ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORKS

Project Report

Submitted in partial fulfilment of the requirement for the award of the degree of

Master of Technology

in

COMPUTER SCIENCE & ENGINEERING

Under the Supervision of

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By

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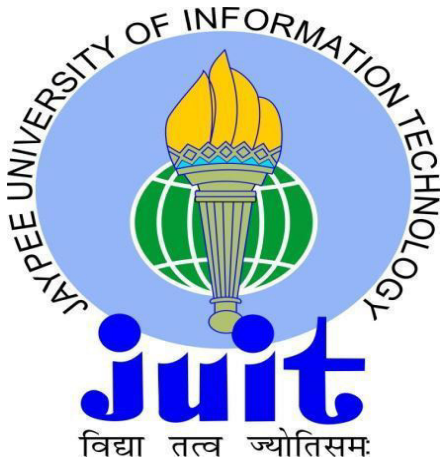

Jaypee University of Information Technology
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MAY,2018

CERTIFICATE

This is to certify that the project entitled, “Energy Efficiency in Wireless Sensor Networks" submitted by "Kapil Sharma (162206)" in partial fulfilment of the requirements for the award of "Master in Technology" in "Computer Science" at the "Jaypee University of Information Technology Waknaghat, Solan, Himachal Pradesh" is an authentic work carried out by him under our supervision and guidance.

To the best of my knowledge, the matter embodied in the project has not been submitted to any other University / Institute for the award of any Degree or Diploma.

Date: 12-05-2018

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ACKNOWLEDGEMENT

While bringing out this thesis to its final form, I came across a number of people whose contributions in various ways helped my field of research and they deserve special thanks. It is a pleasure to convey my gratitude to all of them.

First and foremost, I would like to express my deep sense of gratitude and indebtedness to my supervisors **Dr. Vivek Sehgal and Dr. Pradeep Kumar Singh** for their encouragement, suggestions and support from an early stage of this research and providing me extraordinary experiences throughout the work. Above all, their priceless and meticulous supervision at each and every phase of work inspired me in innumerable ways.

I specially acknowledge them for their advice, supervision, and the vital contribution as and when required during this research. Their involvement with originality has triggered and nourished my intellectual maturity that will help me for a long time to come. I am proud to record that I had the opportunity to work with an exceptionally experienced Professors like them.

I am highly grateful to **Dr. Pardeep Kumar** Co-ordinator, **Prof. Dr. Satya Prakash Ghrera** Head, Department of Computer Science & Engineering and Information Technology for their kind support and permission to use the facilities available in the Institute.

Date: 12-05-2018

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ABSTRACT

Number of sensors are deployed over an area to form Wireless Sensor Networks (WSNs). Thus form a smart grid, while communication between each other consumes high energy and results in better results as compared to simple surveillance or human surveillance. Wireless sensor network consumes large amount of energy. Therefore, energy efficient wireless sensor networks are widely used in smart grid or areas. In the present era, energy consumption or energy management considered as best features of any wireless sensor system. These energy efficient wireless network reduce energy use and increases life time. This paper represents new algorithm "MEEGA: Modified Energy Efficient Gossip algorithm", proposed to reduce energy use in WSNs and communicate among nodes as fast as possible. MEEGA uses simple algorithm for path allocation instead of other complex algorithm, construct simple node deployment which reduces complexity and node overlap. Further simulation results shows that MEEGA is better than basic gossip algorithm, EAPC and BEERAD-E. Results shows that energy use is very less as compared to three algorithm and network life time increases as compared EACP, basic gossip and BEERAD-E.

Chapter 1

1.1 Introduction:

Wireless sensor networks consists of small nodes. These nodes are composed of sensing, computing, processing and capable to transmit data from one node to another. These nodes are used to gather data from environment or surrounding like fields, animal habitat, medical surveillance, military warfare, etc. WSNs are mostly used in those condition which are either more important like nuclear reactors, military surveillance, fire alarms and other condition are those in which human can't survive like under water surveillance, high pressure, acidic or basic climate and radiation prone areas. These are some conditions where we can use WSNs and gather results very efficiently. Wireless Sensor Network is working continuously and drains a lot amount of energy. We can also say that energy is the backbone of wireless sensor networks.

Wireless sensor networks mainly composed of four parts and all requires energy. With proper management of energy among these components we can improve life time of wireless sensor networks and make it more energy efficient. Four basic components used in wireless senor networks.

1. Small memory unit:

   Memory unit is used to save current sensed data. This sensed data is saved for limited amount of time or specific time slot. After data is processed or properly managed depends on the node to transmit or discard if necessary.

2. Limited sensing power:

   Wireless sensor network composed of limited sensing power and cover limited area. These sensor sense data all the time and increases raw data at the same time. Lesser the sensing power lesser energy is consumed.

3. Small processing unit:

   After sensing raw data, this data is processed by processor. This processed data depends upon the algorithm weather to discard on the basis of false or unacceptable data.

4. Small trans-receiver:

   This is capable of both receiving data and sending data at the same time. Both receiving area and transmission area is specified as per user configuration.

As per “Albert Einstein”, “Energy cannot be created or destroyed, it can only be changed from one form to another”. Currently energy conservation is one of the main rising issue. Use of proper energy or proper energy management is one of the best features in any device. WSNs are consists of limited battery, limited sensing area, limited computation power and limited storage memory. We are progressing in every field like processing power, memory allocation techniques but energy remains constant. Use of proper energy consumption in WSN make rise in efficiency automatically. With use of better energy consumption we can increase the life span of WSNs. Thus energy efficiency in WSNs are important and may change the WSNs life span.

There are many techniques used to increase the life span of WSNs. These techniques decrease the energy consumption in WSNs and give better results. Some techniques are intelligent walls [6]. In this they make proper boundaries by which signal moves easily inside the walls without and interference (noise, radio waves and mobile signals). Cluster formation [7, 12, 14, 17, 22 and 23]: In this they combine same nodes together and form clusters. These clusters are consists of CH (cluster head nodes) and SN (sub nodes) and make use base station to gather data from those cluster heads. Neural Networks [1, 4, 5 and 11]: These are like neurons functioning to gather data and transmit as fast as possible to the destination. They are consist of three layers. First is input layer (to collect data from the environment), second is hidden layer (mainly consist of any algorithm to compute data and send as fast as possible to the destination) and third is output layer (to transmit data to the destination). Quorum time slot adaptive condensing (QTSAC) [m42]: In this they provide specific time slot for node to activate and transmit data while others are at hibernation. These techniques are recently used in WSNs to minimize the energy consumption in WSNs and provide better life time. These are some recent techniques used to make WSNs energy efficient and used to increase the life span of WSNs.

This paper presents a new routing algorithm “Modified Energy Efficient Gossip Algorithm (MEEGA)” which decreases the energy use in WSNs and upgrades the performance of WSNs. In basic gossip algorithm it consumes more energy and transmit same data as MEEGA. There are many flaws in Basic gossip algorithm like use more energy by evolving every node in process, make more data replication and make network busy for long time. One of main issue is involving every node in process which leads to energy consumption. This paper presents an algorithm to select specific nodes,

involve them in process and make data transmission easy to the source node. Thus we can reduce node use and results in less energy consumption. Further we compare our algorithm with basic gossip algorithm, energy-aware path construction algorithm (EAPC) and Balanced and Energy Efficient MH (BEERAD-E).

Simulation is done on MATLAB R2016a and show energy consumption less as compared to our algorithm with basic gossip algorithm, energy-aware path construction algorithm (EAPC) and Balanced and Energy Efficient RAD (BEERAD) or Balanced and Energy Efficient RAD- Enhanced (BEERAD-E).

1.2 Motivation:

Wireless Sensor Networks are used to gather data from remote locations or in extreme environmental conditions like Alkaline (natural habitats above pH 9), Acidic (natural habitats below pH 5), Extremely Cold (below 5°C), Extremely Hot (above 40°C), Radiation (high UV and IR radiation), Without Water (hot and cold desert environments), Under Pressure, Without Oxygen and many more thus use of WSN are important and very useful. Main objective of this research is to study:

1. To identify the issues that affect energy consumption in Wireless Sensor Network.
2. To identify the factor effects energy consumption in wireless sensor network.
3. To identify where is the energy consumed.
4. To identify when is the energy consumed.
5. To use proper resource utilization.
6. To identify how to increase the life span of Wireless Sensor Network.

These are some main points taken in consideration while doing literature survey.

1.3 A Brief History of Wireless Sensor Networks

History of sensor nodes starts back in Cold War. A raw system is used by USA to track Soviet submarines which is now comes under by the National Oceanographic and Atmospheric Administration (NOAA) for surveillance in Oceanic activity e.g., seismic

and animal activity. During that time period, United States works on developing the network of air defense radar systems to defend its territory, which is now used for drug reduction activity. Main research on sensor networks started around about 1980 with Distributed Sensor Networks (DSN) program at DARPA (Defense Advanced Research Projects Agency) where in Arpanet (predecessor of the Internet) approach in communication among nodes was extended to sensor networks. The network was supposed to have many spatially distributed low cost data aggregation nodes that mix with each other and operate autonomously, with information being moved to whichever node can best form the information.

In 1978 technology components used for a DSN were identified in a Distributed Sensor Nets workshop. These included sensors (for sound data aggregation), processing techniques and algorithms (which include help in organization of sensors), communication and distributed software. For target problem demonstration Distributed acoustic tracking was chosen.

The Accent (a network assist operating system that allows transparent access and flexible distributed resources for DSN) was developed by CMU (Carnegie Mellon University). These are then evolved into the Mach operating system, which found useful as acceptance in considerable commercial. Other efforts by CMU included protocols for network inter process communication to support dynamic rebinding of active communicating computations, an interface specification language for building distributed system software and a system for dynamic load balancing and fault reconfiguration of DSN software.

Further, in 1980, a multiple-hypothesis tracking algorithm influenced by DSN was developed by Advanced Decision Systems (ADS), Mountain View, CA, which deals with error and difficult situations involving large target objects, missing deep or upper detection and false alarms. MIT Lincoln Laboratory developed the real-time systems of bed for acoustic tracks of low-flying aircraft for demonstrations. A PDP11/34 computer and an array processor was used to process the acoustic signals. The nodal computer (for target surveillance) consists of three MC68000 processors with 512-kB shared memory size and 256-kB memory size, and a custom operating system. Communication was by Ethernet and microwave radio. That was the state of the art in the early 1980s.

This interest coupled with the DARPA low-power wireless integrated micro sensors (LWIM) project in the mid-1990s and continued with the launch of the SensIT project in 1998, which focuses on wireless ability, and hoc networks for large surveillance in

military projects. A total number of 29 research projects, from different 25 institutions, were funded under this project.

In the past 85 years, wireless sensor data networks have gone from manually operated systems of transcontinental radio telegraphic networks to fully automatic local and personal area networks employing spread spectrum techniques. The methods of MAC, and network organization and operation developed for early radiotelegraphic networks were often independently reinvented for use in the computer communication networks that arose from the development of packet-switched systems in the 1960s. Although public funding of packet-switched systems development (mostly for defense applications) has continued from the 1960s to the present, commercial development of WLANs beginning in 1990 accelerated research in wireless packet data systems for a wide variety of applications, including WPANs and wireless sensor networks. The SensIT DARPA program supported 29 research programs in the field of wireless sensor networks, and the first commercial interest in wireless sensor network systems is now appearing.

Chapter 2

Background

In this section, many papers have been reviewed from various sources like IEEE, Scopus, Transaction, ELSEVIER and Google Scholar. Papers are taken from last ten years (2007 to 2017). In order to conduct the review, similar approach is followed as taken by various authors. Last two papers are used for review as well as comparison among these two papers and our proposed solution.

2.1 Literature Work

In [1], Zaho et *al*. proposed NNR (Neural Network Routing) algorithm which increases the efficiency of WSN without changing any hardware. Their proposed algorithm is composed of collecting information: to collect information about other neighboring nodes, testing samples: test whether distance between sender and receiver is better, node training: train nodes to select best and cost efficient route between sender and receiver and message routing: main objective is to check whether receiver is final node or not else send till it reaches destination. It can send data efficiently as compared to GEAR (Geographical and Energy Aware Routing). The parameters used in their methods are energy uses, communication time and routing speed. Further, the simulation results show that energy uses and routing speed is better in NNR as compared to GEAR. While applying algorithms there are some properties which may or may not rise. In this NNR routing algorithm it effects the communication time but reduces energy use as compared to GEAR.

In [2], Ailas et *al*. proposed a method for scheduling of nodes which is known as **opportunistic large arrays with a transmission threshold** (OLA-T). In their work they consider and compare its received power to a threshold whether to decide if it should forward data or not. If nodes have specific amount of energy for transmitting a message then only the message is transferred else it is neglected. In this main parameters are power of a node and threshold energy of nodes. Further the simulation results show that it can save as much as 32% of transmitted energy compared to other

broadcast approaches without requiring **global positioning system** (GPS), it also involves individual node addressing and supports inter-node interaction to transmit data efficiently among nodes.

In [3], Averkin et *al*. proposed a method of making sensors smart and able to act itself so that they can take better decision. As smart sensors are introduced they are capable of making better decisions and help in reducing false sensors and increase work efficiency. They make sensors by combining fuzzy logic and neural network. Main parameters used are data processing: to process data with help of neighbor nodes and make proper results with less time consumption and middleware challenges: to use only those sensors and nodes which are in use while rest of the nodes are put in hibernation or sleeping. By putting those nodes in sleeping and hibernation reduce energy usage. Further simulation shows that using of smart sensor in WSN we can increase the efficiency of the network by detecting false alarms and put useless sensors in sleep or hibernation to reduce energy usage.

In [4], Chagas et *al*. proposed that it is better to use ANN to optimize a set of parameters to solve the problem easily. As to use the best solution for desired problem is the best way to gather results easily. They proposed some methods like cricket location system: to use of light and sound to locate the source node and calculate the distance between sender and receiver, active badge location: it is inside the node network, used to identify mobile node but only when mobile node is active and inside the network and RADAR location: as to get the distance between access points and nodes by using triangulation. Further simulation shows that making machine capable of taking decision as per the situation is better. By this way they claimed that it can save energy and use better resources in desired situation.

In [5], Chuang et *al.* proposed a new method to increase the efficiency of the WSN. Their method is known as neural network-based location scheme which are used to attain the inner node distance estimation so as to choose better node to transmit the data. That method makes trained model completely relevant to the topology via online training and correlate topology. Main parameters used in that are previous localization methods like Distance estimation by RSSI, Distance estimation by HCs, Statistics - based localization and AI-based localization. Further simulation shows that their node

localization scheme can produce better localization success rate with small localization error than previous method at reasonable cost.

In [6], Subrt et *al*. proposed an idea of using **Intelligent wall** (IW) or a system of multiple IWs. The concept is based on the fact that signal coverage and interference levels in inside an area are strongly influenced by the position of obstacles mostly walls and their material properties. As the intelligent walls are capable of many properties like make walls capable of transmitting signal with less resistance, make sensor to reach each and every corner of the area, use reflection state in which all energy is reflected and reduce transmission loss and decreases outer signal strength and interference level to maximize the power of nodes as they use to transfer the data as well as sense the data. Further simulation shows that IWs increases the efficiency of the nodes as they use less energy in transmission and communication inside IWs with respect to normal areas. Further simulation shows that the efficiency of the nodes increases as they use less energy in transmission and communication inside IWs with respect to normal areas.

In [7], Hoang et *al*. proposed a centralized cluster based protocol for WSNs. In this they make them able to do strong computation in the **Base Station** (BS). By this the optimization algorithm like **Harmony Search Algorithm** (HAS) can be executed in real time operations. HAS is composed of some steps. First, it is applied to minimize the distance between clusters and reduce the energy consumption rate. Second, to select a specific or desired cluster head. Third, if the rate is low new cluster heads are formed and if rate is suitable they are stored in memory. The main objective is to improve the life time of WSNs and make it capable of doing work in real life surveillance. In this LEACH-C and FCMCP are used as the main parameters. Further simulation shows that by using **Harmony Search Algorithm cluster-based protocol** (HSACP) can provide fast communication and computation time is reduced to 10ms.

In [8], Ahmed et *al*. proposed a robotized hybrid WSN. In their work they make another advanced trajectory control algorithm which is combined with robotized WSN. The hybrid WSN is composed of doing work like gathering data from the environment, make real surveillance and give efficient results. Another is advanced trajectory, these are used to move or place the sensor in the perfect position for perfect observation. Sometimes sensors are not properly placed and miss a lot of data while sensing, which

results in process failure or may lead to some other failure. Further simulation shows that this is capable of doing work in real time systems. As the results shows that trajectory control algorithm can move and make position as per the condition and minimize the error rate.

In [9], Gayathri et *al*. proposed an idea as to select the best node for sending information form one node to another easily by minimizing the energy cost. Minimization of cost can be done in many ways but in this paper main parameters are. (i) Make connection between nodes good and efficient. By making connection reliable and good they are eliminating the error rate and system failure rate. (ii) Select the node on the basis of Less Packet Drop. Sometimes nodes are also responsible for packet drop, hence eliminating that node is best way. (iii) Packet Latency: this may be caused by distance between the nodes, power of the node and technology used by that node.(iv) Less Energy Consumption, by selecting best node which reduces energy usage in transmission of data form one node to another node. Further simulation shows that average packet delivery rate is increased by 20% and energy consumption is reduced by 1.5%.

In [10], Tian et *al*. proposed a method which is capable of making decision whether to use technology or not, this is known as **Network Coding and Power Control based Routing** (NCPCR). In their method they adopt network coding gain by making best decision on whether to apply network coding or not. Sometimes activity may occur somewhere near the sink node. In that case use of some other algorithm may increase the energy usage instead of reduction. This kind of decision are taken care by NCPCR. As per the decision it can save the energy consumption by reducing the number of packet transmission. Further simulation shows that energy consumption per node in NCPCR decreases as the number of nodes grows and letting choose their optimal transmit powers also increases efficiency.

In [11], Mehmood et *al*. proposed a new artificial neural network based **energy efficient and robust routing scheme** for WSNs called ELDC. In their work, they have trained a huge data set almost of all conditions as to make them more adaptable in any environment. It also uses group based methodology: in this they use to have unique id for every group, any node can keep the record of whole id's of the network, each node

sends data form one node to another and last is the outer node which is known as border node and helps to connect nodes of one cluster to the nodes of other clusters. This also helps to increase the life span of the network by sending information from one BS to another BS by selecting the nearest group and further more till it reaches the destination. Further simulation shows that ELDC is better than LEACH, HEED, DDAR and EEVC.

In [12], Mittal et *al*. proposed a method **Self Organization Feature Map.** In SOFM main part is that there is no teacher or guide to control the structure of the nodes. In SOFM they are organized as per the area or environment. Some main points in SOFM are they learn the network first, second they organize nodes in such a way that results in full view of data with minimum error rate. In SOFM mainly two topologies) are used (Hexagonal and Square). In hexagonal cluster head is surrounded by six node in first ring and twelve nodes in second ring and in square cluster head is surrounded by eight nodes in first ring and sixteen nodes in second ring. Further simulation shows that communication becomes less bulky and derives better and fast results. Also the energy consumption is less as there is no other admin to look over or wait for the instruction.

In [13], Sunita et *al*. proposed an idea that by eliminating the complexity of network and data processing in wireless sensor network can easily increase the life span of WSN. As in previous paper author discussed about the processing in the node itself but by reducing that we can increase the efficiency. Some of the main parameters used in this method are Clustering: to combine like nodes together and solve big problem by solving them together, Classification: To classify one sender's data to be true or false and reduce the false error rate, by doing this we can reduce overall process over false computation, Rule Mining: to find most occurred data set and eliminate that data, Prediction Technique: to select the most frequent data used in communication and store it in the sender and receiver to reduce the traffic data or packet size. Further simulation shows that it can increase the life span of WSN, reducing communication time and increase efficiency of the WSN.

In [14], Thakur et *al*. proposed a method which states that by reducing the grid size of the cluster, the life span of the WSNs may increase. As they proposed smaller the size of the grid and smaller the range it consumes less energy in it. As the full cluster consumes more energy they have to divide cluster into small parts and if the cluster is

not used put that cluster in sleep or hibernation. Some parameters used are cluster formation: to forma cluster as small as possible which covers large area as per condition, cluster head formation: form cluster head as per situation like near all cluster nodes and another cluster head, cluster head rotation: move cluster head or choose another cluster head if needed and role of head: to specify the role of cluster head and give specific powers to reduce energy use and eliminate unnecessary use of cluster. Further simulation shows that increase in life span of the WSN and also improvement in efficiency of the network may be possible.

In [15], Balasubramanya et al. propose a method which calculate fixed estimate for residual carrier frequency offset (CFO) in base station and compensation. By saving fixed amount of carrier frequency offsets we can eliminate that work load and reduce that amount of energy for that work. By selecting that saved offsets at the base station result in low use of energy consumption as compared to other techniques. Further simulation shows 22% to 55% of energy reduction in IoT.

In [17], Assaf et *al*. proposed novel analytical algorithm robust against the anisotropic signal attenuation. They produced a new approach which derives the efficient distances between the nodes and sensors. In their approach, they calculate the distances between the nodes by calculating mean hops between sender node and receiver node and then select specific nodes. These specific selected nodes are used for transmission of data from one point to another. Further simulation shows that proposed solution is accurate as well as robustness against anisotropic attenuation (different value when measured in different directions/situation).

In [18], Hu et *al*. proposed **multi-mode clusters maintenance** (M2CM) for WSNs as to decrease the energy used in the cluster. As the maintenance is most important part of any system. M2CM: it consists of four parts first cluster generating phase: to construct a cluster for specific size and give better results in any field, second communication phase: to make proper communication in those clusters, third maintenance phase: one of the main phase to maintain the formed cluster with same properties as in initial stage. In any part of the system if there is any error it can cost the communication time, receiving time, processing time and mainly energy use. Thus they state that to maintain

the system and above mentioned parameters must be taken in consideration. Further results show that by maintaining the system it can prolong the network lifetime and increase the amount of transmitted data as compared to unmaintained systems. This technique is also used in reducing the cluster failure and increase the life span of WSNs easily.

In [19], Yang et al. propose a model as to lower the total energy consumption of wireless sensor network by joint power control and proper time allocation for circuit power consumption. In this they divide time slot for circuit, these circuit then generate data and goes into hibernation. By turning such kind of devices at their ideal time results in saving large amount of energy.Further simulation shows circuit size decreases as well network size which result in low power consumption.

In[20], Zhang et *al*. proposed a method which can detect the input data from the sensor and with the help of machine learning algorithm it can detect whether the input is correct or not. Main approaches used by them are **Logistical Regression** (LR): This includes learning of problems from previous data and learns about those problems that it has to face in the future and Execution: they use previous occurred results and give desired results with input occurs in the same rate. Further simulation shows that sensor can detect faulty data using LR algorithm. By using LR algorithm sensor doesn't work and derives wrong result instead of discarding it in the first place and save energy.

In [21], Peizhi et *al*. proposed a **software-defined WSNs** (SD-WSNs) which is based on **software- defined networks** (SDN). In SDN there is one controller which controls all the switches in network while in SD-WSNs controller is replaced by Sink Node and switches are replaced by Sensor nodes. These sink nodes maintain balance between the nodes. As the sink node check each and every sensor node and use their energy as per require in finding desired result. Further simulation shows that it performs better in balancing energy consumption, increasing life time and increases energy efficiency as per other existing methods.

In [22], Zhang et *al*. proposed an **Energy-Efficient Heterogeneous Ring Clustering** (E2HRC) Routing Protocol for Wireless Sensor Networks. In their work head of the cluster rotates as per situation. Some time in a field or area only required one or two

cluster head thus eliminating or disabling other may gather better results, main comparison is done with **Recognition of Prior Learning** (RPL) which is designed for Low Power and Lossy Wireless Networks. Further simulation shows that energy consumption in E2HRC decreases with increase in network, energy consumption as per node is low and packet loss in E2HRC is also reduced as compared to RPL.

In [23], Nayak et *al*. proposed cluster algorithm with combining **Type 2 Fuzzy Logic** (T2FL) which is better than **Type 1 Fuzzy Logic (**T1FL) model. In this homogenous network is used as to give equal and proper energy distribution to each node in the network. Main parameters used in this are type 1 fuzzy logic model vs. type 2 fuzzy logic model, T1FL and LEACH. Further simulation shows that T2FL is better lifetime as compared to T1FL, LEACH single hop and LEACH multi-hop protocol.

In [24], Fawzy et *al.* proposed an algorithm **Balanced and Energy Efficient MH** (BEEMH) that is basically developed on Dijkstra algorithm. BEERAD-E is basically form of three phase's first, initiation phase: in this when nodes are randomly deployed over the area base station broadcast the message for all nodes to identify themselves. Second, setup phase: in this base station set the efficient way between those nodes. Third, steady-state phase: in this energy or power is used by that node according to that packet. After energy is attached to that packet, node is ready to transmit data. Further simulation shows that they improved the stability period of those nodes and increases the throughput also.

In [25], Wen et *al.* proposed an **energy-aware path construction** algorithm (EAPC). Which is better than exiting wireless sensor network in form of data collection, energy consumption, fairness index and last efficiency of network. In this nodes are randomly distributed all over the area. In randomly deployed nodes first, initialization phase: to initialize the set of parameters construction of path is done. Second, collection point selection: so that sink node uses those points and collects data from those points. Third, construct the path: which covers all collection point and form efficient path all over the network. Further simulation shows that life time (rounds) of EAPC is better and perform round about 560 rounds.

In [26], Krishna et al. proposed a new algorithm to deploy nodes over an area in some specific manner. In this they perform basically three types of structures (circular, pentagonal and hexagonal). By applying these structures one of the main objective is to cover large area of field with minimizing the number of node. As the nodes decreases energy use per node decrease and result in energy consumption. Further simulation shows that energy consumption is decreased by 25% and delay in communication decreased by 50%. Thus over all energy efficiency is achieved as compared to their techniques.

[27], Kaur et al. propose a new hybrid method which consist of Ant colony optimization (ACO) and Practical swarm optimization (PSO). By combining these two techniques a new hybrid ACOPSO is introduced which help in collecting data from all nodes in efficient way. This efficiency is achieved by making shortest path among the nodes and collects data efficiently from inter clusters while utilising less energy. Further simulation shows that proposed energy efficient hybrid algorithm colluded in better life time as compared other techniques and results in better QoS and reliable data transmission.

[28], Yahiaoui et al. propose a method to provide better quality of work while communication and energy management in term of energy use. They develop an algorithm in which cluster head (CH) is selected on the basis of some factors. First is Importance matrices: in this they calculate the importance of node with compare to neighbouring nodes, second Energy capability: in this they see energy level of node and select on that basis, third Node with higher neighbouring density: it selects node with higher neighbouring as to get information within small area. These are the some parameters used in their method to make better wireless sensor network. Further simulation shows results in less energy consumption and better connectivity among other nodes

[29], **Biswas el al.** propose a method to collect data from different sensor nodes with shortest path. By making small path they make use of less sensor communication among each other and without wasting other nodes energy they can increase network life time. As per other aspect eliminating unnecessary nodes in data transmission can increase the life time of wireless sensor network. Further simulation shoes that energy

consumption decreases and connection between nodes are reliable and minimised by less node use. Thus results in increase in life time as well as quality of service.

2.2 Review table for above Literature work:

Table 1: regarding literature review

STD NO.	Source	Year	Finding	Technique	Future Scope
[1]	IEEE	2007	NNR (Neural Network Routing) algorithm which increases the efficiency of WSN without changing any hardware	1. NNR 2.GEAR 3.Dijkstra's algorithm	1. In case of energy management it is good 2.In case of communication time is not so good
[2]	IEEE	2007	Opportunistic large arrays with a transmission threshold (OLA-T). It consider and compare its received power to a threshold whether to decide if it should forward data or not	1. Cooperative diversity 2. Network broadcast 3. Wireless communicatio ns 4. Wireless sensor networks.	In this they only compare the threshold we can use another parameters also to increase the efficiency.
[3]	EUSFLAT	2007	Making sensors or hybrid sensors smart and able to act itself so that they can take better decision.	1. Fuzzy Logic 2. Smart sensors	If the decision making is good we can use it to increase throughput.
[4]	IEEE	2012	It is better to use ANN for optimize set of	1. ANN	We can make machine more

			parameters to solve the problem easily. As to use best solution for desired problem is the best way to gather result easily	2.Genetic Algorithm 3.Machine learning	capable of taking decision.
[5]	IEEE	2014	They used a method known as neural network-based location scheme which are used to attain the inner node distance estimation as to choose better node to transmit the data	1. RSSI 2. HCs 3. Statistics-based localization. 4. AI-based localization. 5. Neural Network.	This can also help in reducing localizing error rates.
[6]	IEEE	2014	The intelligent walls are capable of many properties like: 1. Transmitting signal with less resistance. 2. Make sensor to reach each and every corner of the area. 3. Use reflection state in which all energy is reflected and reduce transmission loss.	1. IWs (Intelligent walls). 2. FSS (frequency-selective surfaces).	To increase efficiency by changing environment.
[7]	IEEE	2014	Harmony Search Algorithm (HAS). To do strong computation in the Base Station (BS). Provide fast	1. Cluster-based protocol 2. Harmony search (HS)	To increase the efficiency of WSN and make it more adaptive.

			communication and computation time less than 10ms.	3. Meta-heuristic 4. Wireless sensor networks (WSNs).	
[8]	IEEE	2016	They make advanced trajectory control algorithm which is combined with robotized WSN. Which results in efficient results and give less error by placing sensors at specific position to gather data.	1. Neural Net Trajectory control approach 2. Neural Net Learning algorithm	For real time approach there is a good chances of it.
[9]	IEEE	2016	To select the best node for sending information form one node to another easily by minimizing the energy cost by. 1. Make connection between nodes good and efficient. 2. Select the node on the basis of Less Packet Drop 3. Packet Latency 4.) Less Energy Consumption	1. Biomedical Wireless Sensor 2. Neural network	Efficiency may be increased by giving more section parameter to the system.
[10]	IEEE	2016	Network Coding and Power Control based	1. Energy conservation	Increase efficiency as the no of nodes

			Routing (NCPCR), which is capable of making decision whether to use technology or not. Results in better results and energy cost efficient.	2. Network coding 3. Power control routing 4. Wireless networks.	increase. Thus this can be used useful in mass communication.
[11]	IEEE	2016	Energy efficient and robust routing scheme for WSNs called ELDC. They have trained a huge data set almost of all condition as to make them more adaptable in any environment	1.ANN 2.EDLC 3. Group based 4.Cluster based	Securing CN from external attack
[12]	IEEE	2016	Self-Organization Feature Map (SOFM). There is no teacher or guide to control the structure of the nodes. In SOFM they are organized as per the area or environment	1.ANN 2.SOFM 3.Data aggregation	If better average selection method is used it may reduce the data and thus reduce the energy consumption
[13]	IEEE	2016	By eliminating the complexity of network and data processing in wireless sensor network can easily increase the life span of WSN.	1. Cluster tech. 2. Data mining. 3. Prediction. 4. Soft computing.	If we eliminate other reason which effect the efficiency, to increase the life span and efficiency.

			1. Clustering: to combine like nodes together and solve big problem by solving them together. 2. Classification: To classify one sender's data to be true or false and reduce the false error rate 3. Rule Mining: to find most occurred data set and eliminate that data 4. Prediction Technique: as to select the most frequent data used in communication.		
[14]	IEEE	2016	That by reducing the grid size of the cluster, the life span of the WSNs may increases. They also proposed that smaller the size of the grid and smaller the range it consumes less energy in it	1. Grid clustering. 2. Wireless sensor technique. 3. Energy efficiency.	We can achieve sink optimises to get better energy conservation.
[15]	IEEE Access	2016	They propose that a fixed estimate for residual carrier frequency offset (CFO) in base station and compensation can result	1.Third Generation Partnership Project (3GPP) 2.Internet of Things (IoT)	We can increase energy efficiency in IoT by making specific assumption of data sets in base station.

			in low use of energy consumption.	3. Long Term Evolution (LTE)/LTE-Advanced (LTE-A)	
[16]	Internet Of Things Journal	2016	They propose a simple modified Discontinuous Reception (DRX). Which launches quick sleeping indication (QSI) mechanism as a simple, energy efficient and novel solution form low-mobility MTC users.	1.Third Generation Partnership Project (3GPP) 2.Internet of Things (IoT) 3. Long Term Evolution (LTE)/LTE-Advanced (LTE-A)	To make energy efficient hibernation system this can be used in IOT.
[17]	IEEE	2016	They produced a new approach which derives the efficient distances between the nodes and sensors. They calculate the distances between the nodes by calculating mean hops between sender node and receiver node and then select specific nodes.	1. Artificial neural networks 2. Radio propagation pattern (RPP) 3. Cost and power efficiencies	To reduce the energy use and make accurate algorithms.
[18]	IEEE	2016	They proposed multi-mode clusters maintenance (M2CM). First cluster generating phase: to construct a	1. M2CM 2. Cluster 3. Energy Efficiency	To reduce the cluster failure we can use this technique.

			cluster for specific size and give better results in any field. Second communication phase: to make proper communication in those clusters. Third maintenance phase: one of main phase to maintain the formed cluster with same properties as in initial stage.		
[19]	Internet Of Things Journal	2016	They propose a model as to lower the total energy consumption of nay network by joint power control and proper time allocation for circuit power consumption.	1. Internet of Things (IoT) 2. Machine-to-machine (M2M) 3.Non-orthogonal multiple access (NOMA)	Proper time allocation for any circuit may be useful in proper hibernation technique.
[20]	IEEE	2017	They proposed a method by which can detect the input data from the sensor and with the help of machine learning algorithm it can detect whether the input is correct or not. Logistical Regression (LR): This include	1. Machine learning	It can be used in modern day to reduce false alarms and conserve energy.

			learning of problems from previous data and learn about those problem that it has to face in the future.		
[21]	IEEE	2017	SD-WSNs controller is replaced by Sink Node and switches are replaced by Sensor nodes. These sink nodes maintain balance between the nodes. As the sink node check each and every sensor node and use their energy as per require in finding desired result.	1. SD-WSNs, 2. OPGEA, 3. WSNs, 4. Game theory 5. energy-efficient algorithm.	Using game theory can make WSN more adaptive, efficient and intelligent.
[22]	IEEE	2017	An Energy-Efficient Heterogeneous Ring Clustering (E2HRC). 1. Rotate cluster head as per situation or disabling them. 2. Recognition of Prior Learning (RPL) which is designed for Low Power and Lossy Wireless Networks.	1. Wireless sensor network 2. Clustering algorithm 3. Routing algorithm 4. E2HRC.	It is good for loosy communication,
[23]	IEEE	2017	Cluster algorithm with combining Type 2 Fuzzy Logic (T2FL) which is better than	1. WSN 2. type 2 fuzzy logic	To make better decision making in WSN it can help.

			Type 1 Fuzzy Logic (T1FL) model. Homogenous network is used as to give equal and proper energy distribution to each node in the network.	3. Mamdani's method	
[24]	IEEE	2018	Algorithm Balanced and Energy Efficient MH (BEEMH) 1. Initiation phase: in this when nodes are randomly deployed over the area base station broadcast the message for all nodes to identify themselves. 2. Setup phase: in this base station set the efficient way between those nodes. 3. Steady-state phase: in this energy or power is used by that node according to that packet.	1. Minimum transmission energy (MTE) 2. Energy saving oriented least-hop routing algorithm (ESLHA) 3. Energy saving-oriented routing algorithm based on Dijkstra (ESRAD)	Used to increase the stability of nodes.
[25]	IEEE	2018	An energy-aware path construction algorithm (EAPC) 1. Initialization phase: to initialize the set of parameters construction of path is done.	1. Energy consumption. 2. Efficient Path. 3. Maximal benefit. 4. Collection point.	To increase fairness in transmission of data.

			2. Collection point selection: so that sink node uses those points and collects data from those points. 3. Construct the path: which covers all collection point and form efficient path all over the network.		
[26]	Springer	2018	They propose a new model by which they can place node in an intelligent manner: 1. They place nodes in circular manner. 2. They place nodes in penta circular model or hexagonal manner. Main objective to cover large area by less minimising node number.	1. Penta circular Node placement 2. Hexa circular node placement 3.Novel node deployment in WSN 4.Energy saving in WSN	To cover wide area with minimizing number of nodes.
[27]	ELSEVIER	2018	They propose a hybrid system consist of Ant colony optimization (ACO) and practical swarm optimization (PSO). This new technique uses both technique to gather data	1.Hybrid Ant colony optimization (ACO) 2. Particle swarm optimization (PSO)	Two make efficient data aggregation technique to reduce energy consumption for raw data aggregation.

			from network as well as inside a cluster.	3. Hybrid ACOPSO	
[28]	ELSEVIER	2018	They propose s method to provide better and efficient communication in term of QoS (quality of service) and energy use: Selecting cluster head on the basis of 1. Importance matrices. 2. Energy capability 3. Node with higher neighbouring density.	1.WSAN 2.Routing 3.Clustering 4.QoS 5.Energy consumption 6.End-to-end delay	To increase the Quality of service with energy efficient wireless sensor network this method may be used.
[29]	Springer	2018	They propose a method to collect data from different sensor nodes with shortest path. By making small path they make use of less sensor communication among each other.	1. Wireless sensor network 2. Target coverage 3. Energy-efficient 4.Network lifetime	For short path data aggregation techniques we can use this method.

2.3 Factors identified and responsible for energy deficiency with in WSNs:

Above mentioned papers shows many factor that effects the efficiency of wireless sensor network. Some of the solutions are proposed by different authors. Theses proposed solution are helpful and gives best results. While some time these proposed solution make wireless sensor network energy efficient but effects other parameters. Example, in [1] it makes network energy efficient but effects communication time.

2.3.1 False Alarms [3] [7].

False alarms may be detected by sensors and energy is used in false computation (sensing, sending of data and processing). This may result in excess use of energy while gathering false results.

2.3.2 Other Factors (noise, disturbance, interference and signal strength) [6].

Some other factors are also responsible for decreases in efficiency of WSNs like noise, signal strength, interference and disturbance added by other application. These factors may reduce the coverage area and communication efficiency

2.3.3 Poor Distribution of Nodes in Area [11] [5] [9].

Sensor deployment systems use different methods/protocols for the deployment of sensor nodes in specific area. However some locations are not suitable for those systems. Though these systems get the desired results from those locations but never achieve full results.

2.4 Methods Identified and used to improve energy efficiency in WSNs:

Some methods are useful and increases energy efficiency in wireless sensor network. In above mentioned papers, there are many solution for energy efficiency in wireless sensor network. Some of the main solution by which we can increase energy efficiency are:

2.4.1 Smart Sensors [3, 4, 7 and 10].

Combining fuzzy logic and neural network makes it more capable for decision making [3].

Use decision whether to select specific ANN as per situation make it more efficient [4].

To take decision for real time operation and to reduce false alarms at first place smart sensor may be a better choice [7].

To make decision whether to use NCPCR or not such may help in reducing the energy consumption is significantly reduced [10].

2.4.2 Intelligent Walls [6].

IW concepts use proper area coverage for WSNs. It proposed a technique to make proper boundaries which eliminates the effect of other disturbances (Wi-Fi signal, cellular networks and radio waves) [6].

2.4.3 Proper Clustering or Network Deployment [7] [13] [14].

Using centralized cluster based protocol and give power for strong computation ability in BS, strongly reduce energy consumption [7].

Combining alike nodes to come together and solve large problems easily may increase efficiency and derive better results [13].

By reducing the size of cluster may reduce energy consumption and gather better results [14].

2.4.4 Routing Algorithms [1] [3] [4] [5] [11]

Gathering data from NNR algorithm may increase the efficiency without changing any hardware [1].

Combining fuzzy logic with neural network may increase the efficiency and make better decision [3].

Selecting best ANN as per the situation results in better performance and increase efficiency also [4].

Using NNR as per situation may provide better and trained network model by online training it may further attain more efficiency as per other NNR [5].

Training of NNR on huge data sets can make it more adaptive and reduce energy use in WSN [11].

Chapter 3

Network Simulation Parameters:

3.1 Simulation Tool:

In this we use MATALB 2016a tool. This stands for matrix laboratory. MATLAB provides multi-paradigm numerical computing environment. MATLAB allows many functions like matrix solution, data plotting, function plotting creation and manipulation of algorithm. MATLAB support other language interfacing like C, C++, C#, Java, FORTRAN and Python. There are many other packages includes in MATLAB which provides best support for user. Some packages are Simulink, adds graphical multi-domain simulation, model-based design and many more. This is used to compute our testing results with specific parameters. In these [25] and [24] papers they also use MATLAB tool for conclude results with specific parameters.

3.2 Deployment of Network:

In this section, we first deploy our nodes over an area. Deployment of nodes depends upon number of nodes used at that specific time and how nodes are deployed over an area. There are many simulation done thus number of nodes varies in each simulation. Deployment of nodes are random and varies each time when new deployment is done.

Some specific points are taken in mind while doing deployment of nodes like number of nodes for each simulation, sink node location and activity point where some event is occurred.

3.2.1 Number of Nodes:

Number of nodes varies from minimum 100 nodes used and maximum 300 nodes over an area. These nodes deployed with specific pattern over the area. This is one of the main point regarding efficient deployment. In pure random deployment one or more nodes overlap each other as you can see in figure 1(a). These overlap nodes is not efficient to produce desired result. Thus in figure 1(b) we deploy 100 nodes randomly but in specific manner. By using specific

pattern we can increase the coverage area of sensor, increases efficiency and reduce error rate in detection of data.

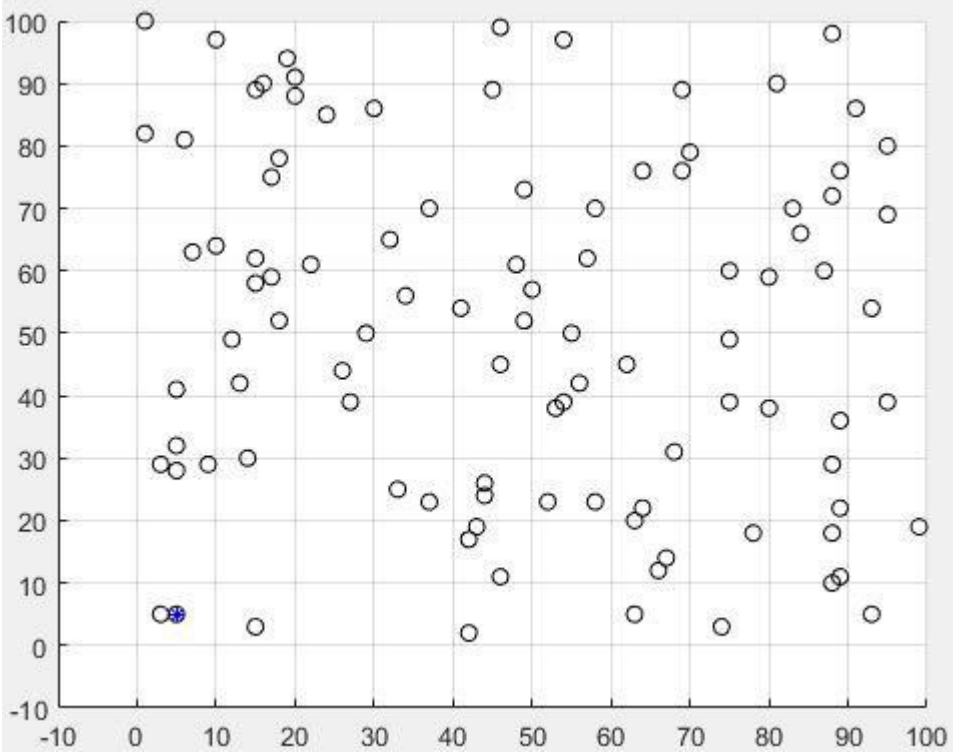


Figure 1 (a): Random deployment of nodes.

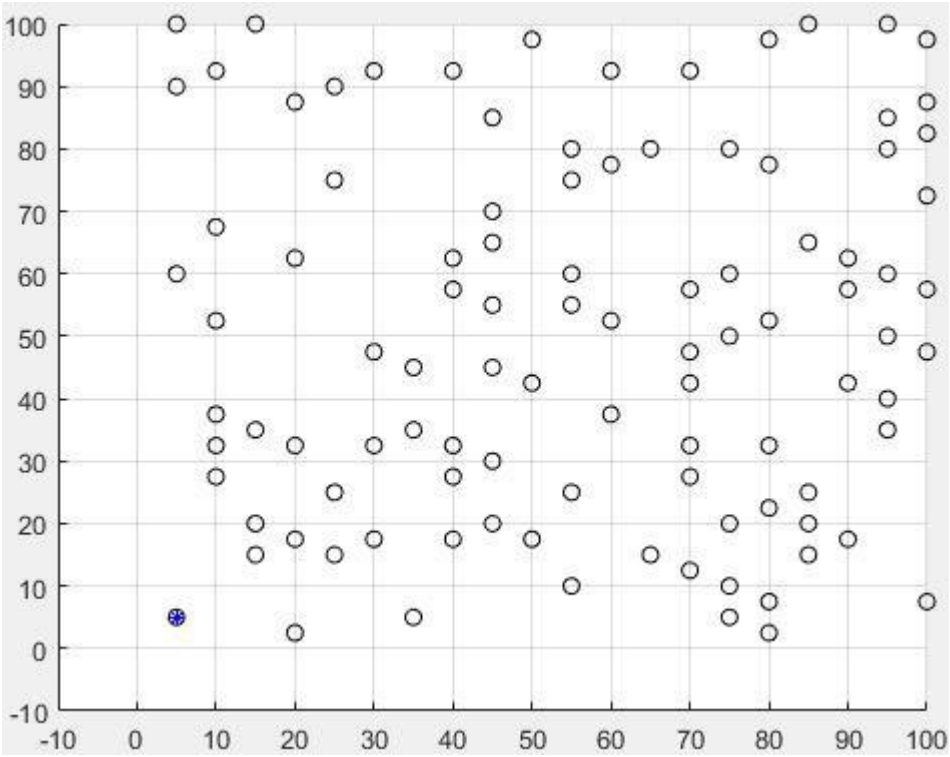


Figure 1(b): random deployment but specific pattern.

In figure 1(a) 100 nodes are randomly deployed over the area and in figure 1(b) 100 nodes are deployed randomly but specific pattern. By making specific pattern we can eliminate overlap of nodes over each other. Thus we can decrease error rate. We have perform many simulation in which nodes varies from 100 to 300 some of examples are shown in figure 2 (a, b, c, d, and e).

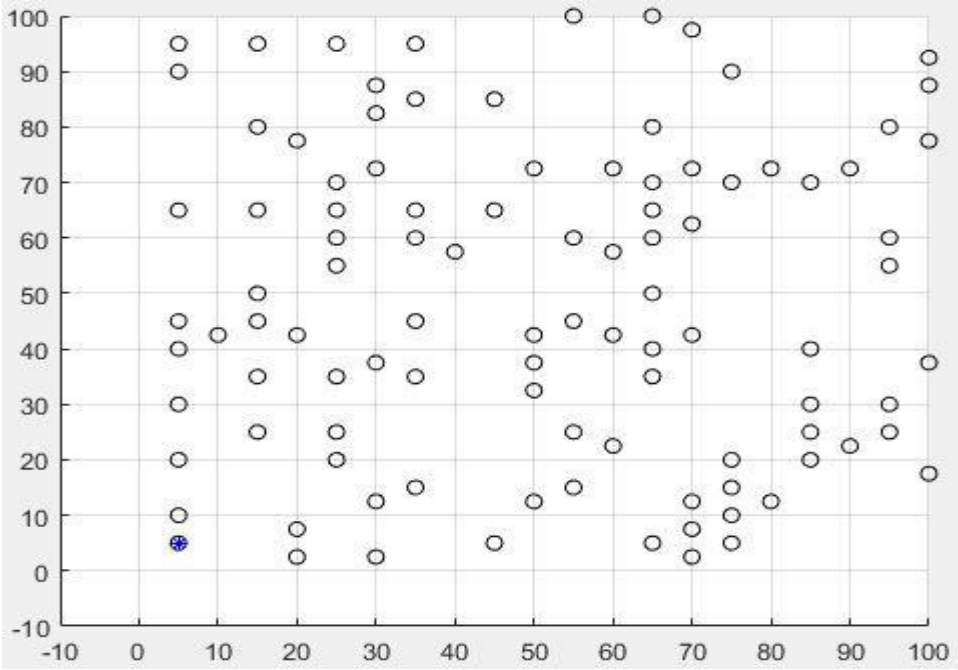


Figure 2(a): deployment of 100 nodes.

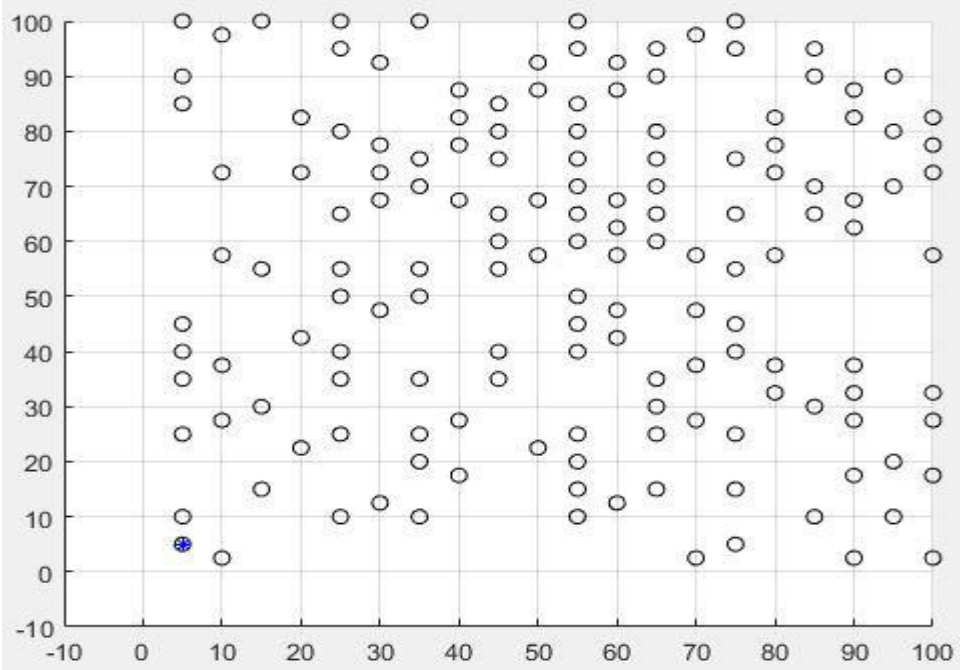


Figure 2(b): deployment of 160 nodes.

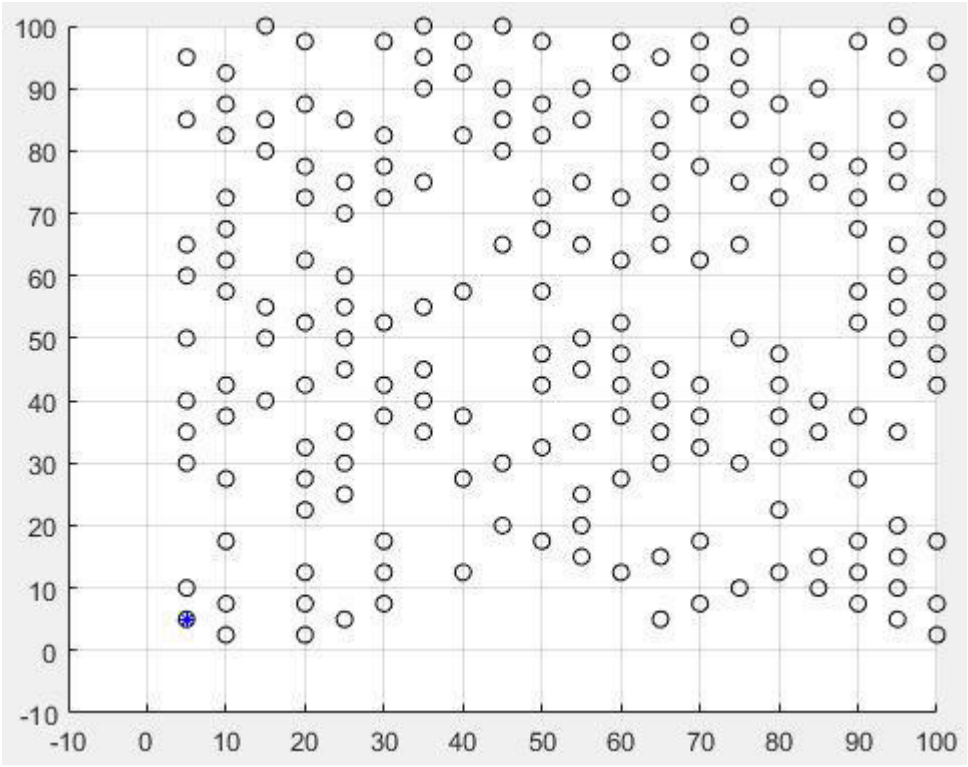


Figure 2(c): deployment of 200 nodes.

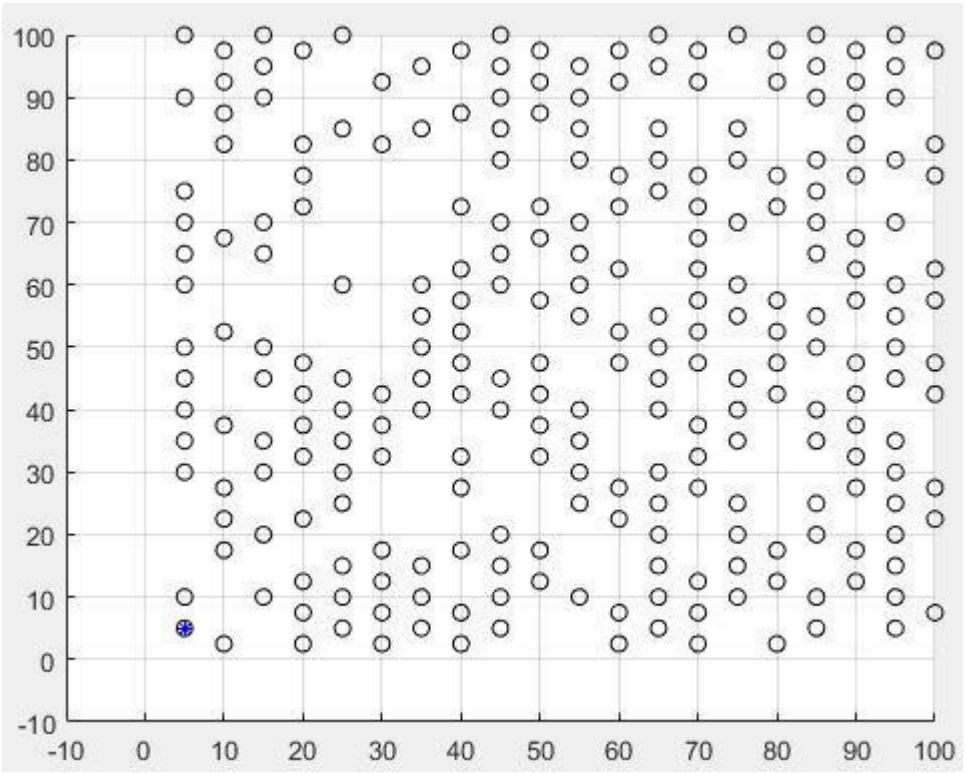


Figure 2(d): deployment of 250 nodes.

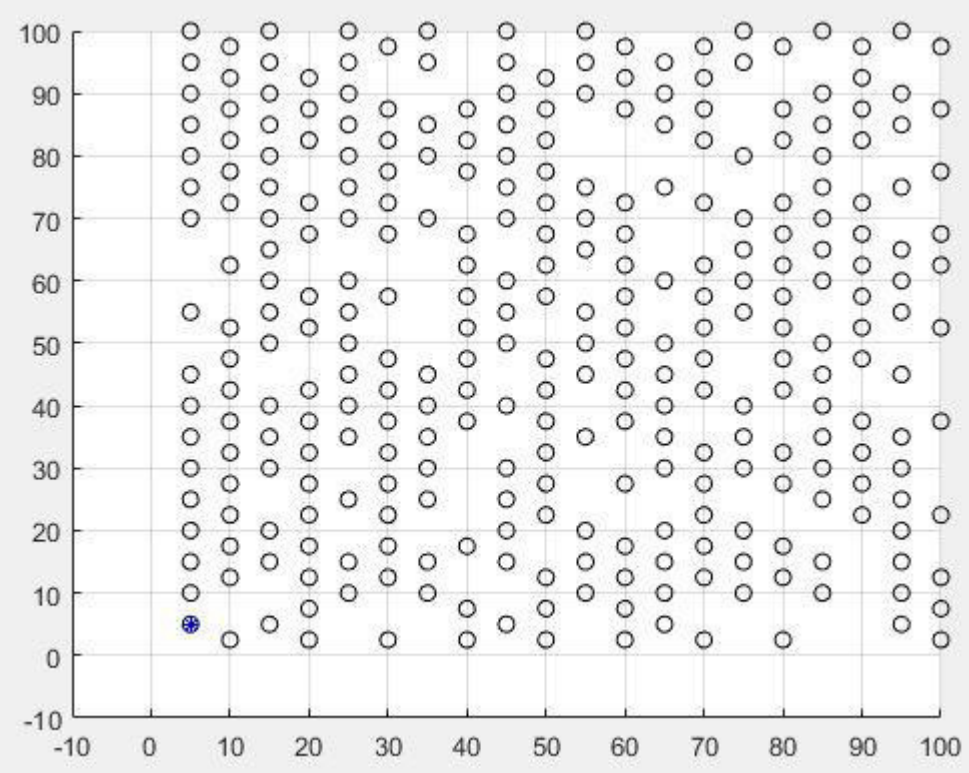


Figure 2(e): deployment of 300 nodes.

These are some network deployment used in our simulation. In these deployment we used our proposed methodology (MEEGA) and compared the results with other techniques.

3.2.2 Sink Node Location:

Sink node plays a crucial role in any network. It is basically a destination where all the data is collected. It is also known as base station where data is received and processed in definite manner. It depends on the algorithm, how sink node acts or work on receiving a specific data. It is one of the main unit of any sensor network as it works as a gateway or interface between user and sensor network. In our simulation we have deployed one sink node which is located at (5, 5) axis in each and every deployment shown in figure 2 (a, b, c, d and e).

3.2.3 Activity Occurred:

Suppose activity occurred at any point. This activity was sensed by the sensor and that message travelled through desired node as per algorithm. These

selected nodes are also knows as route by which sink node gets data and further do computation on it.

In simulation we use random number generator which generates activity at any point. This activity is sensed by any nearby sensor and thus message reaches to the sink node.

3.2.4 Path Construction Phase:

In this section we doesn't use any algorithm to construct path from activity point to the sink node. We simply uses one formula (natural rule) by which we can calculate which node is best for further communication.

Natural law: In 2D dimension network plotting, sum of coordinate near to origin is always low. In our proposed solution we are moving towards the sink node which is at (5, 5) almost origin. Thus using summation of coordinates to detect nearest coordinate among other coordinates towards origin or (5, 5) is easy to detect.

3.3 Energy Formula [24] [33]:

In this section we calculate how energy is used all over a network. As we all know there is limited amount of energy in each wireless sensor network. Thu using that limited energy in specific manner can increase life span of wireless sensor network. Mainly energy consumption is divided these parts. In our simulation we use trans-receiver which do transmission and receiving at the same time.

3.3.1 Amplification Cost [24] [33]:

Amplification is denoted by $\mathbf{E_{amp}}$ and depends mainly upon distance denoted by **D.** As distance increases amplification cost increases. Product of distance covered by message and energy used for amplification is known as amplification cost. This amplification cost is represented by $\mathbf{E_{amp} * D}$.

3.3.2 Component Cost [24] [33]:

Component cost is denoted by $\mathbf{C_n}$. It depends mainly on the technology used by the user for construction of circuit and which type of material is used for that

circuit formation. Energy consumption depends upon the material used for example: in case of energy consumption use of iron over copper can increase cost and in case of speed use of copper over gold increases cost.

3.3.3 Transmission Cost [24] [33]:

Transmission coat is denoted by **Tp**. It mainly depends upon the amount of packets send denoted by **k** , summation of component cost $\mathbf{C_n}$ and amplification cost $\mathbf{E_{amp} * D}$**.** So desired formula for transmission cost id denoted by $\mathbf{Tp = k * (C_n + E_{amp} * D)}$ [24] [33].

3.3.4 Receiving Cost [24]:

Receiving cost is denoted by **Rp.** It mainly depends upon the amount of packet received denoted by **k** , summation of component cost and data aggregation cost $\mathbf{E_{dv}}$.

So desired formula for transmission cost id denoted by $\mathbf{Rp = k * (C_n + E_{dv})}$ [24] [33].

3.3.5 Total Energy cost Function[24]:

Total cost function of any nodes depends upon the summation of receiving cost and transmission. As trans-receiver performs both function at same time. So desired formula are:

Total Energy cost Function [24] [33] = **Tp + Rp.**

$$= \mathbf{k * \left(C_n + E_{amp} * D\right) + k * (C_n + E_{dv}).}$$

$$= \mathbf{k * \left[\left(C_n + E_{amp} * D\right) + (C_n + E_{dv})\right].}$$

3.4 Limitation of Network:

3.4.1More Than One Deployment:

Sometime deployment nodes in a field is not up to the point. Thus we have to make deployment again and again until it attain proper positioning. This situation occur because of sink node located at (5, 5) and node coverage area is 20m – 40m. Sometime nodes near towards the sink are low or negligible and fail to transmit message as per figure 3 (a, b).

This problem occur mostly when number of nodes are less than 160. Node more than 160 show no such problem as nodes are more cover almost each and every corner of the area.

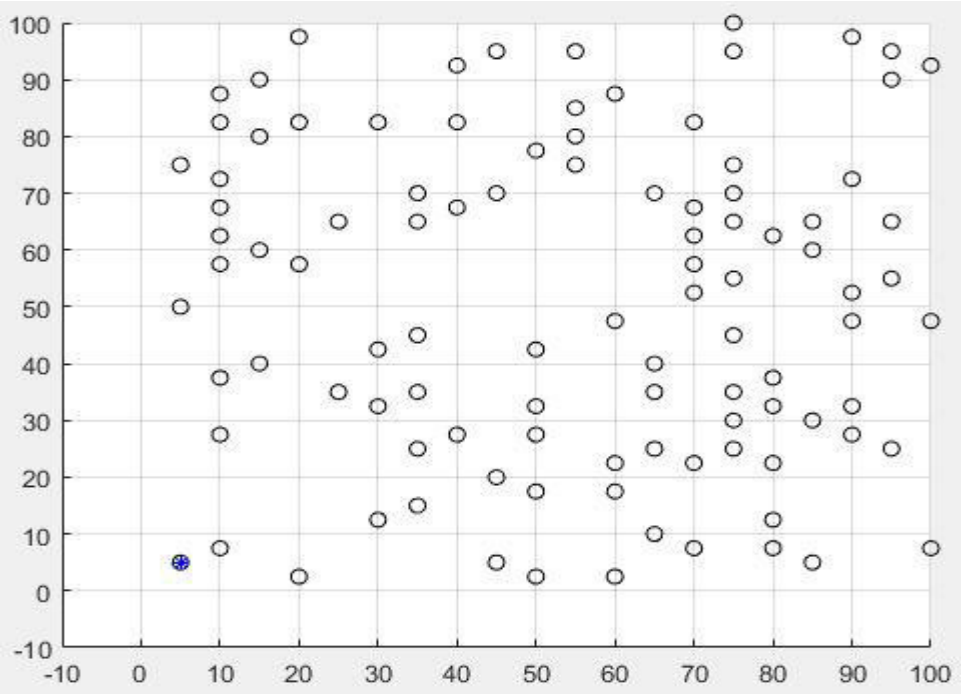


Figure 3(a): sink node covers only one node:

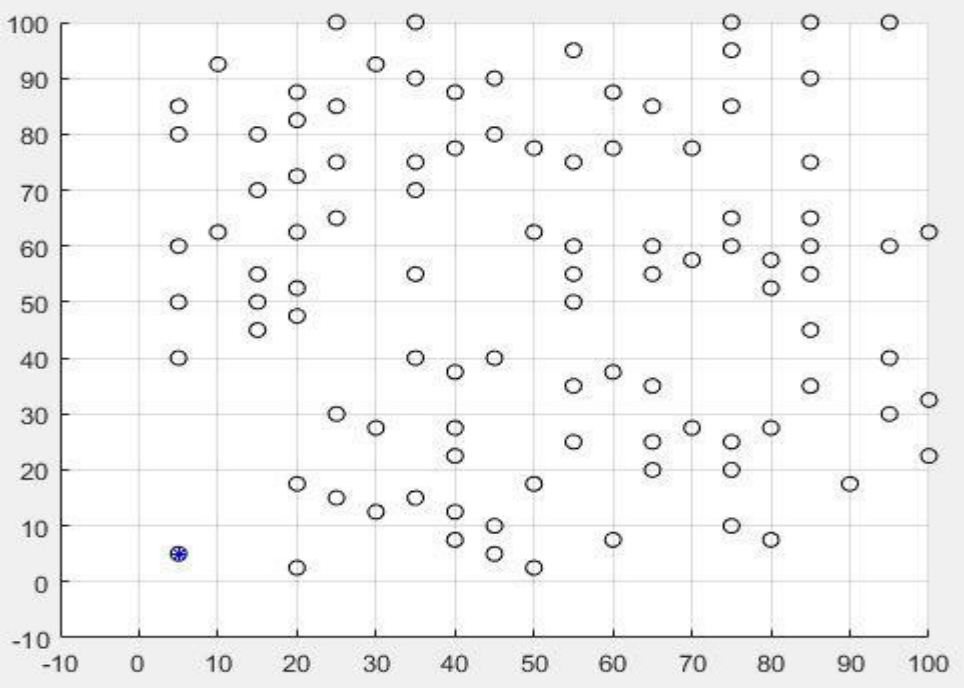


Figure 3(b): sink node covers none node:

3.4.2 Miss Rate:

Miss rate means when message is not received by sink node. This happens mostly due to two main reasons first is node deployment factor and second in last stages of network. Deployment factor is discussed above. While second factor happens when near nodes of the sink are dead fail to communicate message further. This mostly happens in last stages of the network. At that point nodes close to the sink are dead. As shown in figure.

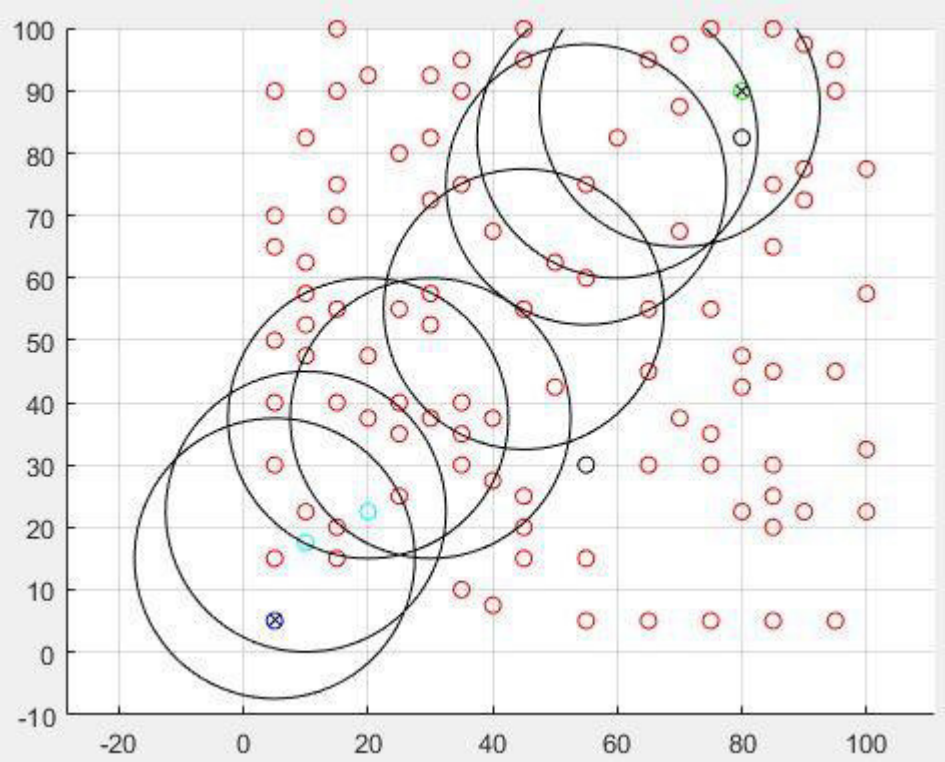


Figure 4: dead node representation.

In this figure blue nodes are dead, as result further communication is not done. Thus miss rate occur and stop. This error occur maximum when there is less node deployment (less than 160 nodes).

Chapter 4

Parameters Identified:

Parameters are the some variables or benchmarks on which we compare the efficiency of any proposed solution. These parameters help us to compare our results from any other solution and derive new results, improve our solution, make amendments and give full certified results.

These are some parameters that are taken in may research papers and give results in proper simulation results. These results show how simulation work is done, what are the finding and how proposed solution is better than other previous solution.

4.1 Network Life Time (round):

In MEEGA network life time is calculated in terms of rounds. In each round activity is occurred at any point in the field. That activity is thus carried out by sensors and message goes to the sink node. Thus number of rounds taken by network is considered as the network life time of MEEGA. This is one of the best parameter considered to do comparison between other techniques.

4.2 First Node Dead:

In this number of nodes as per simulation in MEEGA (100, 110, 120, 130 ----- 300 nodes) are used. In each case number of rounds increases respectively. As per round goes residual energy decreases and results in node failure or node dead. This is most common and best used parameter for wireless sensor network.

4.3 Energy Consumption:

As per total energy cost function each node have its initial energy. This energy reduces in each round. In each round nodes uses energy for transmission, data aggregation, communication and many other processes. Thus energy consumption or energy utilization is important. Energy efficiency increases life time of nodes. Energy consumption formula is evaluated in chapter 3, section 3, point V.

4.4 Simulation Time (time period):

It is also known as time used by wireless sensor network for total work done. This may differ for each and every simulation tool. Each simulation tool has its own technique, memory usage, communication time and many other process. Thus simulation time is not perfect comparison parameter and gives different results in each machine.

4.5 Real Time Simulation:

Real time simulation means to deploy sensors in real time environment. In an actual field node deployment cost much higher and very difficult. This simulation gives best and accurate results but at same time it require huge amount of cost. This type of simulation require large funding or support. This gives accurate findings and best results as compared to other parameters.

4.6 Packet Transmission Rate:

As per simulation packets is transferred from one node to another until it reaches to the destination. In some cases packet may loss or not reached at destination this causes failure in wireless sensor network. To compare the network packet transmission efficiency this parameter is used. This parameter tells us how good the transmission rate of any algorithm and which its error rate.

4.7 Last Node Dead:

This is also a good parameter but stands only in some proposed solution. As the network is simulated by number of node and single node cannot perform much work or we said same node left cannot perform properly. Thus last node dead gives some time results as network starts failing after some amount of nodes are dead max to 30% nodes are dead. Thus this parameter is used very less.

In this research work I have used some parameters mention above. I have previous results of other solution [25] [24] and [bg] in their respective parameters. Those results helped me to compare my method MEEGA. These are some parameter used:

i. **Network Life Time (rounds)**: in this I compared my proposed solution with EAPC [25], BEERAD-E [24] and compared number of rounds done by my solution as per there's.

ii. **First Node Dead**: in this I compared my results again with EAPC [25], BEERAD-E [24] and get results in terms of first nodes runs out of energy.

iii. **Energy Consumption**: in this energy of my proposed solution is compared by EAPC [25], BEERAD-E [24] and Basic gossip. Thus derive most energy efficient algorithm among each other. This shows how energy is used till the communication is done.

Some of the parameters are not used like last node dead: in this my solution derive enough results until it reaches it limit (last node) thus I have to eliminate this parameter, real time simulation: this gives huge cost for making each sensor and deploy in real environment. Thus I have to eliminate this parameter also, packet transmission: in this parameter my solution gives miss rate when certain amount of nodes are dead or likely when it reaches its limit (30% of nodes are dead) and at last simulation time (time period): because I used MTLAB 2016a and some other solution like EAPC [25] and BEERAD-E [24] are performed at some other simulator thus I have to eliminate this parameter.

Chapter 5

Problem Statement:

5.1 Proposed Solution:

According to Chapter 2 section 4, some of the methods are discussed. By these methods we may increases energy efficiency in wireless sensor network. Out of all mentioned methods I choose routing algorithm and proper network deployment. Proposed solution are based on these two methods:

Proper network deployment: This section is mention in Figure 1(a) and Figure 1(b) at chapter 3 section 2. How node deployment effects the efficiency of network. Make random deployment as in figure 1(a), shows nodes overlap. These nodes overlap makes two or mode nodes to detect same data and same area coverage. These type of deployment increase resource wastage and produce less data as compared to resource usage.

Routing algorithm: We propose Modified Energy efficient Gossip Algorithm (MEEGA). In MEEGA we use technique of basic gossip to send message from source to destination. In MEEGA full gossip is not, we modified basic principal of gossip to spread information limited and reduce energy use, secondly we don't use some other algorithm for selecting best path for sending data from source to destination. We use %% method to select best node or choosing path for sending data.

5.2 Pseudo Code:

Step 1: Start;
Step 2: Use random nodes distribution in a grid, produced by Random Deployment of nodes.
Step 3: Initialize sink node at (5, 5) coordinates.
Step 4: Sense data from activity point.
Step 5: Activity is sensed by nearest node. Initial x, y coordinates intix and intiy.

Step 6: Gossip message or infect neighboring nodes.

Step 7: Select best node among infected nodes, which are near to the sink. Initialize newx and newy.

$$\text{sm} = \sum_{i=1}^{n}(x_i + y_i)$$

Step 8: check weather sink is infected or not.

If sm = = 10 (summation of sink node coordinates which is lowest in the grid)

{

Message is reached the destination

Stop forwarding message

Break the loop

Stop;

}

else

{

Make intix = newx; and intiy = newy;

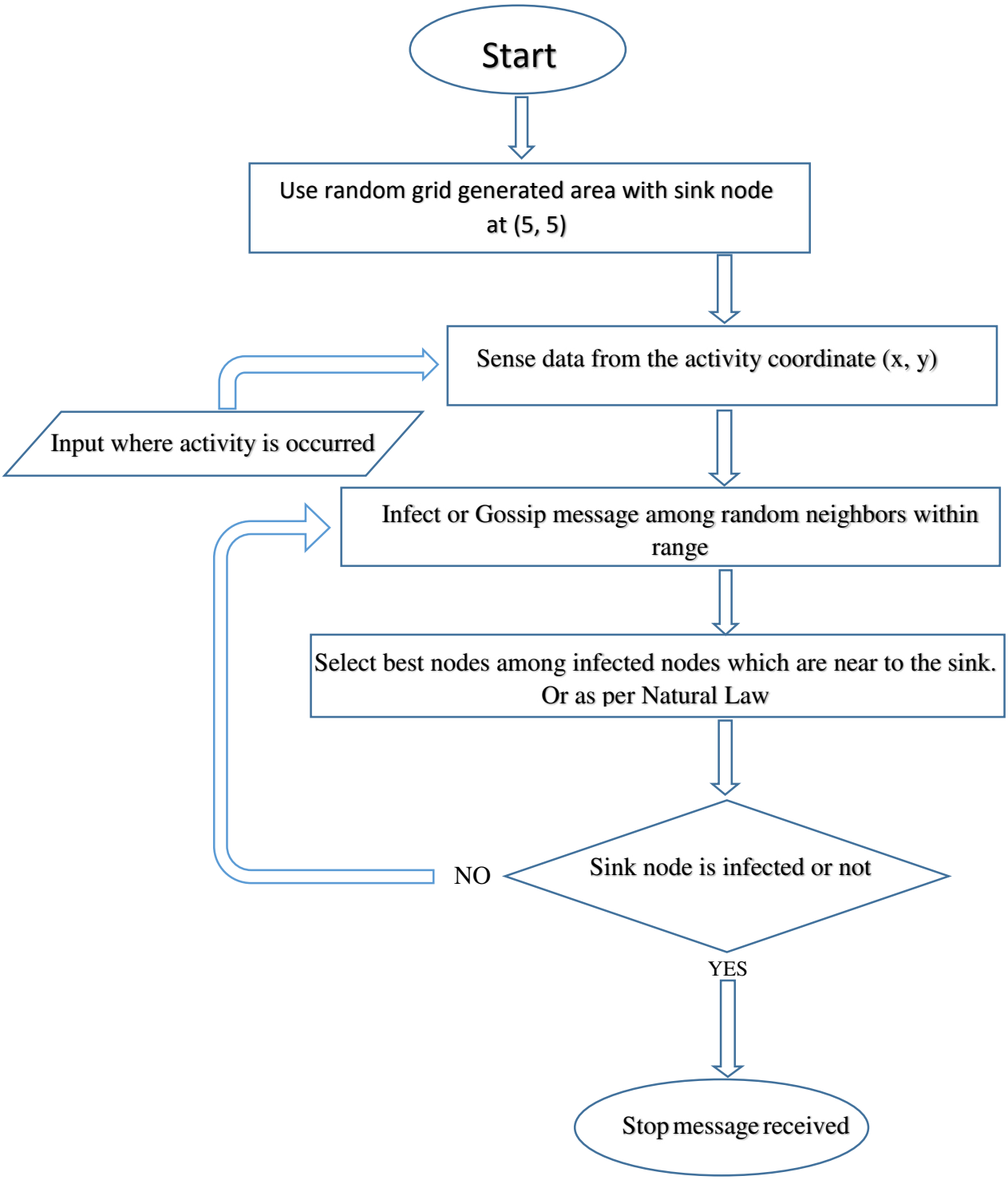
Repeat from step 5 to step 8 until message received at sink node;

}

Step 9: End;

5.3 Flow Chart:

Flow chart for MEEGA:



Chapter 6

Comparison Parameter:

6.1 In case of MEEGA vs. Basic Gossip vs. EAPC:

In this case we compare our proposed solution (MEEGA) with basic gossip and Energy-Aware Path Construction for Data Collection Using Mobile Sink in Wireless

Sensor Networks (EAPC). In this we take simulation parameters as per EAPC [25]. By these parameters (as in table 2) we compare our proposed solution. We consider these three main parameters to gather results as per shown in simulation:

Table 2: Simulation parameter as per EAPC [25].

S. No.	**Parameters**	**Values**
1	Simulation	MATLAB
2	Number of nodes	100 - 300
3	Initial Energy	100J
4	Transmission Power	0.18J
5	Receiving power	0.10J
6	Transmission range	20m-40m
7	Node deployment	Random

6.1.1 Network Life Time (round):

This simulation compares MEEGA with other proposed solution on the basis of network life time or rounds performed by MEEGA. In this simulation runs until network stops working. This simulation work until nodes are failing more often and give more miss rate in term of packet transmission.

In Figure 3(a), as per simulation number of nodes are 100 and simulation done over that network are three. In some simulation results are not good as nodes are not properly deployed and gives bad results.

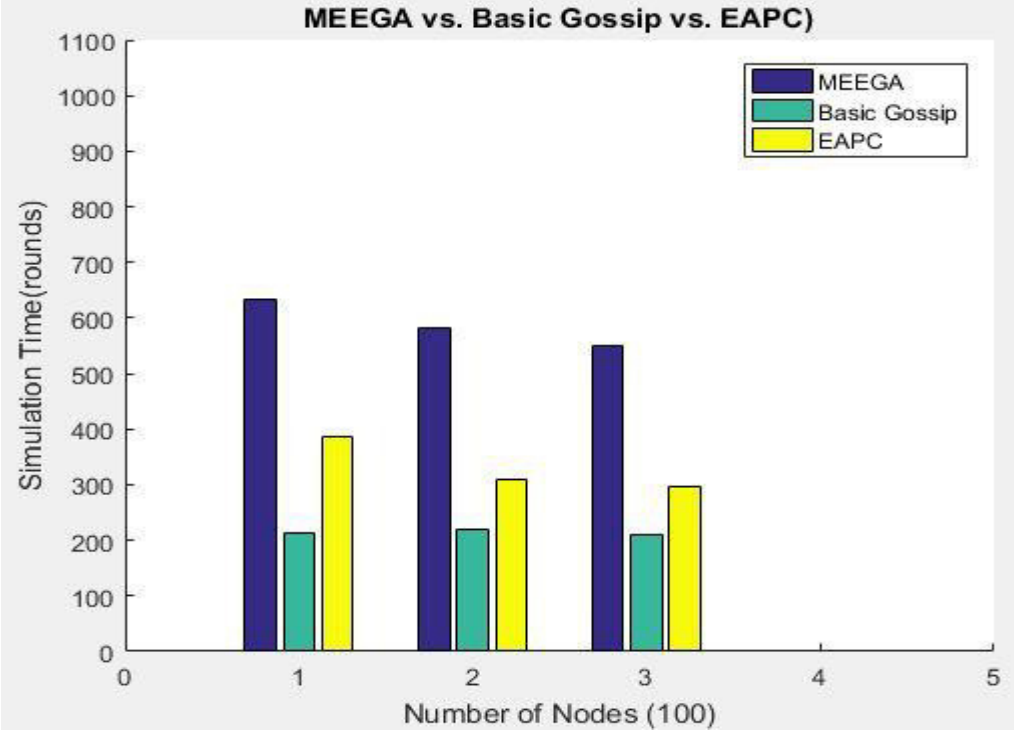


Figure 5(a): Comparison between MEEGA vs. EAPC vs. Basic Gossip

In Figure 5(b), as per simulation number of nodes are 200 and simulation done over that network are three. In some simulation results are stable as nodes are mostly deployed in perfect way and and gives less miss rate results

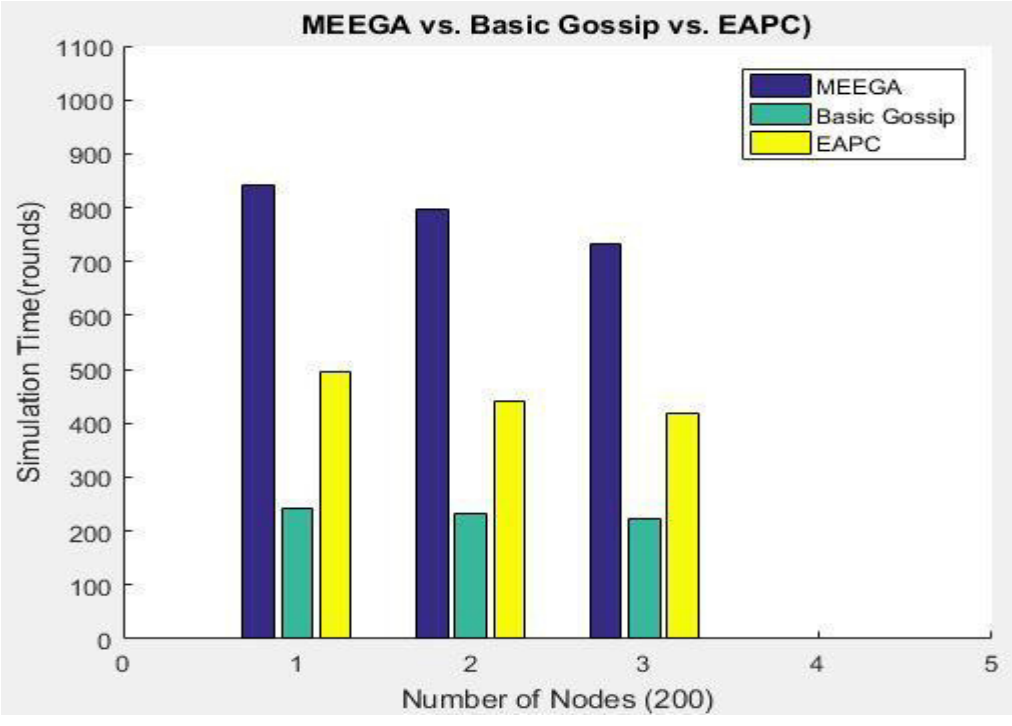


Figure 5(b): Comparison between MEEGA vs. EAPC vs. Basic Gossip

In Figure 5(c), as per simulation number of nodes are 300 and simulation done over that network are three. In some simulation results are stable as nodes are deployed in perfect way and and gives negligible miss rate results.

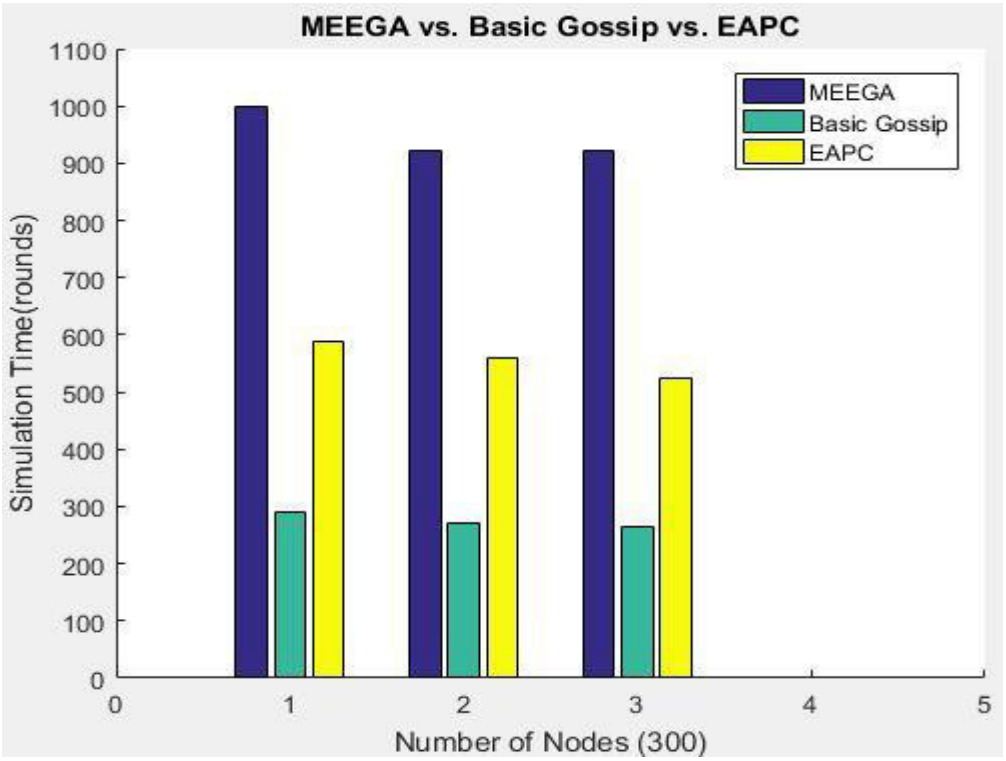


Figure 5(c): Comparison between MEEGA vs. EAPC vs. Basic Gossip

6.1.2 First Node Dead:

In Figure 6, as per simulation node are randomly deployed over the area. Nodes varies from 100 to 300 nodes. Each nodes carries initial energy of 100J. Randomly activity is occurred over the area. This activity is sensed by a sensor and information packets travel from nodes and reaches by the sink node. First node dead means first nodes in a network runs out of energy or become dead.

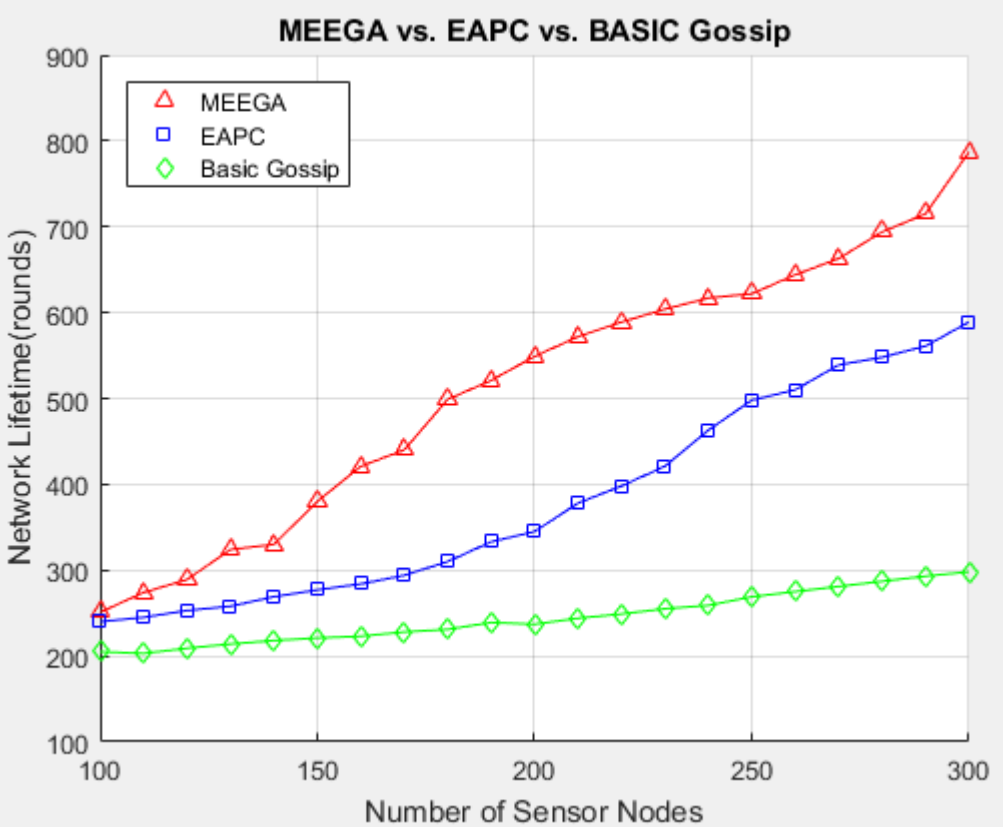


Figure 6: FND comparison between MEEGA vs. EAPC vs. Basic Gossip:

6.2 In case of MEEGA vs. Basic Gossip vs. BEERAD-E:

Table 3: Simulation parameter as per BEE [25].

S. No.	**Parameters**	**Values**
1	Simulation	MATLAB
2	Number of nodes	100
3	Initial Energy	0.5J to 1J
4	Transmission Power	0.000216J
5	Receiving power	0.00022J
6	Transmission range	20m-40m
7	Node deployment	Random

6.2.1 Network Life Time (round):

In this section we done our second simulation on different parameters as shown in Table 3, this simulation contains comparison between BEERAD-E [24], basic gossip, and our proposed solution MEEGA. We have done five simulation on same parameters and get results as shown in figure 7.

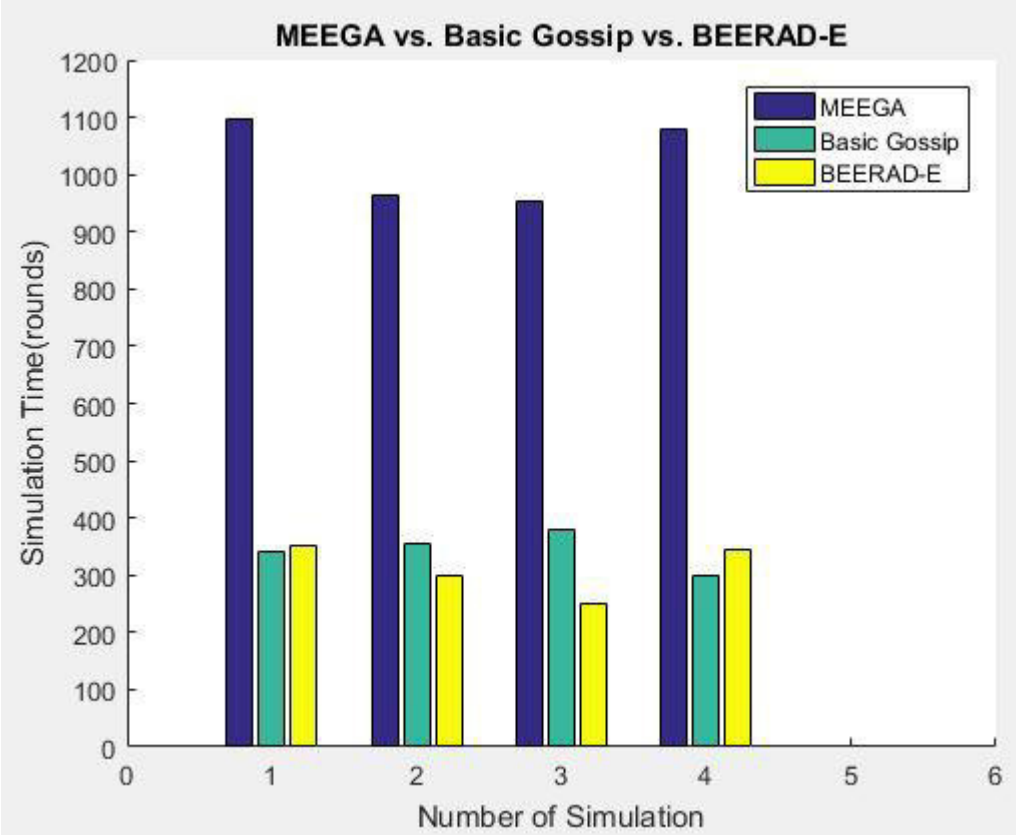


Figure 7: comparison between MEEGA vs. Basic Gossip vs. BEERAD-E

In this figure number of nodes taken are 100 and energy values for transmission and receiving as per table 3, in this number of nodes are constant (100) so we have done many simulation and took 4 best simulation results. In some simulation results are not clear because node allocation is not perfect. In maximum comparison MEEGA gives best results in term of number of rounds.

6.2.2 First Node Dead:

In this section we have done four simulation and compared results between BEERAD-E [24], basic gossip and MEEGA. We have done many simulation and took four best results. Number of nodes are constant (100) and energy

parameters are taken from table3. In some simulation results are not clear because nodes are not perfectly deployed over the area. Results are shown in Figure 8.

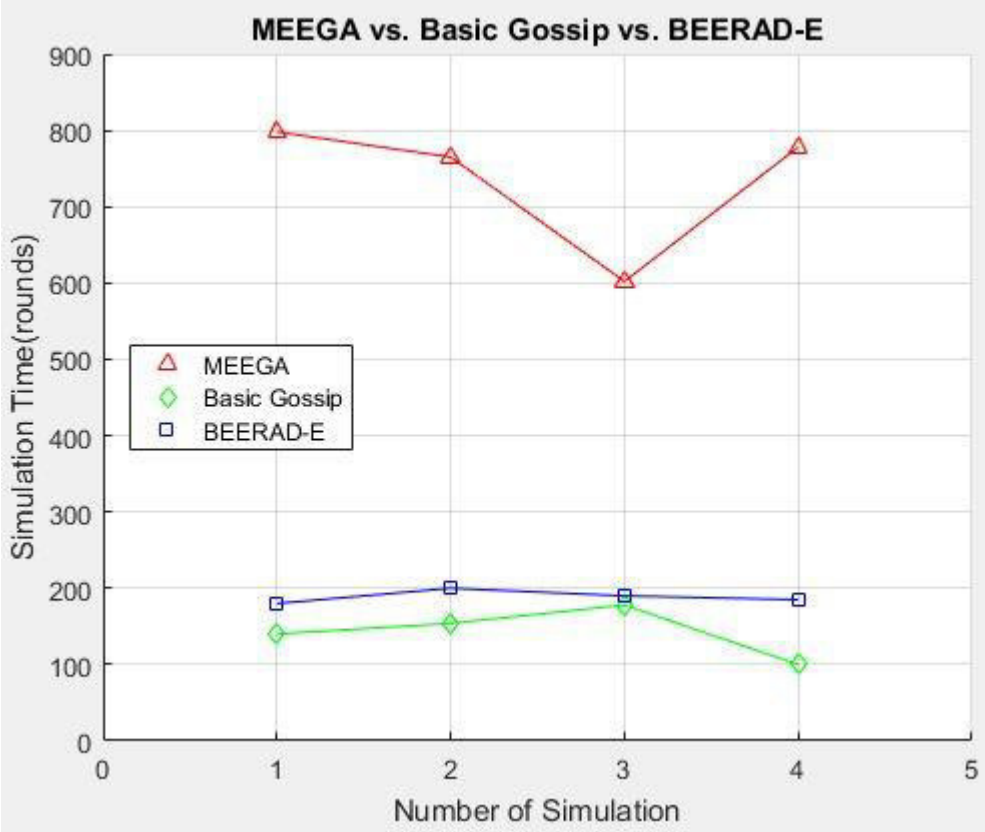


Figure 8: comparison between MEEGA vs. Basic Gossip vs. BEERAD-E

6.3 Energy Consumption:

In different simulation different simulation are done under different parameters as per table 2 and table 3. Energy formula for receiving and transmission are calculated in chapter 3 under Network simulation parameters section 3.

In figure 9(a, b): different energy of MEEGA is represented when nodes are taken 100. In Case II: BEERAD-E initial energy is 0.5J. In Case I: EAPC initial energy is 100J as per table 2 and table 3. Thus consumption of energy for receiving a message and transmission of message depends upon the number of rounds simulation is done and when network stops working.

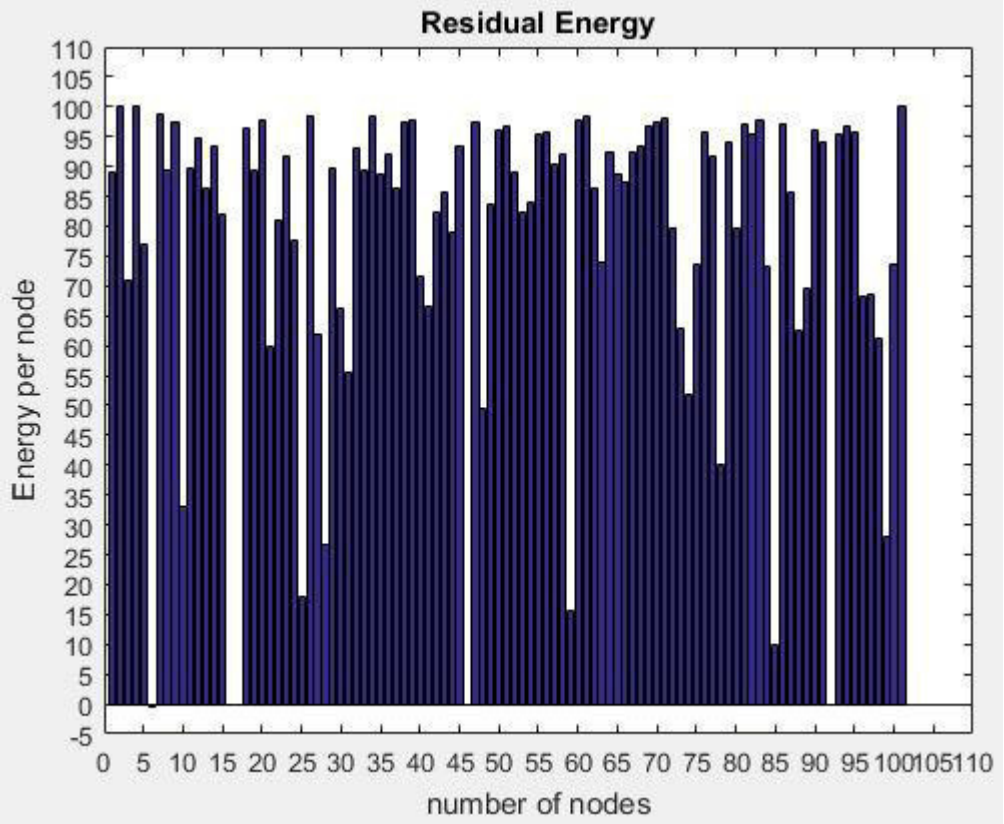


Figure 9(a): Energy consumption in case of Case I

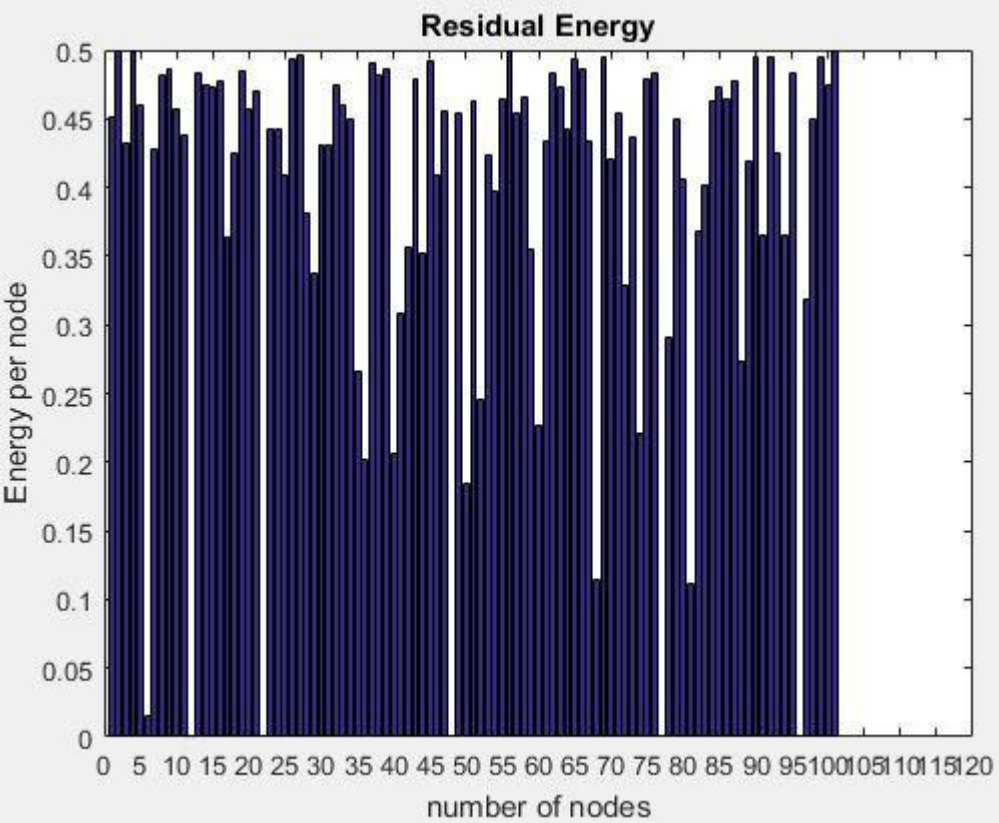


Figure 9(b): Energy consumption in case of Case II

Chapter 7

Conclusion:

In this research work our main objective is to find the best solution for energy efficient wireless sensor network. There are many proposed solution by different authors which are helpful and concluded in interest of energy efficient wireless sensor network. We have proposed our method Modified Energy Efficient Gossip Algorithm (MEEGA) and thus able to increase the life span of wireless Senor Network. We had done many simulation and find maximum results in favor of MEEGA.

These results are taken with comparison of our proposed model MEEGA vs. EAPC [25] and MEEGA vs. BEERAD-E [24]. We have concluded our research in these points taken in motivation.

1. To identify the issues that affect energy consumption in Wireless Sensor Network. There are many factor which affects the energy consumption in wireless sensor network. These findings are done in literature survey shown in chapter 2. There are many solution proposed by different authors and these solution contribute best in interest of energy efficient wireless sensor network. Some of the factor responsible are false alarm, poor distribution of nodes, noise and disturbance in communication and some other factors. For detail review refer to Chapter 2 section 3.

2. To identify the factor effects energy consumption in wireless sensor network. These factor effects wireless sensor network and cost large amount of energy consumption as a result wireless senor network dies fast or fails to work up to its capability. For example false alarm: if false alarm is not detected at its initial stage. Then false data is gathered, then communicate among nodes, processed and in last done whole computation on that data by base station. At last stage data is identified and discarded, while doing all these process large amount of energy is consumed. So if we detect false data in initial stages we can save energy.

3. To identify where is the energy consumed in wireless sensor network?

There are many points where energy is consumed like processes, data aggregation, and communication. In our proposed solution MEEGA we have done our own routing and own network deployment. These are the two main domain we have solved in our solution. Thus able to reduce energy consumption and increase life span of wireless sensor network. In chapter 5 we have briefly explained this part.

4. To identify when is the energy consumed in wireless sensor network.
   Energy is consumed mostly while communication, data aggregation and data transmission. In our proposed solution we have used energy formula for calculation of both data aggregation and data transmission. As per [33] technology used for the construction of trans-receiver is one of the main method to reduce energy consumption, While second is path construction phase for sending data: in our proposed solution MEEGA uses natural law (chapter 3 section 2 point iv) for selecting best path or best node for transmission of data from one node to sink node. Thus MEEGA results in low energy consumption and increases life span of wireless sensor network.

5. To use proper resource utilization.
   Use of proper resource allocation is one of the main property of any system. In wireless sensor network use of nodes as per situation is best way to utilize node efficiently as well as energy consumption by those nodes. We use random allocation (chapter 3 section 2 point i) of nodes over an area but eliminates overlap of nodes which results in cover large area with less nodes and thus derives best results.

6. To identify how to increase the life span of Wireless Sensor Network.
   By elimination the factor that affects wireless senor network. Like in our proposed solution MEEGA we eliminate node deployment and routing algorithm. In node deployment MEEGA uses nodes to deploy in such a way that covers large area and eliminate overlapping of nodes. In routing algorithm MEEGA uses proper routing algorithm for path construction phase. These two methods help MEEGA to attain results in term of network lifetime (rounds). Thus increases life span of wireless sensor network.

In chapter 6 results shows better performance of MEEGA as compared to EAPC [25] and BEERAD-E [24]. In case I when we compare our result with respect to EAPC and basic gossip we have use nodes varies from 100 to 300 and done our simulation many time. Figure 5 (a, b, c) shows number of rounds done by each method. Results shows better performance of MEEGA in term of network lifetime (rounds). In figure 6 we compare our result on the basis of first node dead. Results shows better performance as number or rounds done by MEEGA are 778 as compared to EAPC and basic gossip. In case II we compare our result with respect to BEERAD-E and basic gossip. In figure 7 shows number of rounds done by each method. Results shows that MEEGA perform 1045 rounds as compared BEERAD-E and gossip algorithm. In each simulation case we have took number of nodes constant (100). In last figure 8 we compare our result as per first node dead. Results shows that MEEGA perform 767 rounds as compared to BEERAD-E and gossip algorithm. In all results MEEGA shows best results and give better performance in case of energy efficiency as well as resource management.

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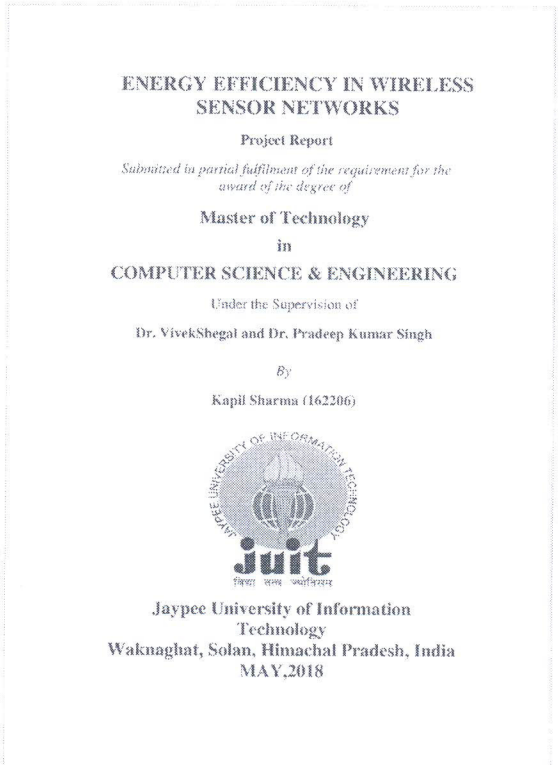

ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORKS

Project Report

Submitted in partial fulfilment of the requirement for the award of the degree of

Master of Technology

in

COMPUTER SCIENCE & ENGINEERING

Under the Supervision of

Dr. VivekShegal and Dr. Pradeep Kumar Singh

By

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