Abstract' at Home page. The major advantage of this coding is that, the research work will be exposed to and shared with all over the world as we are being abstracted and indexed worldwide.

The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

The Author can submit the paper either online or offline. The authors should prefer online submission.Online Submission: There are three ways to submit your paper:

(A) (I) First, register yourself using top right corner of Home page then Login. If you are already registered, then login using your username and password.

(II) Choose corresponding Journal.

(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

(B) If you are using Internet Explorer, then Direct Submission through Homepage is also available.

(C) If these two are not convenient, and then email the paper directly to dean@globaljournals.org.

Offline Submission: Author can send the typed form of paper by Post. However, online submission should be preferred.

Preferred Author Guidelines

MANUSCRIPT STYLE INSTRUCTION (Must be strictly followed)

Page Size: 8.27" X 11'"

- Left Margin: 0.65
- Right Margin: 0.65
- Top Margin: 0.75
- Bottom Margin: 0.75
- Font type of all text should be Swis 721 Lt BT.
- Paper Title should be of Font Size 24 with one Column section.
- Author Name in Font Size of 11 with one column as of Title.
- Abstract Font size of 9 Bold, "Abstract" word in Italic Bold.
- Main Text: Font size 10 with justified two columns section
- Two Column with Equal Column with of 3.38 and Gaping of .2
- First Character must be three lines Drop capped.
- Paragraph before Spacing of 1 pt and After of 0 pt.
- Line Spacing of 1 pt
- Large Images must be in One Column
- Numbering of First Main Headings (Heading 1) must be in Roman Letters, Capital Letter, and Font Size of 10.
- Numbering of Second Main Headings (Heading 2) must be in Alphabets, Italic, and Font Size of 10.

You can use your own standard format also.
Author Guidelines:

1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

1. GENERAL

Before submitting your research paper, one is advised to go through the details as mentioned in following heads. It will be beneficial, while peer reviewer justify your paper for publication.

Scope

The Global Journals Inc. (US) welcome the submission of original paper, review paper, survey article relevant to the all the streams of Philosophy and knowledge. The Global Journals Inc. (US) is parental platform for Global Journal of Computer Science and Technology, Researches in Engineering, Medical Research, Science Frontier Research, Human Social Science, Management, and Business organization. The choice of specific field can be done otherwise as following in Abstracting and Indexing Page on this Website. As the all Global

Journals Inc. (US) are being abstracted and indexed (in process) by most of the reputed organizations. Topics of only narrow interest will not be accepted unless they have wider potential or consequences.

2. ETHICAL GUIDELINES

Authors should follow the ethical guidelines as mentioned below for publication of research paper and research activities.

Papers are accepted on strict understanding that the material in whole or in part has not been, nor is being, considered for publication elsewhere. If the paper once accepted by Global Journals Inc. (US) and Editorial Board, will become the copyright of the Global Journals Inc. (US).

Authorship: The authors and coauthors should have active contribution to conception design, analysis and interpretation of findings. They should critically review the contents and drafting of the paper. All should approve the final version of the paper before submission

The Global Journals Inc. (US) follows the definition of authorship set up by the Global Academy of Research and Development. According to the Global Academy of R&D authorship, criteria must be based on:

1) Substantial contributions to conception and acquisition of data, analysis and interpretation of the findings.

2) Drafting the paper and revising it critically regarding important academic content.

3) Final approval of the version of the paper to be published.

All authors should have been credited according to their appropriate contribution in research activity and preparing paper. Contributors who do not match the criteria as authors may be mentioned under Acknowledgement.

Acknowledgements: Contributors to the research other than authors credited should be mentioned under acknowledgement. The specifications of the source of funding for the research if appropriate can be included. Suppliers of resources may be mentioned along with address.

Appeal of Decision: The Editorial Board's decision on publication of the paper is final and cannot be appealed elsewhere.

Permissions: It is the author's responsibility to have prior permission if all or parts of earlier published illustrations are used in this paper.

Please mention proper reference and appropriate acknowledgements wherever expected.

If all or parts of previously published illustrations are used, permission must be taken from the copyright holder concerned. It is the author's responsibility to take these in writing.

Approval for reproduction/modification of any information (including figures and tables) published elsewhere must be obtained by the authors/copyright holders before submission of the manuscript. Contributors (Authors) are responsible for any copyright fee involved.

3. SUBMISSION OF MANUSCRIPTS

Manuscripts should be uploaded via this online submission page. The online submission is most efficient method for submission of papers, as it enables rapid distribution of manuscripts and consequently speeds up the review procedure. It also enables authors to know the status of their own manuscripts by emailing us. Complete instructions for submitting a paper is available below.

Manuscript submission is a systematic procedure and little preparation is required beyond having all parts of your manuscript in a given format and a computer with an Internet connection and a Web browser. Full help and instructions are provided on-screen. As an author, you will be prompted for login and manuscript details as Field of Paper and then to upload your manuscript file(s) according to the instructions.

To avoid postal delays, all transaction is preferred by e-mail. A finished manuscript submission is confirmed by e-mail immediately and your paper enters the editorial process with no postal delays. When a conclusion is made about the publication of your paper by our Editorial Board, revisions can be submitted online with the same procedure, with an occasion to view and respond to all comments.

Complete support for both authors and co-author is provided.

4. MANUSCRIPT'S CATEGORY

Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications.

Research letters: The letters are small and concise comments on previously published matters.

5. STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

(d) An Introduction, giving necessary background excluding subheadings; objectives must be clearly declared.

(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and to make suggestions to improve briefness.

It is vital, that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

Format

Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

Color Charges: It is the rule of the Global Journals Inc. (US) for authors to pay the full cost for the reproduction of their color artwork. Hence, please note that, if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a color work agreement form before your paper can be published.

Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

6.1 Proof Corrections

The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

As changes to proofs are costly, we inquire that you only correct typesetting errors. All illustrations are retained by the publisher. Please note that the authors are responsible for all statements made in their work, including changes made by the copy editor.

6.2 Early View of Global Journals Inc. (US) (Publication Prior to Print)

The Global Journals Inc. (US) are enclosed by our publishing's Early View service. Early View articles are complete full-text articles sent in advance of their publication. Early View articles are absolute and final. They have been completely reviewed, revised and edited for publication, and the authors' final corrections have been incorporated. Because they are in final form, no changes can be made after sending them. The nature of Early View articles means that they do not yet have volume, issue or page numbers, so Early View articles cannot be cited in the conventional way.

6.3 Author Services

Online production tracking is available for your article through Author Services. Author Services enables authors to track their article - once it has been accepted - through the production process to publication online and in print. Authors can check the status of their articles online and choose to receive automated e-mails at key stages of production. The authors will receive an e-mail with a unique link that enables them to register and have their article automatically added to the system. Please ensure that a complete e-mail address is provided when submitting the manuscript.

6.4 Author Material Archive Policy

Please note that if not specifically requested, publisher will dispose off hardcopy & electronic information submitted, after the two months of publication. If you require the return of any information submitted, please inform the Editorial Board or dean as soon as possible.

6.5 Offprint and Extra Copies

A PDF offprint of the online-published article will be provided free of charge to the related author, and may be distributed according to the Publisher's terms and conditions. Additional paper offprint may be ordered by emailing us at: editor@globaljournals.org .

You must strictly follow above Author Guidelines before submitting your paper or else we will not at all be responsible for any corrections in future in any of the way.

Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.

- Do not give permission to anyone else to "PROOFREAD" your manuscript.

- Methods to avoid Plagiarism is applied by us on every paper, if found guilty, you will be blacklisted by all of our collaborated research groups, your institution will be informed for this and strict legal actions will be taken immediately.)
- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

save our planet

Global Journal of Computer Science and Technology

Visit us on the Web at www.GlobalJournals.org | www.ComputerResearch.org
or email us at helpdesk@globaljournals.org

ISSN 9754350