ENERGY EFFICIENT MULTIPATH ROUTING IN WIRELESS SENSOR NETWORKS

Project Report submitted in partial fulfillment of the requirement

for the degree of

Master of Technology

in

Computer Science & Engineering

under the supervision of

Dr. Pradeep Kumar Singh

By

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CERTIFICATE

This is to certify that project report entitled **"Energy Efficient Multipath Routing in Wireless Sensor Networks"**, submitted by **Swedika Sharma** in partial fulfillment for the award of degree of Master of Technology in Computer Science & Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been made under my supervision.

This report has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date: 1.5.2017

Dr. Pradeep Kumar Singh

Assistant Professor (Senior Grade)

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the dissertation entitled **"ENERGY EFFICIENT MULTIPATH ROUTING IN WIRELESS SENSOR NETWORKS"** in partial fulfillment of the requirements for the award of the degree of Master of technology and submitted in Computer Science and Engineering Department, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Swedika Sharma** during a period from July 2016 to May 2017 under the supervision of **Dr. Pradeep Kumar Singh,**

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I have not submitted the matter embodied in this dissertation for the award of any other degree.

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Date:

Swedika Sharma

TABLE OF CONTENTS

ABBREVIATIONS

WSN	Wireless Sensor Network
MATLAB	Matrix Laboratory
CW	Command window
EW	Editor Window
PEGASIS	Power-Efficient Gathering in Sensor Information Systems
RTS	Request-to-send
GA	Greedy Algorithm
CPU	Central Processing Unit
PC	Personal Computer
QoS	Quality of Service
ACK	Acknowledgement
CH	Cluster Head
BS	Base Station

CHR	Cluster Head Relay
ACO	Ant Colony Optimization
PSO	Particle Swarm Optimization

LIST OF FIGURES

ABSTRACT

Wireless Sensor Networks (WSNs) are subject to node failures because of energy constraints. The most important feature of a routing protocol, in order to be efficient for WSNs, is the energy consumption and the extension of the network's lifetime. Sensor webs containing of nodes with restricted battery power and wireless communications are organized to collect beneficial material from the field. Gathering sensed information in an energy efficient manner is dangerous to operate the sensor network for an extensive period of time. In a data collection problematic is defined where, in a round of message, each sensor node has a container to be sent to the unfriendly base station. If each node conveys its sensed data straight to the base station then it will deplete its power speedily. Wireless sensor network is turning into a dynamically imperative and testing investigation territory. Progress in WSN empowers an extensive variety of natural observing and item following framework. Routing is a very important aspect in terms of wireless sensor networks. Routing stands for the sending the required data to the destination in such a manner that it reaches efficiently with high throughput and accuracy. The data is transporting over the network each sensor use some energy in receiving data, sending data. The life of the network is contingent how much energy used up in each transmission. The problem occurs when the transmission path meets with some sort of failure like path failure or node goes to sleep mode. The focus, however, has been given to the routing protocols which might change contingent on the application and network architecture. In this project, we have proposed the state-of-the-art routing technique using PEGASIS protocol to choose an alternative path in WSNs. It forms a chain that makes the path more even-distributed and the total square of transmission distance much less. Moreover, in the constructing process, the energy factor has been taken into explanation, which carries about a balance of energy consumption between nodes. In each round of transmission, according to the current energy of each node, a leader is selected to directly communicate with the base station and the evaluated PEGASIS protocol with greedy algorithm result in terms of parameters such as dead nodes and throughput.

CHAPTER 1

1. INTRODUCTION

1.1 Introduction

An essential comprehension of PC systems is important in order to comprehend the estimations of security of the system. In this area, we will cover a portion of the establishments of computer networking, then move to an overview of mainstream systems. A system has been characterized as any arrangement of interlinking lines looking like a system of streets an interconnected framework, a system of collusions. This implies it suits our motivation well: a PC system is only an arrangement of interconnected PCs. How they are associated is unessential yet there are various approaches. Wireless sensor networks are turning into a dynamic point of research, where sensors are units with detecting, preparing, and remote systems administration capability. They can naturally gather the information and report the amounts to the sink [1]. As of late, numerous wireless sensor systems have been planned and conveyed for various types of uses. WSNs are used as a piece of a broad assortment of potential applications with military, medical coordination and many more. Since sensor nodes are generally battery fueled, monitoring their vitality and drawing out the framework life time are prime objectives while outlining conventions for those systems [2]. There is a less substructure utilized as a piece of WSN. WSN contains of substantial number of nodes which may differ from couple of thousands to get the data from the atmosphere. WSN is really a sort of use situated system which in turn demands the single desire connected with several individual needs to be understood by simply network like it is energy saving, simplify network protocol, flexibility and autonomy. A few applications require that sensor handles can be left unattended for a drawn out stretch of time because of cost suggestions or troublesome access to the sending zone [3]. In this project we present general PEGASIS, modified PEGASIS. We implement PEGASIS (Power-Efficient Gathering in Sensor Information Systems)convention frames a progression of the sensor nodes and the chain is shaped utilizing a greedy approach, beginning from the node most distant to the sink hub. The closest node is sending the data to the neighbor node. This technique is continued until each one of the nodes are consolidated into the chain. This

approach will appropriately the distribute energy uniformly among the sensor nodes in the system. Here beforehand passing the data to the adjoining neighbor information conglomeration happens[4].

1.2 Wireless sensor network and protocol

A system is a group associated with tree that is matched nearby for you to talk all in all. It's truly a media transmission group that enables PCs to change know-how. The specific contacts between nodes are built up abuse frequently wire publicizing or Wi-Fi promoting. The specific known computerized group can be the web and totally unique frameworks talk about resources are accessible inside the group [1].

1.2.1 Wireless sensor network

Talked about resources could be associated with program kind or segments kind. The specific gadgets that kind group to change know-how is alluded to as community nodes. These sorts of nodes will adjust to proprietors simply like pcs, phones, facilitating space in addition while arrange parts. Note pad destinations don't concede to the thought associated with genuine physical publicizing natural exchange their driving forces, the specific correspondence conventions well-known arrange group movement, the specific extents of the group, topology used in the specific group.Communities could be categorized while using:

1. Transmission media based systems simply like wired locales (correspondence happens by methods for wires) in addition to Wi-Fi destinations (correspondence happens remotely).

2. System sizing primarily based sites just like MAN, personal computer community in addition to WAN.
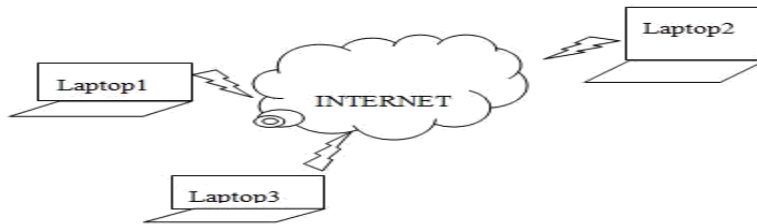
Figure no: 1.2.1 Wireless Sensor Network

Wi-Fi systems administration is an innovation inside which thus three or numerous PCs banter on the whole utilizing exceptionally regular group conventions despite the fact that it is not using string [2]. The transmission happens utilizing the assistance of radio waves at real physical stage. It's otherwise called Wi-Fi or WLAN. The IEEE standard relating to remote system is 802.11.

1.3 Types of Wireless network

Wireless networks can be categorized into two types:

Infrastructure Network

Infrastructure-less Network

1.3.1 Infrastructure Network

Inside business foundation fundamentally based system, communication happens just between the Wi-Fi nodes and furthermore the entry point. The specific correspondence won't right result between the Wi-Fi nodes. The following, access point must be recycled to manage the particular medium entry moreover given it functions while bridge between the Wi-Fi in addition to wired sites. In this system, settled base stations are utilized [6].
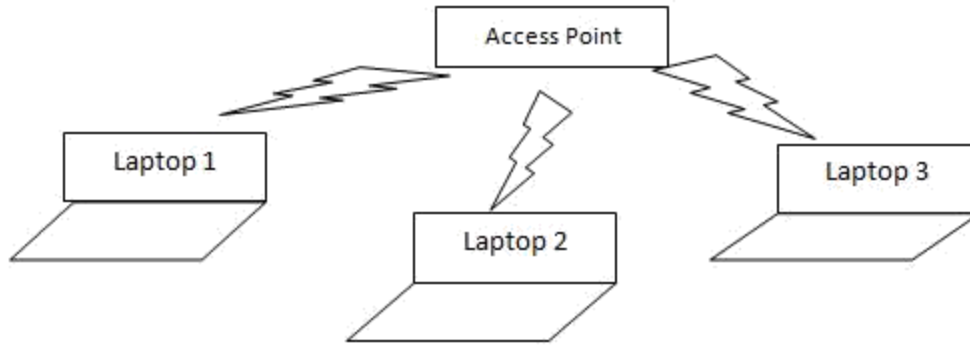
Figure no: 1.3.1 Infrastructure Network

1.3.2 Infrastructure-less Networks

The specific framework less system won't require any sort of business foundation to think. In this group, each node will banter right utilizing particular nodes.Therefore, in this community, not any entry purpose should be applied pertaining to dominating medium entry. In this group, every one of the nodes had got the chance to carry on as switches notwithstanding every one hub are effective at developments and could connect progressively in a lively manner. To help ahead packets between the outside nodes, the center node might be utilized being a router. The specific vital pervasive group under this specific school can be WSN.

Figure no: 1.3.2 Infrastructure-less Network

1.4   Advantages in WSN

The advantages of WSN in various areas are as follows [3]:

1. Energy saving
2. Simplify network protocol [8]
3. Flexibility and autonomy

1.5   Applications of WSN

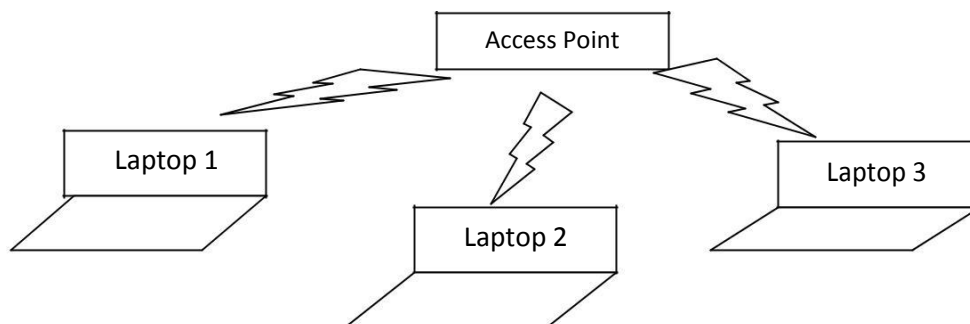WSNs can be utilized for various applications coming to from climate checking to human services and military operations [9].Various uses of wireless sensor networks are:

1. Military Applications [7]
2. Smart Parking
3. Environmental monitoring [10]
4. Medical or health

1.6   Protocols in WSN

Routing protocols in WSN are divided into flat, hierarchical and location based procedureas indicated by the development of the network. In flat routing protocol all the sensor nodes in the framework have same handiness. The purpose of this tradition is not to deal with the framework or keep up the movement, yet to transmit information through skipping and finding the best course to accomplish the objective [11]. This sort of routing is utilized for the most part in level congregations which envelop an enormous number of sensor nodes. It is utilized for finding the best course to achieve the goal. This sort of directing is utilized basically in flat assemblies which incorporate an immense number of sensor nodes.Every node has a separate entry in the routing table. Every nodes in the system are equivalent and carry on in same path in assignment of data assembling and detecting information [12,13]. As worldwide IDS can't be allotted consequently this is an information driven approach in which each node is considered as a potential recipient. In this protocol a hub sends question in a particular area and sits tight for an answer from that region.SPIN (sensor protocol for information and negotiation) is an example of flat

routing protocols. Some other flat routing protocols are Directed Diffusion, Rumor Routing, Gradient Based routing and Information Driven Sensor Query.Ordered routing protocol is used in hierarchical structures like internet. In these protocols distinctive clusters are formed and after that a cluster head is picked relying upon the vitality of the hubs [14]. This protocol is productive in terms of adaptability as it lessens the quantity of passages in the routing table and load on nodes [15].Hierarchical Routing contains two layers. In the main layer gathering head is chosen and in the second layer routing is finished. Hierarchical Routing decreases the utilization of vitality in a group and lessens the transmitted message by information collection [16].

1.6.1 Pegasis Protocol

Illuminated by the possibility of the ant colony algorithm, we propose a routing protocol PEGASIS to develop the chain of PEGASIS. In the building procedure, to pick a hub as the following one on the chain, we make the majority of the present hub's neighbors as candidates and take variables, for example, the remained vitality of the applicant, the measure of consumed vitality.To pick a node as the following one on the chain, we make the greater part of the present hub's neighbors as applicants and we make the majority of the present hub's neighbors as competitors and take variables, for example, the remained vitality of the hopeful, the measure of expended vitality on the off chance that we transmit unit information along the branch between the present node and the applicant and furthermore the amount of pheromone on the branch as a determination standard [17].

PEGASIS is a redirecting method when a chain primarily based method is usually followed. This method employs some sort of greedy approach beginning from the actual furthermost node and each of the sensor nodes form some sort of string just like composition. It functions for the process that many nodes will probably transfer in order to and acquire via it's in close proximity neighborhood nodes. There's a leading light in the string which is in charge of transmitting in the collective facts towards sink node. Nodes take transforms being the best in the network which smoothly allocates the energy load between the nodes. This also do energy sharing and large energy proficiency

contributes to the actual extension in the network life span. It tries to cut back the actual delay the facts acquire on the way towards bottom station. Fig. shows the actual on-line of sensor nodes within PEGASIS method.
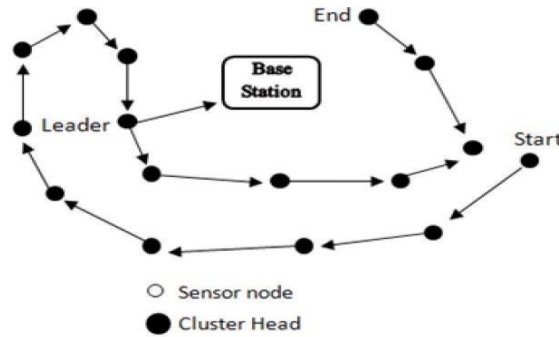
Figure no: 1.6.1(a) Connections between Nodes and Base Station for PEGASIS

PEGASIS is the enhanced convention where just a single is chosen a head node which sends the fused information to the base station per round. It is a nearby perfect chain based convention that is a change over LEACH. In PEGASIS, every node looks at just with an adjoining neighbour and substitutes transmitting to the base station. The key thought in PEGASIS is to layout a chain among the sensor nodes so that every node will get from and transmit to close neighbour.

Steps:

1. Chain Construction: To build the chain we begin from the farthest node from the base station and the n greedy approach is used to construct the chain.
2. Gathering Data: In each round the leader is selected arbitrarily.
3. When the node dies, chain is reconstructed to bypass the dead node.
4. Head hub gets all the melded information and sends to the base station.
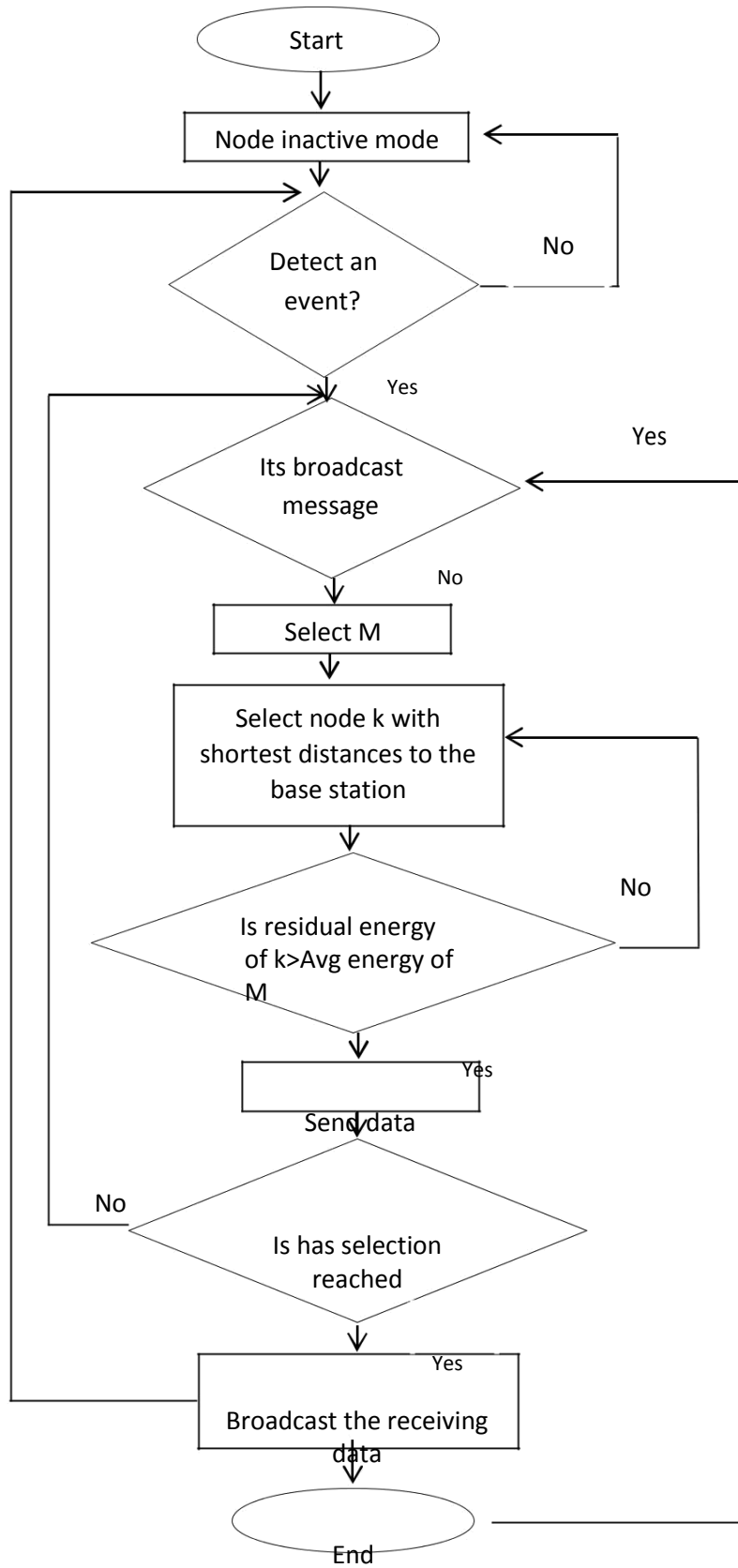
Figure no:1.6.1(b) Pegasis Protocol Simple Flow Chart

1.7 Ant Colony Optimization

Swarm intelligence concentrates the helpful execution of unsophisticated specialists that collaborate locally through their circumstance.It is motivated by social insects, such as ants and termites and bird flocks. Although each different has just constrained abilities, the entire swarm shows complex general conduct. Subsequently, the wise conduct can be viewed as a new recognizing of the swarm. When concentrating on insect states, it can be seen that ants convey just in a circuitous way through their condition by dropping a substance called pheromone. Ways with higher pheromone levels will more probable be favored and along these lines fortified, while the pheromone force of pathways that are not picked is diminished by vanishing. This type of roundabout articulation is known as stigmergy, and offers the ant colony most brief way discovering abilities or the shortest paths. ACO utilizes propagation ants that work together to discover great answers for discrete improvement troubles. These software agents mimic the foraging behavior of their biological complements in finding the most shortest path to the food source.

1.8 Particle Swarm Optimization

Particle swarm optimization is tenants based stochastic advancement method created by Kennedy and Eberhart in 1995. The utilization of PSO calculation is to build up ideal arrangement. In PSO calculation, an ideal arrangement is found from the aggregate conduct of bird flocking. With the point of finding examples that direct the capacity of flying creatures to fly synchronously and to out of the blue change path with a regroup in an ideal development. PSO comprise of gathering of substance called as particles.

PSO comprise of gathering of element called as particles. The particles fly through multi-dimensional scan space searching for best arrangement. The proficient arrangement can be acquired by utilizing normal data of the gathering and all together possess by particles itself. For better standard, every particle changes its velocity time to time in view of its present velocity as for its past best position and furthermore the position of current best particle in the populace. For taking care of the enhancement issues and combinatorial damages, PSO calculation is generally helpful. There are basically two idea of PSO calculation, specifically pbest and gbest. In global best the region for each particle is entire swarm..

CHAPTER 2

LITERATURE SURVEY

In [20], Shaikh et *al.* (2012) described the wireless sensor technology enhances; and an expanding number of associations are utilizing it for an extensive variety of purposes. ZigBee technology was a new standard in wireless personal zone after Bluetooth. ZigBee innovation was another standard in remote individual zone after Bluetooth. After a prologue to this innovation, another remote meter-perusing framework in light of ZigBee convention has developed. This framework, which involved ZigBee arrange and databank administration framework, has numerous vital focal points, for example, minimal effort, low power utilization, and low date rate. Fusion of RFID and Zigbee was also possible which turn out to be boon for wireless sensor network technology. A complete overview of wireless sensor network technology was given in this paper. Wireless sensor network technology was become one of technological basic needs of us.

In [21], Sharma et *al.* (2013) described the Wireless Sensor Networks was an interconnection of a large number of nodes deployed for observing the system for estimation of its structures. Recent research in remote sensor systems prompted different new conventions which are especially intended for sensor systems. To plan these networks, the factors needed to be considered are the coverage area, mobility, power consumption, communication capabilities etc.The survey gives with respect to the engineering undertaking issues, arrangement of conventions. The paper investigates with research issues for the acknowledgment of systems.The survey gives in regards to the engineering endeavor issues, grouping of conventions. The paper investigates with research issues for the acknowledgment of systems

In [22], Hughes et *al.* (2015) described the development of a Wireless Sensor Network and depicted the improvement of a WSN for development commotion recognizable proof and sound finding was researched utilizing the novel use of Bluetooth Low Vitality (BLE). The usefulness of the framework has been shown with information logging examinations and correlations made between the diverse WSN frameworks built up to recognize the relative pay of BLE. Tests utilizing the WSN for vehicle clamor

distinguishing proof and sound area additionally showed the conceivable of the framework. This paper approves the flexibility of a BLE WSNs and the low power utilization that is achievable with BLE gadgets for commotion recognition application.

In [23], Barooah et *al.* **(2012)** described a wireless sensor network can get can get isolated into numerous associated parts because of the disappointment of some of its nodes, which was known as a "cut".In this paper consider the issue of recognizing cuts by whatever is left of the nodes of a wireless sensor and propose an estimation that grants 1) each handle to distinguish when the accessibility to a particularly doled out node has been lost, and 2) one or more hubs (that are related with the remarkable node after the cut) to perceive the occasion of the cut. The algorithm was distributed and asynchronous: each node needs to speak with just those nodes that are inside its correspondence go. The estimation depends on upon the iterative figuring of imaginary "electrical potential" of the nodes. The union rate of the hidden iterative arrangement is free of the size and structure of the framework. Display the sufficiency of the proposed count through a honest to goodness hardware use.

In [24], Khan et *al.* **(2015)** discussedabout the basically survey the best in class and propose a novel engineering for WSN virtualization. The proposed architecture was four layers (physical layer, virtual sensor layer, virtual sensor access layer & overlay layer) and depends on application protocol (CoAP) and represented its potential by utilizing it in a situation where a solitary WSN was shared by various applications; one of which was a fire observing application. Introduce the confirmation of-idea model and worked alongside the execution estimations, and talk about future research bearings.

In [25], Gao et *al.* **(2016)** defined the current wireless sensor networks (WSNs) are ending up plainly progressively complex with the developing system scale and the dynamic way of remote correspondences. Numerous estimation and analytic strategies rely on upon per-parcel directing ways for exact and fine-grained investigation of the mind boggling system conduct and proposed iPath, a novel way induction way to deal with remakinga novel path inference approach to reconstructing the per-packet routing tracks in dynamic and large-scale networks. The essential thought of iPath was to adventure high way comparability to iteratively gather long ways from short ones. IPath

begins with an underlying known arrangement of tracks and performs way derivation iteratively. IPath incorporates a novel plan of a lightweight hash work for check of the surmised ways.

In [26], Kaushal et *al.* **(2014)** provided a review on ZigBee technology. Firstly it gives a prologue to the ZigBee innovation then the qualities of ZigBee. After that there was a prologue to ZigBee alliance. At that point are the get to strategies, gadgets and topologies upheld by ZigBee. The most key some portion of this paper contains of the convention engineering of ZigBee and in the last subdivision there is different use of ZigBee innovation.

In [27], Lakote et *al.* **(2016)** described the Design of Wireless Remote Control for Electric Overhead Travelling Crane was proposed. This framework was a keen for control Electric Overhead Voyaging Crane utilizing Remote. Proposed framework planned in view of Microcontroller 89S52 Processor with Zigbee, Control Switch and Transfers. An89S52 Processor framework can be utilized for differing modern applications required with an ongoing remote control. The crane can be controlled by utilizing remote comprising two unique segments in particular Transmitting segment and Receiving section, the transmitting section consisting PIC microcontroller (Peripheral Interface Controller) and the receiving section consisting AT89S52 microcontroller comes under crane side. The Zigbee was utilized as Remote Connection amongst transmitter and collector circuit. Wireless Remote comprises of different switches utilized for different movement of crane like forward-reverse movement, left-right movement, up-down movement and magnetizing and demagnetizing the electromagnet coil.

In [28], Ahmad et *al.* **(2011)** portrayed the Wireless Ad hoc sensor nodes are having a fundamental influence in wirelesstransmission framework. In view of its negligible size and vitality effective structure these knots can efficiently transmit the disaster related sensed data sent.

In this examination think about, they proposed a model for the disaster survivor detection based on extremely critical disaster situation where this energy efficient architecture can effectively trace and locate thousands of people in critical circumstances.

In [29], Kadi et *al.* **(2013)** described the Wireless sensor networks (WSNs) basically used in military applications because of its conviction and proficiency. These days, it is thought to be the direct in numerous regular civilian applications, for example, leakage discovery. Various technical issues, like power consumption and sensors need to be considered for different types of applications. WSN has risen of late as a viable answer for fluid leakage. Paper described four different solutions for leaks in pipelines using wireless sensor networks (WSNs). The WSN-based solutions are magnetic induction depend continuous pressure checking, underground to above ground radio broadcast and wireless signal networks (WSiN).

In [30], Kaur et *al.* **(2015)** described that in WSNs energy was a scarcest asset of sensor nodes and it decides the lifetime of sensor nodes. These are battery controlled sensor nodes. These little batteries were restricted power and furthermore may not effortlessly rechargeable or removable. Long correspondence remove in the midst of sensors and a sink can incredibly deplete the vitality of sensors and decrease the lifetime of a system.In WSNs, vitality is a noteworthy variable to be considered. Different strategies are utilized to improve vitality level of sensor nodes of WSN. Diverse frameworks are used to enhance imperativeness level of sensor center points of WSN. Also, make a survey of some of these remote sensor organize strategies which are utilized as of late and are useful in enhancing vitality proficiency of wireless sensor knots.

In [31], Gilbert et *al.* **(2012)** described the Wireless Sensor Networks whichincorporates military, human services, conservational, organic, home and other beneficial applications. With the enormous progress in the field of installed PC and sensor innovation, WSN was made out of two or three an extensive quantities of sensor hubs which are prepared for recognizing, detecting and transferring the gathered data which have momentous effect all over the place. This paper displays an outline of the distinctive research issues in WSN based application.

In [32], Gill et *al.* (2015) defined that the generalexamination of the ZigBee as a wireless sensor network depend technology which provides the pursuers with the general outline of ZigBee system innovationincluding its topology, applications and challenges.

CHAPTER 3

PROBLEM DESCRIPTION

Energy efficiency is the most compulsory quality in a sensor network where each node devours some energy with each transmission over the network. Energy consumption is one of the most important and vital factors determining the achievement of the deployment of sensors and wireless sensor networks due to many simple constraints, such as the size of sensors, the unreachability of a power source, and isolation of the location, which avoids further handling of sensor devices once they are deployed. Endeavors have been made to diminish the energy utilization of wireless sensor networks and increment their helpful lifetime utilizing different techniques at various levels. A few systems objective is to limit the energy utilization of the sensor themselves at its working level, some's goal is to diminish the vitality spent in the info or yield operations at the information transmission level and others target is the development of sensor systems regarding their topology and associated routing mechanisms. The common objective here is to minimize the energy consumption of some mechanisms of the application as much as possible by dropping the tasks that have to be achieved by the sensors and the associated networks, yet still fulfill the goal of the planned application.

In addition to the minimization effort, some approaches have tried to replace the energy capacity of the sensors by construction into them components and mechanisms for collecting additional energy from available energy sources within their environments, such as solar, thermal, or wind power sources.

In this proposed work, we study the various routing techniques and swarm intelligence i.e. implement the hybrid approach using pegasis protocol and particle swarm optimization approach, to reduce the energy consumption, packet loss and enhance throughput and reduce the intruder effect with the help of swarm intelligence.

CHAPTER 4

PROPOSED SOLUTION

Main objectives of this thesis work are summarized as follows:

a) To study and evaluate the various routing protocols.

b) To implement a wireless sensor network over MATLAB 2013 in Pegasis protocol.

c) To design and implement a new fitness function of hybrid approach with PEGASIS and PSO based on the link discovery mechanism over the network.

d) To analyze the performance of proposed algorithm with existing algorithm based on various parameters like packet loss, throughput and energy consumption.

CHAPTER 5

METHODOLOGY

```
                    ┌──────────────┐
                    │    Start     │
                    └──────┬───────┘
                           ▼
        ┌──────────────────────────────────────┐
        │        Design the WSN Network         │
        └──────────────────┬───────────────────┘
                           ▼
    ┌──────────────────────────────────────────────┐
    │  Sensor/ Node deployment for the node in WRS  │
    └──────────────────────┬───────────────────────┘
                           ▼
    ┌──────────────────────────────────────────────┐
    │  Search the source and Destination node in WSN │
    └──────────────────────┬───────────────────────┘
                           ▼
    ┌──────────────────────────────────────────────┐
    │  Implementation the routing Protocols in Pegasis │
    └──────────────────────┬───────────────────────┘
                           ▼
    ┌──────────────────────────────────────────────┐
    │  Scenario Generation to carry out the distance │
    │       of the route to Main head (HEADER)       │
    └──────────────────────┬───────────────────────┘
                           ▼
    ┌──────────────────────────────────────────────┐
    │ Calculate the performance parameters with the  │
    │              help of Protocols                 │
    └──────────────────────┬───────────────────────┘
                           ▼
    ┌──────────────────────────────────────────────┐
    │  Apply proposed algorithms i.e. ACO , PSO and  │
    │  HYBRID to further reduce distance and for     │
    │       broadcast and safe communication         │
    └──────────────────────┬───────────────────────┘
                           ▼
    ┌──────────────────────────────────────────────┐
    │ Calculate the proposed results and comparison  │
    │  for the defined parameters i.e. Energy and    │
    │           Delay /Throughput etc.               │
    └──────────────────────┬───────────────────────┘
                           ▼
                    ┌──────────────┐
                    │     Stop     │
                    └──────────────┘
```

CHAPTER 6

IMPLEMENTATION AND EXPERIMENT

6.1 SimulationTool

The ensuing Improvement Apparatuses has been utilized as a part of the development of this work. There might be different devices which can be utilized as a part of this improvement as it depends individual to individual and his advantage. Hence the tools used are:

1.Minimum of 3 GB RAM

2.Intel Pentium III Processor or over

3.MATLAB R2010a

Table 6.1 Tool used

Computer	Core 2 Duo or higher
RAM	4 MB
Platform	Windows7,8,10
Other hardware	Keyboard, mouse
Software	Matlab 2013a

6.2 What is MATLAB?

The expansion of MATLAB is MATRIX LABORATORY. These issues fabricate MATLAB an estimable instrument for instructing and research.

1. MATLAB is contrasted with preservationist coding languages (e.g., C, FORTRAN) for taking care of modern issues.

2. MATLAB is an intuitive framework whose straightforward information component is a cluster that does not require dimensioning.

3. The product bundle has been industrially realistic since 1984 and is presently measured as a model apparatus at almost all colleges and industries around the world.

4. It has telling inherent schedules that empower a wide assortment of calculation. It additionally has simple outiline design guidelines that make the fantasy of result potentially useful.

6.3 Advantages of MATLAB

- It gives a major database of inherent calculations for picture preparing.

- It permits testing calculations instantly without recompilation.

- Ability to prepare both still pictures and recordings.

- Ease of utilization of tool makes it less demanding for new clients.

6.4 Strength of MATLAB

- Used for estimation and representation plotting.

- The fault is easy when performing   operations.

- Contains few OOPs ideas and terminologies.

6.5 Experiment and Implementation

In this section, we have discussed the results:

WIRELESS SENSOR NETWORK
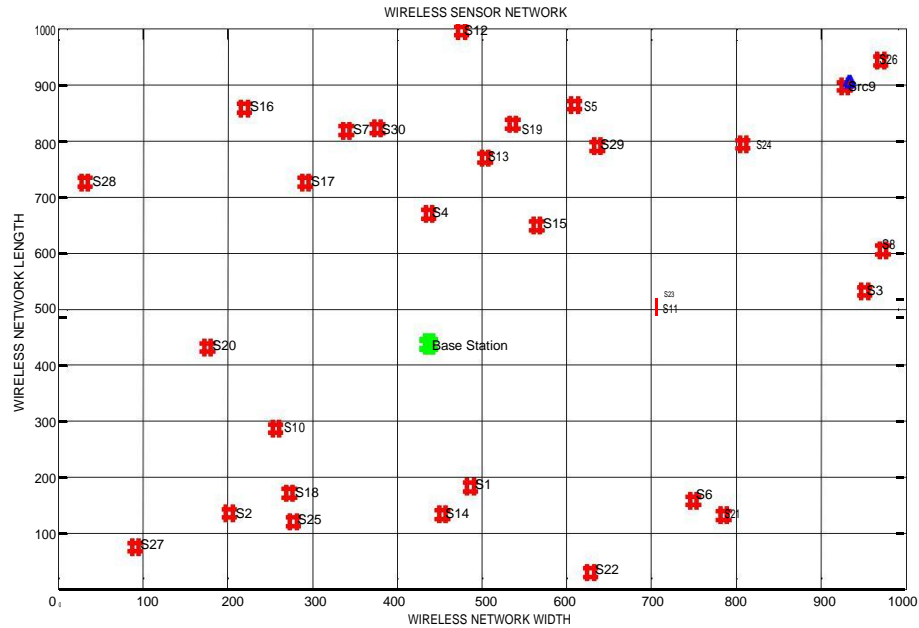
Figure no: 6.5.1 Wireless Sensor Network

Above figure shows the network simulation model containing 25 nodes. Length vs breadth of the network, the channel captures the routing information from source node and then sends the data from the source to destination node. The red color squares represents the nodes which can be either sensor node or one base station node means main head of the wireless sensor network. The whole network has been simulated in 1000*1000.
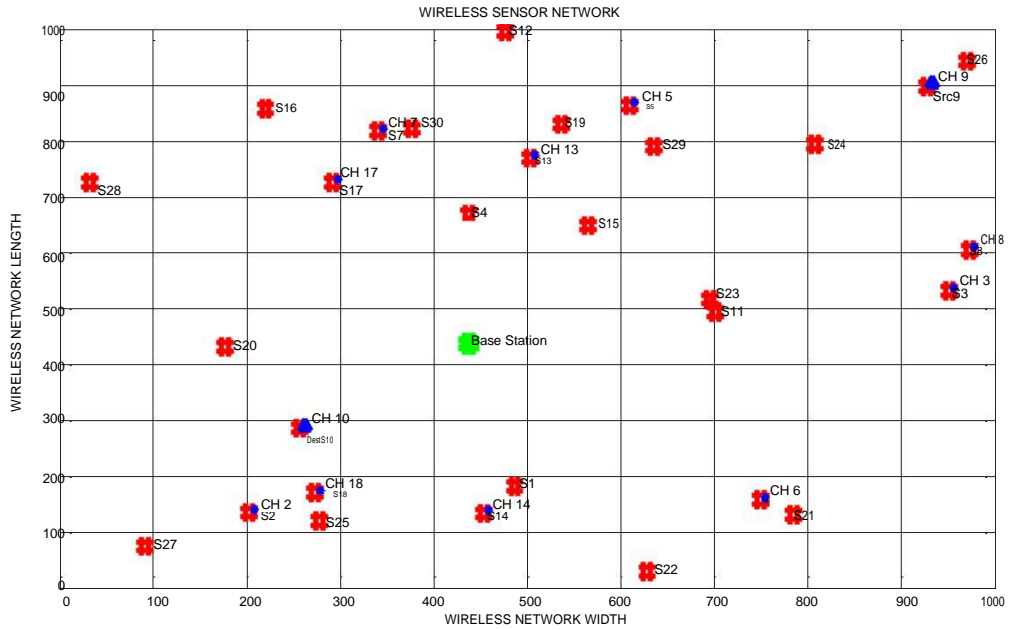
Figure no: 6.5.2 Deploy cluster heads

The above figure shows the cluster heads which are implemented using the Pegasis protocol with greedy algorithm. First it creates or deploys the cluster head nodes in the wireless sensor network.
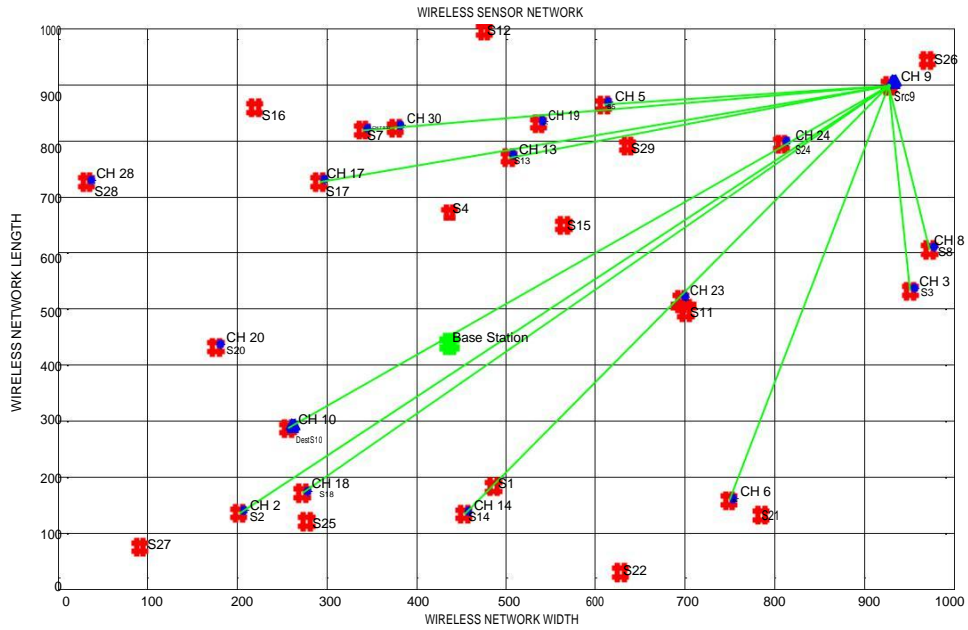
Figure no: 6.5.3 Sent data through CH Head

The above figure shows the CH sent the data / information to the other intermediate cluster head. We deploy the main base station which is known as main head of the network. The data is sent through the cluster head and connect the one node to another cluster head node.
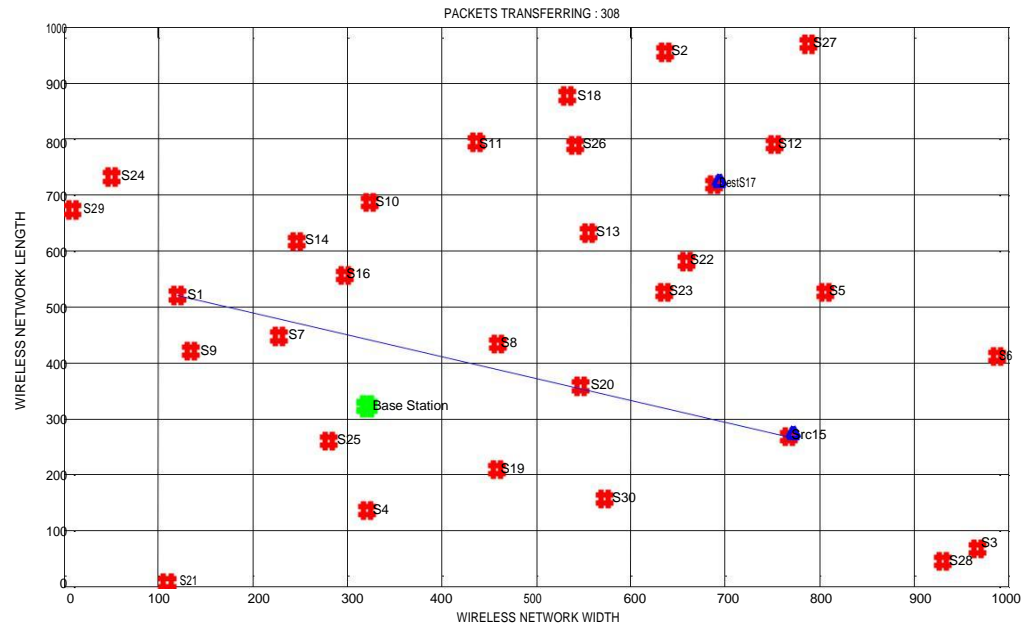
Figure no: 6.5.4 Sent information Source to Destination

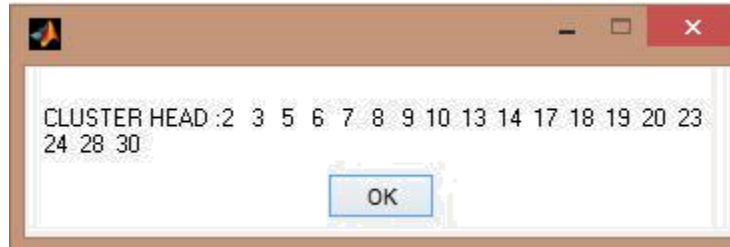The above figure shows the source and destination of the sensor network nodes.

Figure no: 6.5.5 Data Transmission

The above shows the data transmission is possible from one node to another node through the intermediate node. In above figure 1000 * 1000 network deployment has been done. This figure comes after entering the values for network nodes, length and width of the network. With the help of greedy algorithm algorithm the chain is created for the secure data transmit. But in between the data will be transferred to the base station and with the more energy, the nodes will fail.

Figure no: 6.5.6 Cluster head

The message box defined that the cluster head nodes.

Figure no: 6.5.7 Packet received

The message box shows the data transfer start from the source node and finally send it to the destination nodes. This message defines that the packet are received from destination.
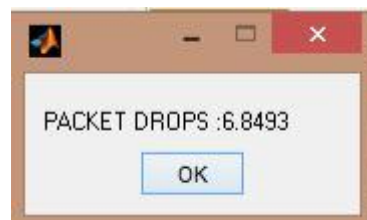

Figure no: 6.5.8 Packet Drop

The above message box shows that the packet drop value is 6.8 bit. Packet drop means problem will occur in chain data for the sent information to the base station. Network load occur and high energy is consumed and packet drop takes place.
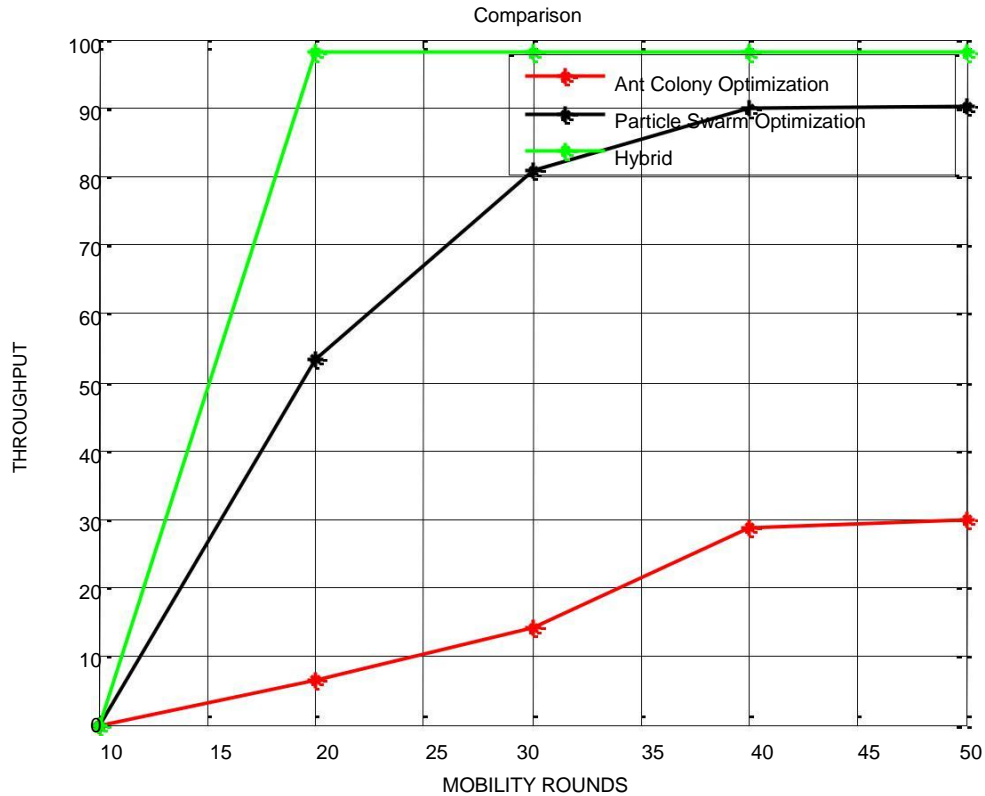
.

Figure no. 6.5.9 Comparison between throughput (ACO,PSO and HYBRID)

The above figure defines the comparison between Hybrid, ant colony optimization and PSO in throughput (Hybrid, Pegasis protocol and PSO) is chain based and optimize the chain approach. Throughput achieved is 98% value in HYBRID, using ACO algorithm for problem resolving the value is 90% and using PSO algorithm throughput value is 30%.
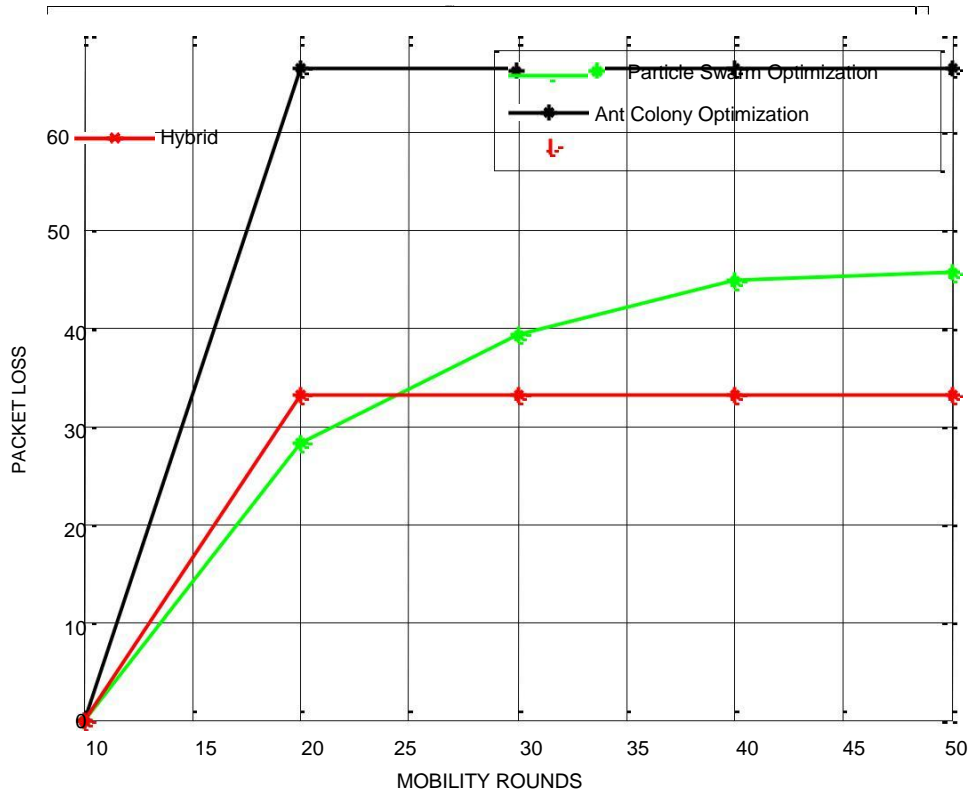
Figure no. 6.5.10 Comparison between packet loss (ACO and PSO and Hybrid)

The above figure defines that the comparison between Hybrid, ACO and PSO. Packet loss achieved in Hybrid is 35(bits) value, the value is improved using ACO algorithm and the value achieved is 65(bits) and packet loss using PSO value is 45(bits).
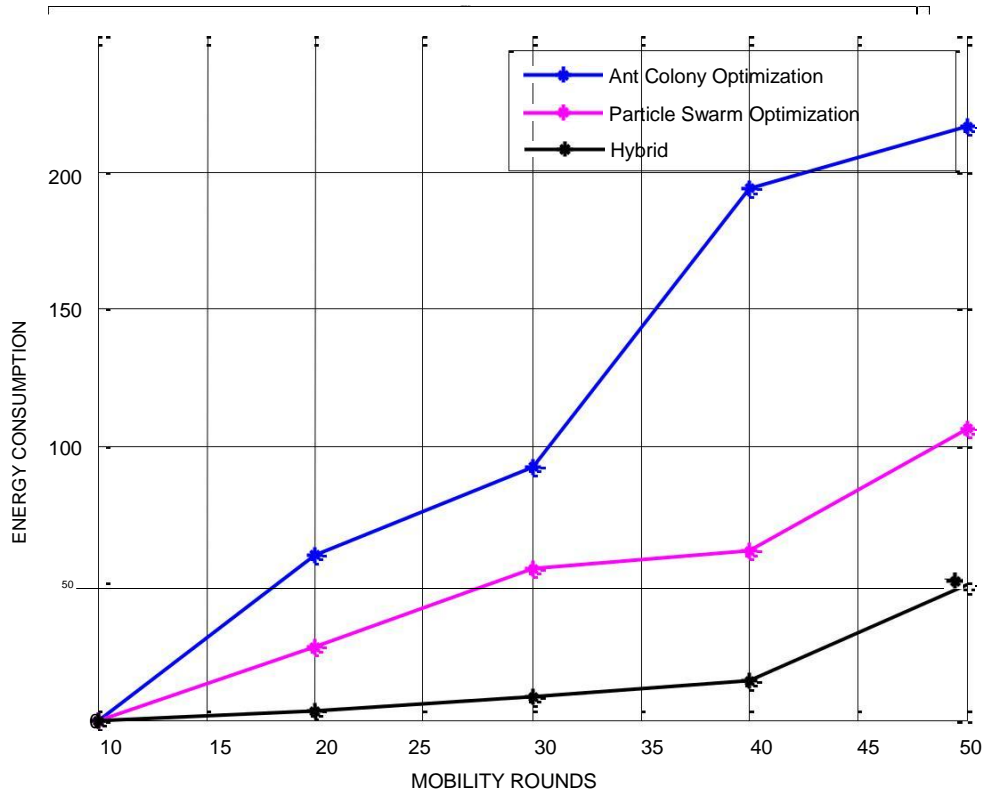
Figure no. 6.5.11 Comparison between Energy Consumption (ACO, PSO and Hybrid)

The above figure defines the comparison between Hybrid, ant colony optimization algorithm and PSO algorithm in energy consumption. In Hybrid protocol, the value achieved is 50 joules, after the implementation of the ant colony optimization algorithm the value achieved is 225 joules and with PSO algorithm energy value is 105 joules.

CHAPTER 7

CONCLUSION

Recently, upgrades in wireless communication and digital electronics have prompted the improvement of Wireless Sensor Networks. WSN has been connected in many fields, for example, military investigation, medicinal treatment and industry management. Be that as it may, it has numerous confinements, for example, restricted vitality supply and compelled calculation. Accordingly, how to extend the system lifetime is an imperative and testing issue, which is additionally the concentration of outlining the WSN routing protocol. Many routing protocols have been planned for WSN. The chain based routing is one of the viable strategies to enhance the limit of system and efficiency of sources under overwhelming activity conditions. The vitality proficiency is an essential issue for the systems particularly for WSNs which are described by constrained battery abilities. Along these lines, we focus on the vitality effective protocols that have been created for WSNs.We have implemented a routing protocol using ant colony and Particle Swarm optimization algorithm to build the chain of the Pegasis protocol. We discussed the protocol in detail, and through the simulation tool in MATLAB 2013. The performance of hybrid algorithm till now is better and compared with the original PEGASIS which uses the greedy algorithm to build the chain is validated. The mentioned comparison is to understand the existing solutions and also design a robust energy efficient routing for WSN and satisfy other parameters like throughput, packet loss and energy consumption.

CHAPTER 8

FUTURE SCOPE

For future degree, more than one advanced routing protocol systems can be actualized to further enhance the convention. More number of parameters can be centered than utilized as a part of this thesis. In future scope, we can implement the enhance particle swarm optimization algorithm to minimize the square sum of transmission distance and consider energy parameter in both chain designing and main head selection to further pro-long the lifetime of WSN.

REFERENCES

[1] S.K. Singh, M.P. Singh and D.K. Singh, "A Survey of Energy-Efficient Hierarchical Cluster-Based Routing in Wireless Sensor Networks," *International Journal of Advanced Networking and Applications*, vol. 2, no. 2, pp. 570-580, 2010.

[2] P. Huang and M. Patricia, "The evolution of MAC protocols in wireless sensor networks: A survey," *IEEE Communications Surveys & Tutorials*, pp. 101-120, 2013.

[3] R. Pazzi and B. Hamdaoui, "E-TRAIL: Energy-efficient trail-based data dissemination protocol for wireless sensor networks with mobile sinks," *IEEE ICC*, 2011.

[4] H.Y. Shwe and F. Adachi, "Power Efficient Adaptive Network Coding in Wireless Sensor Networks," *IEEE ICC*, 2011.

[5] S. Bandyopadhyay and E.J. Coyle, "An Energy Efficient Hierarchical Clustering Algorithm for Wireless Sensor Networks," *IEEE,* pp. 440-489, 2003.

[6] M. Kumar, K. Pandey and M. Sharma, "Survey on wireless sensor networks using MAC protocol," IEEE, 2014.

[7] C. Intanagonwiwat, R. Govindan, D. Estrin, J. Heideman and F. Silva, "Directed Diffusion for Wireless Sensor Networking," *IEEE TRANSACTIONS ON NETWORKING*, vol. 11, no. 1, 2003.

[8] L. Wang and Y. Xiao, "A survey of energy-efficient scheduling mechanisms in sensor networks," *IEEE TRANSACTIONS ON NETWORKING*, pp. 723-740, 2006.

[9] F. Akyildiz, Y. Sankarasubramaniam and E. Cayirci, "Wireless device systems: a survey," *Elsevier*, 38(4), pp. 393-422, 2002.

[10] J. Luo and P. Hubaux, "Joint mobility or steering for lifetime elongation in wireless device systems," *IEEE INFOCOM* , pp. 1735-1746, 2005.

[11] M.S.Gunjal and S.A. Shaikh, "Study of Network Coding Based Multipath Routing Protocol for Multicast Network," *International Journal of Computer Science and Information Technologies*, vol. 5, no. 4, pp.5141-5144, 2014.

[12] S. Shenker, D. Estrin, D. Ganesan and R. Govindan, "Highly-Resilient, Energy-Efficient Multipath Routing in Wireless Sensor Networks," *ACM*, 2001.

[13] A. Ghaffari and S. Babazadeh, "Multi-Path Routing Based on Network Coding in Wireless Sensor Networks," *World Applied Sciences Journal*, vol. 21, no. 11, pp. 1657-1663, 2013.

[14] J. Widmer and J.L. Boudec, "Network Coding for Efficient Communication in Extreme Networks," *ACM*, 2005.

[15] D.Wei, Y. Jin, S. Vural and K. Moessner, "An Energy-Efficient Clustering Solution for Wireless Sensor Networks," *IEEE*, vol. 10, no. 11, 2011.

[16] M.C. Thein and T. Thein, "An Energy Efficient Cluster-Head Selection for Wireless Sensor Networks," *IEEE ICC*, 2010.

[17] Muruganathan, S.D., Daniel, Bhasin, R. and Fapojuwo, A, "A Centralized Energy-Efficient Routing Protocol for Wireless Sensor Networks," *IEEE* GLOBECOM, 2014.

[18] B. Yahya and J.B. Othman, "RELAX: An Energy Efficient Multipath Routing Protocol for Wireless Sensor Networks," *IEEE ICC*, 2010.

[19] R. Vidhyapriya and P.T. Vanathi, "Energy Efficient Adaptive Multipath Routing for Wireless Sensor Networks," *IAENG International Journal of Computer Science,* 2007.

[20] S. Shenker, D. Estrin, D. Ganesan and R. Govindan, "Highly-Resilient, Energy-Efficient Multipath Routing in Wireless Sensor Networks," *ACM*, 2012.

[21] S. Mittal, S. Sharma and R. Sharma, "Wireless Sensor Networks: Architecture, Protocols," *IEEE COMMUNICATIONS,* 2013.

[22] J. Hughes and K. Soga, "Development of wireless sensor network using bluetooth low energy (BLE) for construction noise monitoring*," International Journal on Smart Sensing and Intelligent Systems*, pp. 1379-1405, 2015.

[23] P. Barooah, H. Chenji and R. Stoleru, "Cut detection in wireless sensor networks," *IEEE Transactions on Parallel and Distributed Systems*, vol. 23, no. 3, pp. 483-490, 2012.

[24] I. Khan, F. Belqasmi, R. Glitho, N. Crespi, M. Morrow and P. Polakos, "Wireless Sensor Network virtualization: Early architecture and research perspectives," *IEEE Network*s, pp. 104-112, 2015.

[25] Y. Gao, W. Dong, C. Chen and J. Bugh, "iPath: Path inference in wireless sensor networks." *IEEE Transactions on Networking*, vol. 24, no. 1, pp. 517-528, 2016.

[26] K. Kaushal, T. Kaur and J. Kaur, "ZigBee based wireless sensor networks." *International Journal of Computer Science and Information Technologies*, vol. 5, no. 6, pp. 7752-7755, 2014.

[27] A. Lakote, D. Dharmik and B. Dani, "Wireless Remote Control for Electric Overhead Travelling Crane," *Journal of Network Communications and Emerging Technologies*, vol. 6, no. 3, 2016.

[28] N. Ahmad, N. Riaz and M. Hussain, "Ad hoc wireless sensor network architecture for disaster survivor detection," *International Journal of Advanced Science and Technology*, pp. 9-16, 2011.

[29] Tariq, A. Kadi L. Abdullah, "Wireless sensor networks for leakage detection in underground pipelines: a survey paper," *Procedia Computer Science*, pp. 491-498, 2013.

[30] K. Kaur and S. Waraich, "Energy Efficient Wireless Sensor Networks based on Clustering Techniques," *International Journal of Computer Applications*, vol. 11, no. 119, 2015.

[31] E. Gilbert, P. Kumar, B. Kaliaperumal and E. Rajsingh, "Research Issues in Wireless Sensor Network Applications: A Survey," *International Journal of Information and Electronics Engineering*, vol. 2, no. 5, 2012.

[32] G. Omojokun and B. Kaliaperumal, "A Survey of ZigBee Wireless Sensor Network Technology: Topology, Applications and Challenges," *International Journal of Computer Applications*, pp. 47-55, 2015.