Energy Efficient Wireless Sensor Network based on Cuckoo Search Optimization

Dissertation

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By

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(April, 2015)

CERTIFICATE

This is to certify that the Dissertation titled "Energy Efficient Wireless Sensor Network based on Cuckoo Search Optimization" that is being submitted by "**Harmanjit Kaur**" in partial fulfillment of the requirements for the award of MASTER OF TECHNOLOGY, is a record of bonafide work done under my guidance. The contents of this Dissertation, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.

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LPU, Punjab.

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Examiner I

Examiner II

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Place: LPU, Jalandhar — Harmanjit Kaur

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This is to certify that Harmanjit Kaur bearing Registration no. 11306615 has completed objective formulation of thesis titled, "**Energy Efficient Wireless Sensor Network based on Cuckoo Search Optimization"** under my guidance and supervision. To the best of my knowledge, the present work is the result of his original investigation and study. No part of the thesis has ever been submitted for any other degree at any University.

The thesis is fit for submission and the partial fulfillment of the conditions for the award of Degree of **Master of Technology** in **Electronics & Communication Engineering**.

Signature of Advisor:
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Date:

DECLARATION

I, **Harmanjit Kaur**, student of **Master of Technology** under Department of Electronics and Communication Engineering of Lovely Professional University, Punjab, hereby declare that all the information furnished in this Dissertation report is based on my own intensive research and is genuine.

This thesis does not, to the best of my knowledge, contain part of my work which has been submitted for the award of my degree either of this university or any other university without proper citation.

Date: **Harmanjit Kaur**

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ABSTRACT

A wireless sensor network consists from number of nodes to form a large network. Environment conditions like temperature, humidity, pressure, direction, sound etc are measured by WSN. Wireless sensor network consists from hundreds or thousands of nodes, these sensor nodes sense the environment and communicate with each other or external base station. Routing protocol communicates with whole network paths and from all network paths chooses the best path to reach to destination. To secure WSN from several attacks (TARF) Trust aware secure routing framework is designed & implemented. Main goal of trust aware secure routing protocol is to provide high throughput which tells how efficiently there is delivery & collection of data. It provides an energy efficient and trustworthy route. PEGASIS protocol is used to enhancing the energy efficiency with the collaboration of cuckoo search optimization technique. These two collaborate with each other improving the number of alive nodes in a network for improving the network life & also improving the energy efficiency of the network. This research will particularly focus on providing a cuckoo search approach which increases the energy efficiency. Towards the end the results parameters such as number of alive nodes and energy efficiency of both have been compared. MATLAB is proposed to be used as simulation tool to simulate results.

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CHAPTER 1: INTRODUCTION

1.1 Wireless sensor network

Wireless sensor network (WSN) consist from number of sensor nodes to form a large network. Environment conditions like sound, temperature, pressure, direction, speed etc are measured by WSN. Wireless sensor networks consist from hundreds or thousands of sensor nodes. These sensor nodes sense nodes sense the environment & communicate with each other or an external base station.

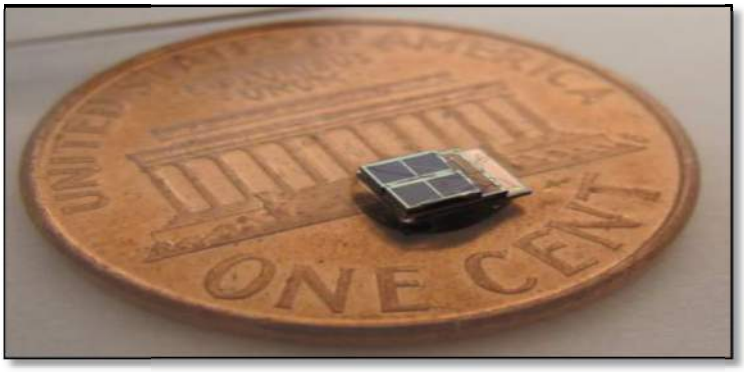

Fig 1.1 Sensor node

The size of the sensor node may vary from a tiny dust particle to the size of a shoe box; but smaller the size of the node, more efficient is the wireless sensor network. Deployment of the sensor nodes becomes easier if the size of node is smaller. Smaller the size of the node, lesser is the cost. Main advantage of sensor networks is that fewer nodes can be deployed with low network maintenance as well as lower cost.

The design constraints taken into account are low bandwidth, short communication range, limited amount of energy and limited processing and storage in particular sensor node. Sensor nodes are equipped with the power batteries and are deployed in harsh environments. These batteries are usually rechargeable.

Efficient working of a sensor node depends upon its lifetime as well. Lifetime of a node is depending upon collision, control packet overhead and idle listening. Lifetime of a node can be increased by using energy efficient routing. Data redundancy is also main objective in wireless sensor networks. As the sensor nodes are densely deployed in same area, so the multiple sensor nodes senses the redundant data. To avoid this, data redundancy is taken into account.

Wireless sensor network structure:

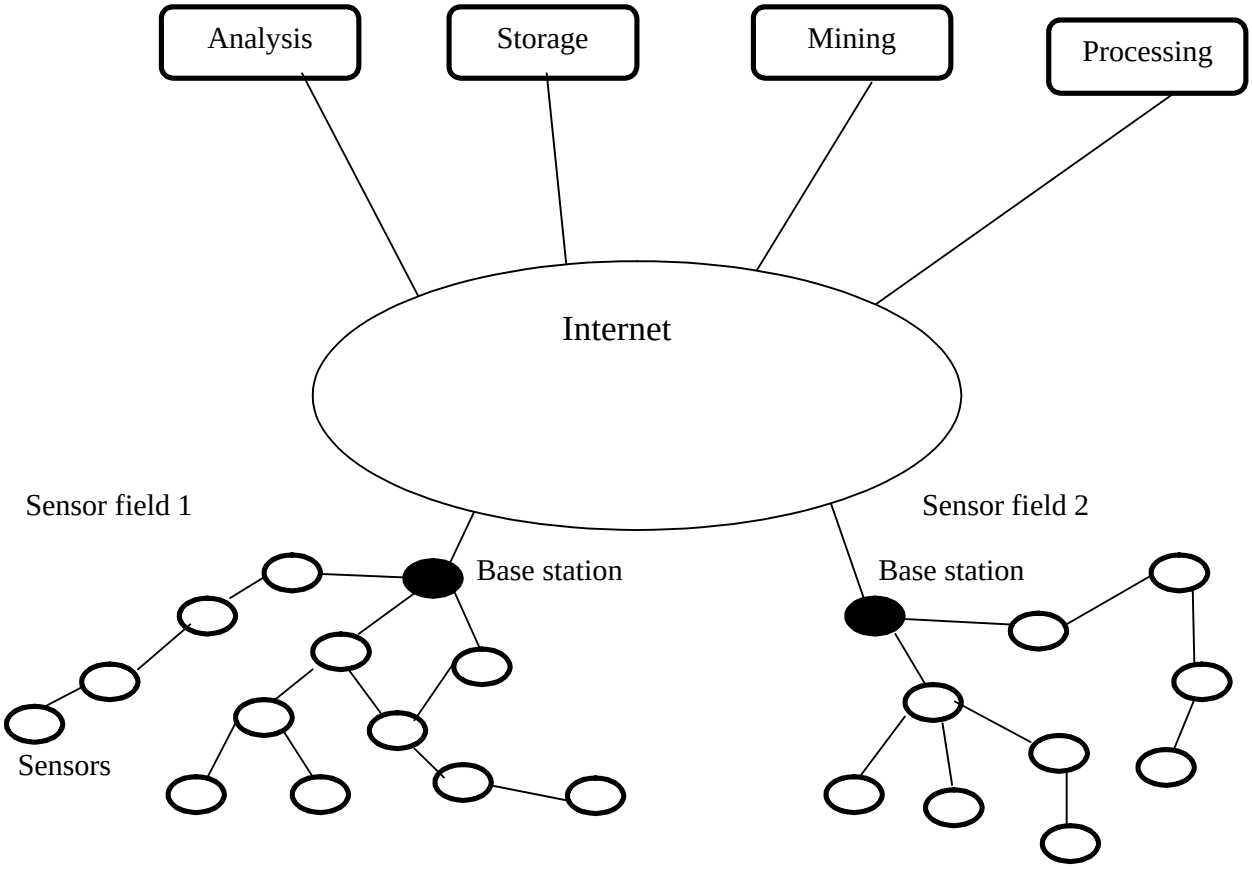

Fig 1.2 Wireless sensor network

Wireless sensor networks are bi-directional and also enabling control of sensor activity. Wireless sensor network consist from very low power wireless sensors and does not have fixed infrastructure network. Power efficiency is accomplished with low duty cycle in WSN. The progression of WSN initially motivated by the military applications. Now a day, WSN are also used in civilian applications. There are two types of WSN: Structural and unstructured. The collection of sensor nodes in a dense manner is referred as unstructured WSN. In an unstructured WSN, the maintenance of network, detection of network failure and managing connectivity is difficult. In structured WSN sensor nodes are deployed with pre-planned manner. The advantage of this is that the maintenance and management of network is easy and cost is low.

1.2 SENSOR NODE ARCHITECTURE

A sensor network node has several parts i.e. a radio transceiver, microcontroller, power supply, one or more sensors or external memory.

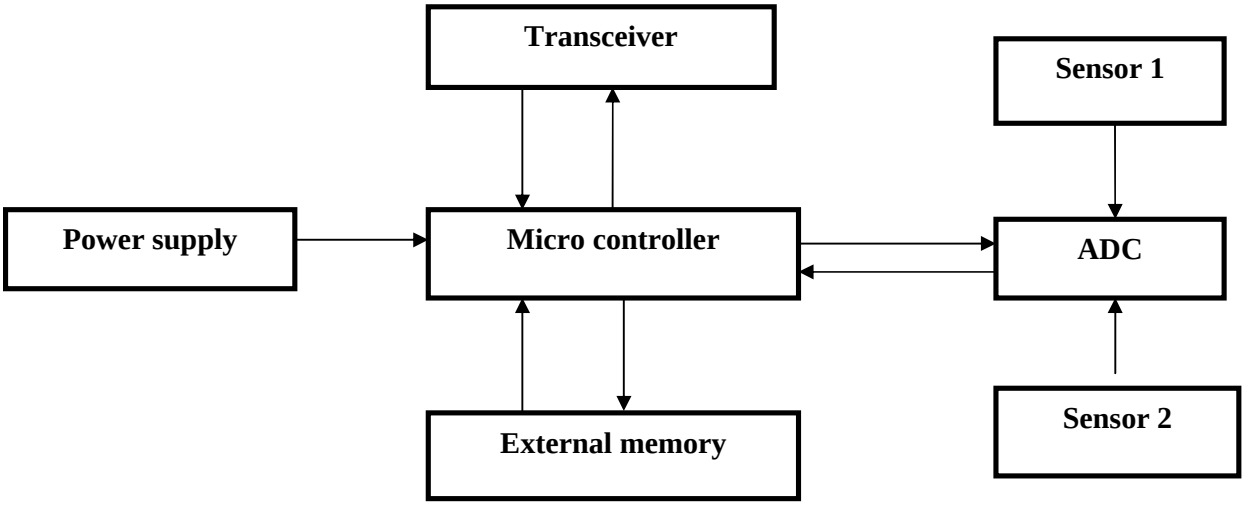

Fig 1.3 Sensor node architecture

Controller- Controller performs the tasks to control the functionality of other components in the sensor node and processes data. Microcontroller is most commonly used; other's can be used as a controller is ASIC's, field programmable gate array, digital signal processors. Microcontroller is generally used because these has the ability of low power consumption, low cost, programming is easy and flexibility to connect other devices. On the other side a microprocessor has power consumption rate high than microcontroller.

External memory- Most suitable memories are on chip memory and off-chip flash memory of a microcontroller. Flash memories have high storage capacity and low cost. Memory requirement are also dependent upon applications. Based on the storage purpose memory are categorized as: user memory- This type of memory is used for storing own data. Program memory - This is used for programming the device

Transceiver- Transceiver is a device which works as both the transmitter and receiver. Sensor nodes give us global availability and free radio spectrum allocation by use of ISM band. Wireless transmission is done under the media of infrared, optical communication

and radio frequency. License free communication frequencies used by WSN are 173MHZ, 433MHZ, 868MHZ, 915MHZ & 2.4GHZ. Lasers required line of sight for communication and less energy required but they are sensitive to environmental conditions.

Sensors- Sensors are those devices which produce a measurable response to change in physical conditions like pressure, temperature. Sensor nodes consumes low energy, operate in high volumetric densities and small in size. Sensors are further classified into three types: active sensor, passive Omni directional sensors and narrow beam sensors.Passive sensor senses the data without actually manipulating the environment by active probing. They are self-powered i.e. external energy is needed only to amplify their analog signal. Active sensor a probe the environment actively for e.g. radar sensor requires a continuous energy for power source.

Power supply- Power supply is an electronic circuit. For sensing, communicating & data processes sensor nodes consumes its power. Energy requirement is high for data communication. Main source of power supply are batteries, which are further divided into two types primary battery & secondary battery. Primary batteries are also called as non-rechargeable batteries. Secondary batteries are also known as rechargeable batteries. Dynamic power management & dynamic voltage scaling are the two power saving policies. Dynamic power management shutting down those parts of senor nodes which are not use currently & depending upon non deterministic workload the power levels with sensor node varies by dynamic voltage scaling(DVS).

1.3 Advantages of WSN

There are some advantages of wireless sensor network over wired ones.

- **Extended range**

  A single large wired sensor may replace with same cost by many small wireless sensor networks. A single sensor can senses only small area whereas network with small sensors distribute over a wider region.

- **Ease of Deployment**

  The wireless sensor networks can be deployed at the interested site without any pre planning. This increases the flexibility & saving the installation cost.

- **Mobility**

  Wireless sensors have limited mobility because they are equipped with battery. Thus if a region becomes unmonitored the nodes can re arrange themselves to distribute evenly which means that these nodes can be made to move towards the area of interest.

- **Fault tolerant**

  Sensor networks should possess fault tolerant capability. If one sensor fails then it doesn't affect the network operation much because other nodes also collecting the same data. The data accuracy may be reduced.

1.4 Applications of WSN

Traditionally, sensor networks used in some high level applications such as biomedical applications, nuclear and radiation threat detection systems for ships. Most recently the interest focuses on networked chemical and biological sensors for the applications of national security. Important sensor network applications includes military sensing, video surveillance, traffic surveillance, industrial and manufacturing automation, physical security, process control, inventory management, air traffic control, distributed robotics, weather sensing, environment monitoring, national border monitoring, and building and structures monitoring. Some applications are as following:

1.4.1 Medical applications

- Monitoring physiological data.
- Inside a hospital for tracking & monitoring doctors and patients.
- Drug administration.
- Elderly assistance.

1.4.2 Environmental applications

- Microclimates.
- Agriculture Research.
- Forest fire detection.
- Flood detection.

1.4.3 Military applications

- Monitoring enemy forces.

- Surveillance of military or battlefield.
- Targeting the enemies.
- Biological, nuclear and chemical attack detection.

1.4.4 Home applications

- Home automation.
- Instrumented environment.
- Meter reading automated.

1.5 INTRODUCTION TO PEGASIS

PEGASIS protocol is a chain based protocol. The main aim of this protocol is to extending the network lifetime, sensor nodes only communicate with their nearest neighbours & take turns in communication with base station. A new round will start when round of all nodes communicate with the base station ends. This also includes the factor that the power required to transmit per round is reduced. Nodes are randomly placed in the field, by using reedy algorithm they organize themselves in form of chain. Figure shows the chain formation process.

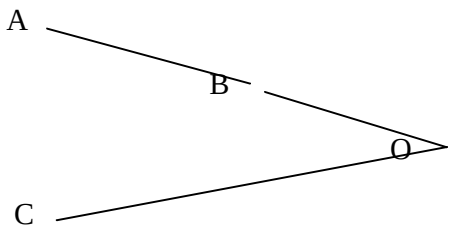

Fig 1.4 chain formation in PEGASIS

Node A & O connecting to node B, node B connecting to node O & node O is connecting to node C. when a node dies. Then the chain is constructed with the bypass of dead node by the same manner.

Main objective of PEGASIS-

1. Using collaborative technique increases the lifespan of each node, thus network lifetime will be increased.

2. To reduce bandwidth consumption in communication, allows only local coordination between nodes that are close together.

1.5.1 Chain construction phase

For the formation of chain the algorithm uses following steps:-

1. Initializing network parameter, number of nodes, initial energy and base station location.

2. Base station sends a hello message to whole network to obtaining the information of alive nodes and also finds the distance to the base station from each node.

3. Set the node as end node, which is farthest from the base station.

4. The distance between itself and other nodes are obtained by end node of the chain, which have not joined yet and finds the nearest node. Setting this node as node i & waiting to join the chain.

For data collection, each node recieves the data from the neighbor node and fuses with own data & transmit it to the next node in the chain. For this round, leader initiates a token passing approach to start data transmission from the ends of chain, the size of token is very small so the cost is very less. In the fig C0 passes its data to C1. Node C1 fuses with its own data & node C0's data and transmit to the leader. C2 passes the token to the node C4, node C4 transmits its data to the C3. Node C3 fuses its own data with C4's data and then transmit to the leader.

1.5.2 Token passing approach

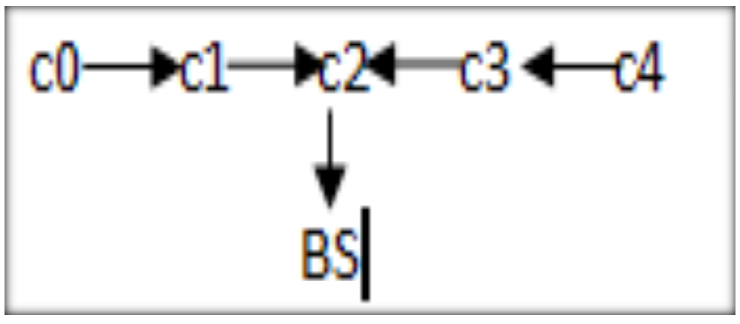

Fig 1.5 Token passing in PEGASIS

Node C2 wait to receiving data from both neighbors & fuses its data with neighbor's data. Finally, node C2 transmits a message to the base station (BS)

CLUSTER HEAD SELECTION IN HIERACHICAL ROUTING:

Nodes are grouped together to form clusters. Each cluster has only single cluster head. Responsibility of cluster head is to sensing information from the cluster to the base station for routing. Data transmission is from lower level cluster to higher level cluster and this forms a hierachical structure. From lower level cluster to upper level cluster data transmision requires high speed data nodes. Cluster head approach is better than from multihop model because in this data aggregation is performed by every cluster head. But in multi-hop data aggregation is performed by each node.

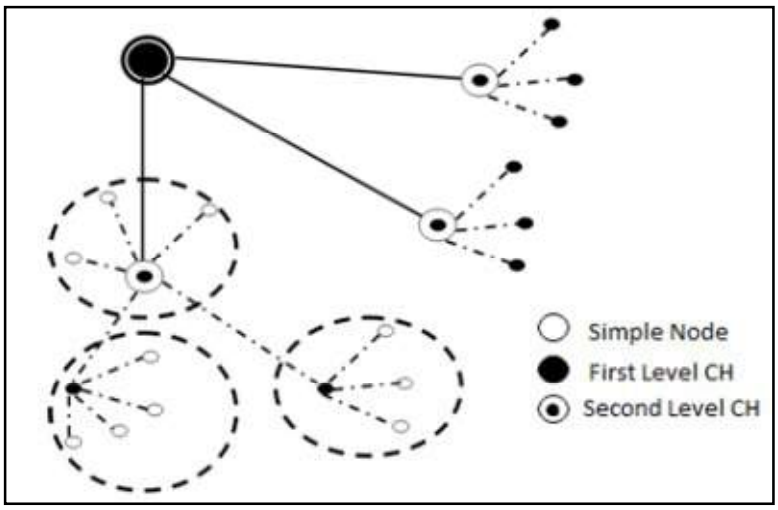

Fig 1.6 structure of hierarchical routing

1.5.3 PEGASIS disadvantages

- In PEGASIS sensor nodes probably dies early.
- Single leader can become a bottleneck.
- Communication suffers from the excessive delays which are caused by the single chain for distinct nodes.

1.5.4 PEGASIS advantages

- Improved version of LEACH

1.6 CUCKOO SEARCH INTRODUCTION

Cuckoo search is an optimizing algorithm developed in 2009 by Xin She Yang & Suash Deb. Cuckoo is a wonderful bird because they makes beautiful sounds. Cuckoo has aggressive reproduction strategy, where a cuckoo lays their eggs other species. This is known as blood parasitism. The basis for this algorithm is the specific eggs laying & breading of cuckoo itself. If a host bird discover that the eggs are not its own eggs, either it will throws these eggs away or abandon its nest and creates a new nest in new place.

Fig 1.7 Guira Cuckoo, scientific name: Guira guira
[courtesy: http://www.birdforum.net/opus/Guira_Cuckoo]

For describing the cuckoo search algorithm three rules are used, which are described in following:-

a) At a time each cuckoo lays single egg and dumps its egg in randomly chosen nest.

b) With the high quality of eggs, the best nests will carrying to next generations.

c) Available number of host nests are fixed and the egg laid by cuckoo is discover by the host bird with the probability of pa [0,1]. In this case the host bird completely builds a new nest in new location by either abandon then nest or throws the eggs from the nest.

New solutions are obtained with the following equation:

$$X_i^{t+1}=x_i^t+\alpha \oplus Lev'y$$

Lev'y describes the random walk to obtaining the new solutions. α is the step size which is adjusted according to the scale of problem of interest. Lev'y flight is a random walk and the step size of lev'y also rndom with the distribution as follows:

$$\text{Lev'y} \sim u = L^{-\square}, \quad (1 < \lambda \leq 3)$$

1.6.1 Pseudo random code for Cuckoo Search algorithm

Cuckoo search via Lévy flight algorithm:

Begin

Objective function $f(x), x = (x_1, x_2, \ldots, x_d)^T$

Generate initial population of n host nests x_i $(i = 1, 2, \ldots, n)$

While (t < Max Generation) or (stop criterion)

Get a cuckoo randomly by Lévy flight

Evaluate its quality/fitness F_i

Choose a nest among n (say, j) randomly

If ($F_i > F_j$),

replace j by the new solution;

End

A fraction (p_a) of worse nests are abandoned and new ones are built;

Keep the best solutions (or nests with quality solutions);

Rank the solutions and find the current best

End while

Post process results and visualization

End

Fig 1.8 pseudo random code for CS

1.6.2 Variations in CUCKOO search

CUCKOO search have three variations described below:

a) Modified Cuckoo Search (MCS)

The main goal of modification is to speeding up the convergence & reducing the evaluations of objective function required to find the global minimum. In cuckoo search α is constant and generally take value of α=1. In MCS, with the number of generations increases the value for α was made to decrease. Initially value for levy flight coefficient is 1 & a new value is calculated at each generation by using formula. $\alpha=A/(G)^{1/2}$ where G is the generation number.

b) Binary Cuckoo Search (BCS)

For feature selection purposes a binary version of the cuckoo search is called as binary cuckoo search. Search space is modified with d-cube, d representation number of features. The main function to associate with binary coordinates set for each nest. This represent that a feature belongs to final set of features or not & function to be maximized.

c) Improved Cuckoo Search (ICS)

Cuckoo search algorithm uses a constant value of α and p_a. At initial, these values are set and cannot be change during the new generations. The drawback of cuckoo search is finding the optimal solution for number of iterations. If the value of α is large and value of p_a is small then the performance of algorithm is poor. When the value of α is small & value of p_a is large, it may be unable to find the best solution although, the speed of convergence is high.

In ICS algorithm uses variables values of both α and p_a rather than choosing fixed values. To result in a better tuning of solution vectors these values should be decreased in final generations. With the number of generations the values for α and p_a are dynamically changed.

1.6.3 Applications of Cuckoo Search

Cuckoo search is applied as an optimization algorithm for various tasks to finding optimal features, finding optimizing cluster centers, finding optimal path, optimizing the parameters of neutral network, radial basis function, and also many more in different domains like health sector, image processing, wireless sensor network etc.

1.6.4 Cuckoo search optimization algorithm

Cuckoo search optimization algorithm is summarized as following:

a) Preparing cuckoo habitats on objective function with some arbitrary solution.

b) Each cuckoo assigns some eggs.

c) For each cuckoo determine egg laying radius.

d) Allows cuckoo to laid eggs inside their egg laying radius.

e) Remove those eggs which are discovered by the host birds.

f) Allowing eggs to hatch & chicks to grow up.

g) For each grown cuckoo assess its habitat.

h) Removing cuckoo lives in worst habitats & calculate maximum number of cuckoo in environment.

i) Clustering the cuckoo, detect the best place & select the goal point.

j) Allowing new cuckoo population toward the goal point.

k) Stop, if stop condition satisfied otherwise, go to b.

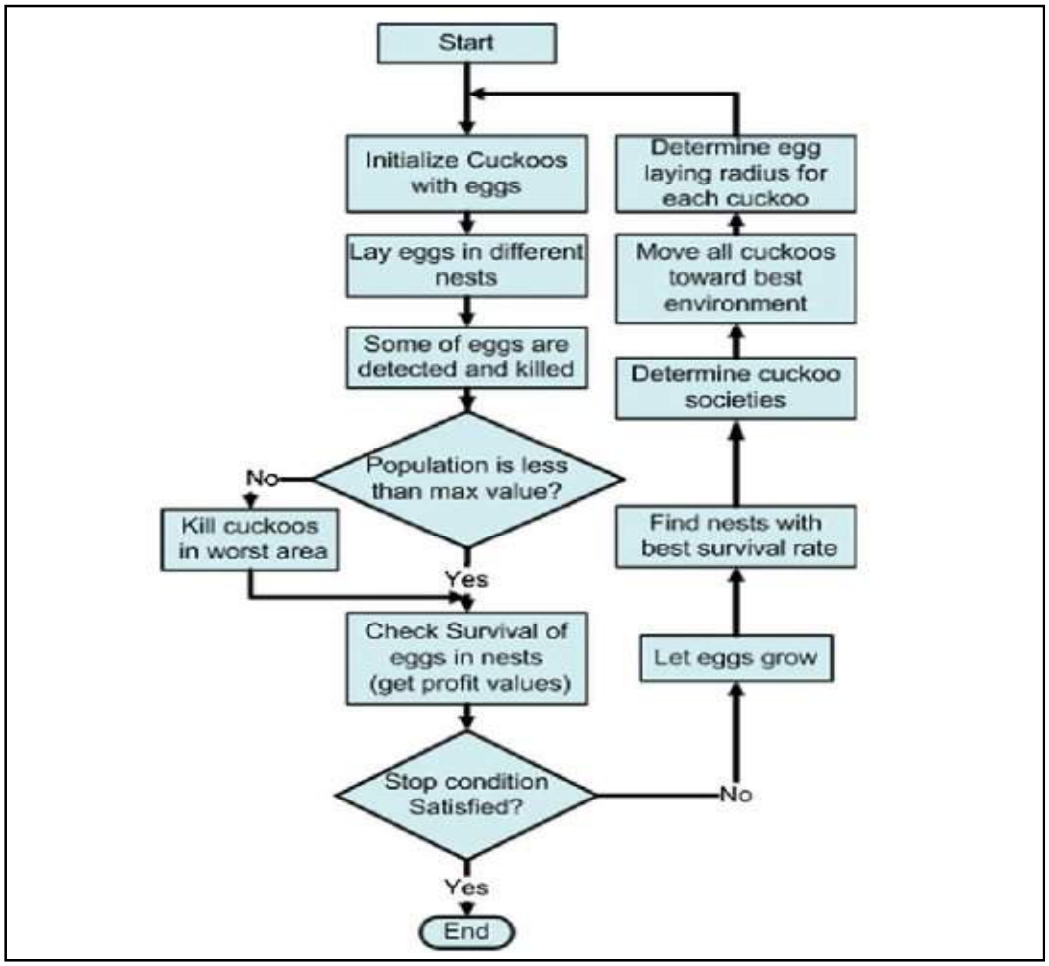

Fig 1.9 Flowchart of cuckoo search optimization algorithm

1.7 OSI reference model

OSI (open system interconnection) model is the reference model for data transmission and reception. OSI model is a seven layered structure model. Layers in OSI model are independent and each layer communicate with their above layer & lower layer. OSI reference model is an ISO standard model for designing various network protocols in wireless sensor network. In this model each layer is communicating with the layer either above or below. When the data is transmitted from one layer to another encapsulation is done in OSI model.

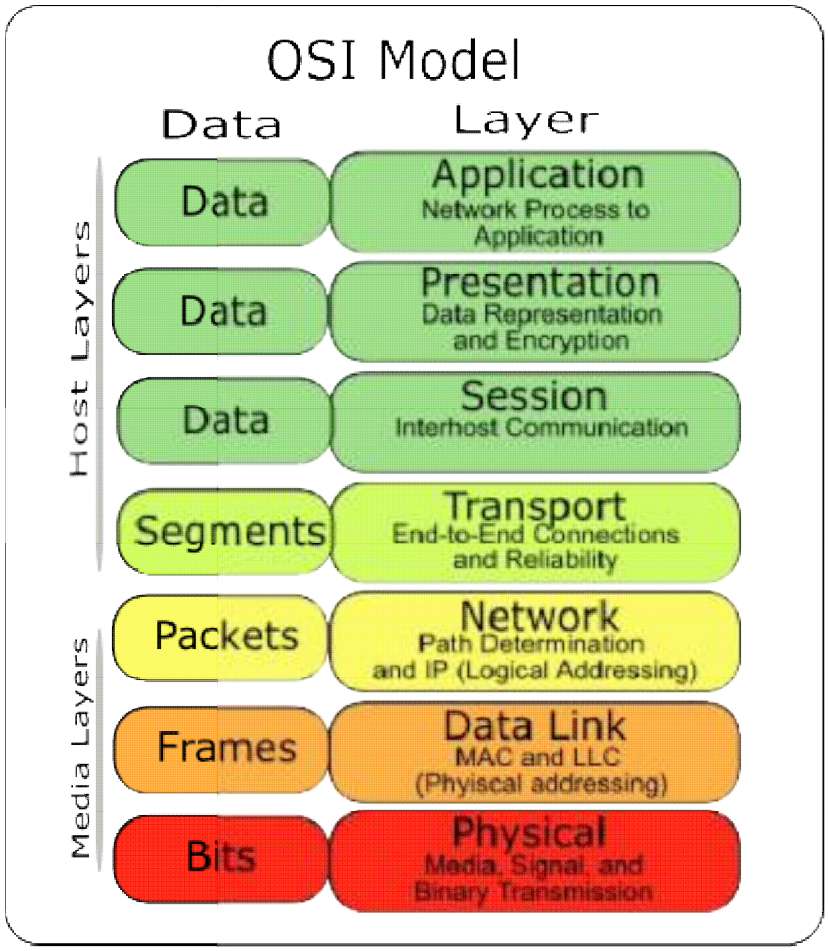

Fig 1.10 OSI Reference model

Physical layer- It defines the interface between the transmission medium & devices. The sender & receiver must be synchronized at bit level during the transmission process. It also defines the mode of transmission i.e. simplex, full duplex, half duplex.

Data link layer- The responsibility of data link layer are, frames are exchanged between one node to another. It also detect the error, correct the sequence of bits and flow of data is controlled. Frames have the address of source & destination. Data link layer is sub divided into two types: Logical link control (LLC) - Logical link control is responsible for flow & error control.

Medium access control (MAC) - MAC has physical address of each device in the network.

Network layer- It deals with the delivery of packet from source to destination. Delivery of packet is done between different networks. Routers are used to send the information

through the devices. For sending information in different network there is a requirement of logical addresses. Network layer adds header to the packets which are coming from data link layer, these are known as source & destination.

Transport layer- Responsibility of network layer is process to process delivery of message. Transport layer may be connectionless & connection oriented. If it is connection oriented the connection is established with destination, packets are sent & after this termination of the connection. In connectionless each segment treated as independent packet & delivered. Segmentation, reassembly, flow control, error control are the responsibilities of transport layer.

Session layer- It establishes maintains & synchronizes the interaction among communication system. Synchronization is done by session layer, for understanding this let take an e.g. if a file of 1000 pages are sent by a system & insert checkpoints after every 200 pages. This is done to ensure that each 200 pages are received & send acknowledge independently. If a problem is occur during the transmission at 420 pages, and then there is no need to resend all pages before 401. Session layer uses token management, tokens are provided to the parties. Task is performed by those parties, having token at time.

Presentation layer- During communication, presentation layer deals with the format of data being transferred. Translation, encryption & compression are the responsibilities of presentation layer.

Application layer- It provides an interface between the human or software. File transfer, mail services, file management are the tasks of application layer.

1.8 STRUCTURE OF THESIS

This thesis consists of six chapters relevance of each chapter is below:

In chapter, dealt with the introduction part in which, wireless sensor network explained with its architecture, advantages, and applications. The basic concept of PEGASIS protocol, cuckoo search optimization is discussed.

In chapter 2, review of literature has been done by reading published papers about the topic.

In chapter 3, problem formulation and objective of this research has been given. Also contains the methodology & implementation of the project. It consists of five phases in which firstly, implement the previous work done & then implement the proposed strategy by using MATLAB.

In chapter 4, explained the work plan of the research with timeline by the table and then simulate proposed strategy.

In chapter 5, conclusion and future scope of this thesis is explained. References are also included in this.

In chapter 6, contains the biography and abbreviations.

CHAPTER 2: LITERATURE REVIEW

2.1 LITERATURE SURVEY

Al- Karaki et.al [1] in 2004, ”Routing technique in wireless sensor networks a survey” states that routing is the process of choosing the best path in a network and according to network structure routing in wireless sensor network are divides into three types i.e. flat based routing, hierarchical based routing and location based routing. In flat based each node have their own functionality. In hierarchical based routing every node plays different roles in the network. In location based routing the tracking of node location by the sensor node. Flat based routing- In flat based network every node plays the same role and collaborates together to performing sensing task. Due to the presence of large number of nodes, it is not feasible to assigning global identifier for every node, data centric routing is used where the queries are performed to the sender and data is transmitted to the receiver node. BS sends the queries to the selected regions and waits for the data response from the selected regions of sensor nodes. This includes SPIN & Directed diffusion to reduce energy consumption and also eliminate of redundant information or data. These protocols motivated for other protocols design which follow a similar concept. SPIN is a protocol which broadcast all the information to every node in the network. Each node has similar data with the neighbouring node. This protocol distributes information to all nodes when user doesn’t require exchanging data between nodes. SPIN is 3-stage protocol. It uses three messages i.e. ADV, REQ & DATA. ADV is advertising new data, REQ is request for data & DATA is the message itself. When a node wants to share data it broadcast an ADV message contains with data. If the neighbouring node is interesting for receiving the data then it sends a REQ message back to the node for data transmission & DATA is send to the node. Then the neighbouring nodes repeats process with its neighbours & the whole sensor area network will receive copy of the data.

Hierarchical based routing- Hierarchical routing is also called as cluster based routing. The main motive is to developing the cluster based routing protocol is for reducing the network traffic towards the sink. The main aim of hierarchical routing is minimization of energy consumption of sensor nodes. In which higher energy nodes uses to processes & sending the information while to performing sensing task low energy nodes can be used. Only low energy nodes are participate for generating network path. Hierarchical routing

is two layered routing mechanism where the one layer is used for selecting the cluster head and other is for routing. Protocols under hierarchical routing are: LEACH, PEGASIS, TEEN, and APTEEN.

LEACH (low energy adaptive clustering hierarchy)- LEACH is a cluster based protocol. Randomly it selects few sensor nodes as cluster heads and rotates evenly distribute the energy among the sensor in network. Cluster head node compress the data which are arrives from nodes that belong to respective cluster and to reducing the amount of transmitted information sends an aggregated packet to base station. LEACH uses TDMA/CDMA MAC for reduce the intra-cluster & inter-cluster collisions. Where there is a need for constant monitoring by sensor network this protocol is most appropriate. LEACH performs two tasks i.e. setup phase & steady state phase. Cluster head selection comes under the setup phase. In steady state phase transmission of data to the base station takes place. To minimize the overhead the duration of the steady state phase is larger than the duration of the setup phase

Location based routing protocol- This routing approach is performed for tracking the node location by the sensor node. To calculate the distance between two particular nodes the location information is needed to estimation of energy consumption. Satellite communication is performed using GPS to identify the location of the node. To improve energy efficiency to route the data, geographical routing protocols provide several techniques. Protocols under location based routing are: (GAF) geographic adaptive fidelity, (MECN) minimum energy communication protocol, (SMECN) small minimum energy communication protocol.

GAF (geographic adaptive fidelity) - GAF is an energy aware algorithm designed for ad-hoc networks & also be applicable to sensor networks. In this algorithm firstly, the network area is divided into fixed number of zones & form a virtual grid. In each zone, nodes play different roles with collaborating to each other. When sensor node enters the sleeping mode for energy saving, it turns off radio. In the discovery state, a sensor exchanging discovery messages to learning about other sensors in a grid. In the active state sensor continuously sends its discovering messages to inform equivalent sensors about its state.

Daixian Wu et.al [2] in 2013," an energy efficiency trusted dynamic routing protocol for wireless sensor networks" explained that an efficiency trusted dynamic routing protocol

for wireless sensor network which is designed based on trust management and destination sequenced distance vector protocol. Energy efficiency trust dynamic routing protocol (EETDRP) for wireless sensor network is designed to apply wireless sensor network in the farmland. In EETDRP, according to the communication quality of node the route is generated. When many nodes are joining to the wireless sensor network it reduces the capacity of routing table and bandwidth. Energy efficient trust dynamic routing protocol consists from six modules: route setup module (RSM), global route beacon module (GRBM), data transmission module (DTM), table operation module (TOM), packet operation module (POM), next-hop selection module (NHSM). Route setup module creates a hierarchical sensor network which makes all sensor nodes gain the information of his neighbour sensor nodes. Data transmission modules forward the receiving data packet and also it sends its collected data. Next hop selection module build and transfer data packet when it collect data or receive neighbour sensor node data packet. In Global route beacon, the sink transfer to global route beacon which is return along the transmission route of data packet. Packet operation module builds data packet for receiving the neighbour's data packet & for collecting data. Table operation module provides some data for number of operations & record the trusted information and sensor node communication. The energy efficient trust dynamic routing protocol is made with two phases: route updating phase and data transporting phase. Route setup is running when wireless sensor network is initiated. Route updating is running during the wireless sensor network uptime. Route updating is same as route setup. Their main task is to create a gradient field in wireless sensor network. In energy efficient trust dynamic routing protocol, there is no route updating module, only route setup module is present.

N Suganthi et.al [3] in 2013," A trust aware routing with shortest path framework for wireless sensor networks" explained that under attacks such as wormhole attack, Sybil attack and sinkhole attack, TARF gives improvement in the network performance. WSN consists from hundred or thousand of nodes which forms a large network. For protecting WSN from harmful attacks a robust trust aware routing framework is designed. For TARF, to routing data packet from source node N to destination node N requires three main thins: 1. A broadcast message send to whole network 2. Source to destination all shortest paths 3. On behalf of trust value & energy efficiency decide which neighbouring node forward the data packet. When data is send to next hop node then only work is left to send data to base station.

Guoxing Zhan et.al [4] in 2012,"design and implementation of trust aware routing framework for WSN" explained that for securing WSN, trust aware routing framework is designed and implemented against adversaries misdirecting the multipath routing. A sensor node wirelessly sends message to base station via multihop path with narrow radio communication range. TARF neither requires geographic information nor tight time synchronization. For a trust aware framework node N wants to route data to base station. N node decides which node forward the data packet considering both the energy and trust. Energy watcher calculates the energy cost for its neighbor and also computes how a node decides own energy cost. One-hop retransmission occurs until acknowledgement is received. Trust manager is used for deciding the trust level of neighbors based upon two events: discovery of network loops & broadcast from the base station about delivery of data. At initial, trust level value .5 is given to each neighbor and after that trust levels are updated after any of events occurs, the relevant neighbors. From neighborhood table, node N is able to decide its next-hop neighbor. It broadcasts energy cost to all its neighbors to deliver a packet from node to base station. For node N the level of trust of a neighboring node is a decimal number in [0,1]. Trust value is assigned for each node with the numeric value of 0 and 1. Where trust value 0 represent to be a malicious node and trust value 1 is considered as a normal node. Routing path is constructed based upon the trust value, whose trust value is 1 only those nodes will be including in the route.

Sunita rani et.al [5] in 2012," An improved PEGASIS protocol to enhance energy utilization in WSN" stated that wireless sensor network is an ad-hoc network in which each sensor node is defined with limited energy. Each node collecting the information from neighboring nodes and transmit to the base station. Each sensor node consumes some energy in sending and receiving data while data is transferred over the network. The network lifetime depend upon how much energy spends in each transmission. PEGASIS protocol is chain based protocol & offering high energy efficiency, large network lifetime with minimum delay. In this each chain have one cluster head & it is in charge with each node sending & receiving message that belongs to the chain. It sends data to the closest neighbour saves the battery for WSN & also increases the networks' lifetime.

Shujing LI et.al [6] in 2011,"Energy efficient multipath routing in wireless sensor network considering wireless interface" stated that energy efficient multipath routing protocol is important for applications of wireless sensor network due to source & energy constraints of a sensor node in WSN. High data rate transmission required to provide high

quality information. Multipath routing protocols discovers the path in the interference zones of nodes and are marked & also can't allow to taking part in subsequent routing process. Wireless communication quality can be improved by reducing the interference effects of wireless. Energy efficient, WSN, multipath routing, wireless interface are the keywords which are used in multipath routing technique. Wireless sensor network consist from very low power wireless sensor and does not have fixed infrastructure network.

Ming Tao et.al [7] in 2010," An adaptive energy aware multipath routing protocol with load balance for WSN" stated that direct diffusion is the problem in some current protocols, because they find low energy cost path to optimizing energy usage along the routing at the nodes and uses the path for reporting data gathered by the tasks like humidity & temperature. From long term connectivity and lifespan of network, lowest energy cost path may not be optimal because along the paths it leads excessive energy depletion of the nodes. Adaptive energy aware multipath routing protocol with load balance is used to reduce the above mentioned problem, which focuses on increasing the network lifetime. Energy is evenly distributed to whole network in this protocol.

Meenu et.al [8] in 2014," Modified PEGASIS in WSN to increase network lifetime" stated that PEGASIS protocol comes under chain based routing scheme. Earlier, it is based on the two parameters residual energy and distance. In this paper decision parameter is added i.e. which check the response of a node nearby before the data transmission. Main objective is to increasing network lifetime & increases the live nodes present in the network. In modified pegasis, increase the parameter that is making the decision in which route data will be transfer called cidel. Cidel defines the response of the node or we can also say that how quickly a node gives response. After the process of chain construction, it will check all the three parameters for decision making and then data is forward.

Md .Arif Ali et.al [9] in 2014," development of energy efficiency routing protocol using Hop pegasis in Wireless Sensor Network" stated that in wireless sensor network, When there is constant flow of information from the sensor nodes to the base station, due to limited battery resources of sensor node, energy of nodes gets drained. This directly affects the entire network's lifetime. Our main motive is to devise a routing protocol which will minimizes the energy consumption and also achieving extended lifetime of the sensor network. Hop pegasis approach is used to enhancing the pegasis protocol network

lifetime. In this network inter clusters are formed and divide the sensor nodes into clusters.

Sandeep Kumar E et.al [10] in 2014," clustering approach for wireless sensor networks based on cuckoo search strategy" stated that wireless sensor network are garnering lots of interest in present applications due to less human intervention and its self management capabilities. Many sensor nodes are battery driven, since energy efficiency is a critical requirement in these types of networks. As compared to other routing protocols clustering protocol proved to saving more energy. This paper is based on the blood parasitism of some cuckoo bird species. Thereby basic LEACH protocol is compared with the increasing the lifetime of the network.

Feng Sen et.al [11] in 2011," An Improved Energy-Efficient PEGASIS-Based Protocol in Wireless Sensor Networks" explained about chain based protocol EEPB (energy efficient PEGASIS based protocol) has some deficiencies. When building a chain, there is uncertainty of threshold adopted, non optimal selection of leader node and when valuing threshold inappropriately, the inevitability of long link exists. To improve above problems, IEEPB (improved energy efficiency PEGASIS based protocol) is discussed in this paper. For selecting the leader node, IIEPB uses weighting method. Assign each node a weight and also uses new method for build a chain. IEEPB gives better results with balancing the energy consumption and lifetime of the wireless sensor network. [11]

Ahmed S. Tawfik et.al [12] in 2013," One Rank Cuckoo Search Algorithm with Application to Algorithmic Trading Systems Optimization**"** explained that nature-inspired metaheuristic algorithm is cuckoo search based on brood parasitism of cuckoo species also with the random walks of levy fights. In this presented work, new solutions generated from the exploration. Rather than separately, these exploration phases together are combined, evaluated and ranking. Additionally, to imposing a bound by the best solution mechanism helps to improving the performance and the convergence rate. The algorithm tested on set of standard benchmark functions. A real world experimental analysis gives an improved performance in all the benchmark functions.

Navpreet Singh et.al [13] in 2014," Relative Analysis of Hierarchical Routing in Wireless Sensor Networks Using Cuckoo Search" explained that wireless sensor network is composed by the collection of node which is very small devices. Battery usage is required for sensing, gathering & computing capabilities. Therefore, battery life should be large as possible it is, for sensing the information in wireless sensor network. In

hierarchical routing, the nature of nodes is homogeneous & nodes are working in hierarchical manner by the formation of cluster heads within the cluster. Cluster forms the cluster head for transferring data to another from one cluster. The simulation results shows network lifetime of LEACH is more efficient by using cuckoo search. [13]

Gurpreet Kaur Bhatti et.al [14] in 2014," Cuckoo based Energy Effective Routing in Wireless Sensor Network" stated that with the transmission over the network each node consumes some energy over the network & most required quality in sensor network is energy efficiency. This is required to improving the network life. This paper tells about the performance of energy effective routing so, from that the network throughput and network lifetime will be improved. On the basis of cuckoo search, routing will be defined to optimize the network &by using fuzzy system modification is done in PEGASIS protocol. The work defines for an effective communication to be performed without the congestion increasing over the network. Hence, work defines an energy effective routing over the sensor network.

CHAPTER 3: PRESENT WORK

3.1 PROBLEM FORMULATION

Due to huge transmission of data through the sensor nodes, lots of energy wastage exists in wireless sensor network, which decreases the network lifetime. The lifetime of the network depends upon each transmission means how much energy is spend in each transmission. So, for increases the lifetime of the network, number of alive nodes present in the network and energy efficiency of the network increases. PEGASIS protocol uses for reducing the delay and enhancing the energy efficiency of the network because PEGASIS protocol is based on chaining structure. In every chain one node is selected as cluster head, which do the responsibility of routing from lower level cluster to higher level cluster.

3.2 RESEARCH METHOD

In this research, the energy efficiency of PEGASIS protocol is improved and also increases the number of alive nodes using cuckoo search optimization. In order to proceed research; literature survey must be done. Literature survey is to exploit the research & gathering information about the methods. Then the next step is to formulate the hypothesis which leads to better results and after that formulate the problem based on analysis.

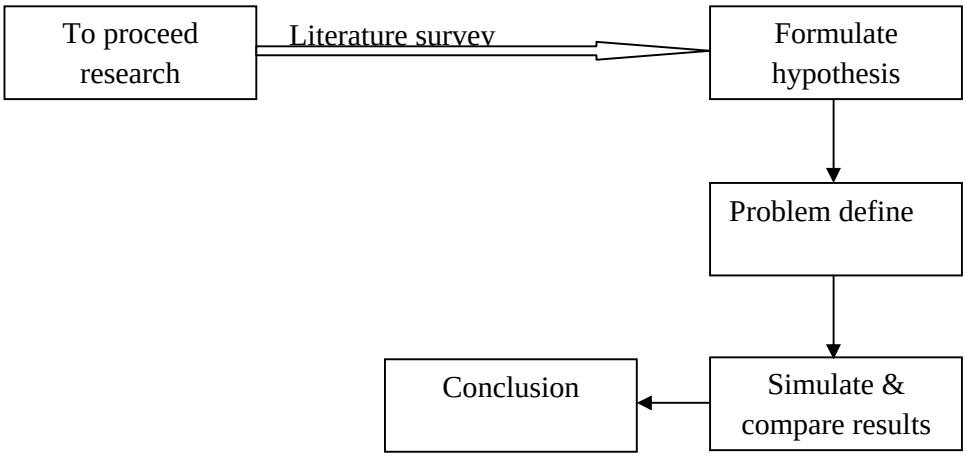

Fig 3.1 Flowchart of research methodology

3.3 EXECUSION OF METHDOLOGY

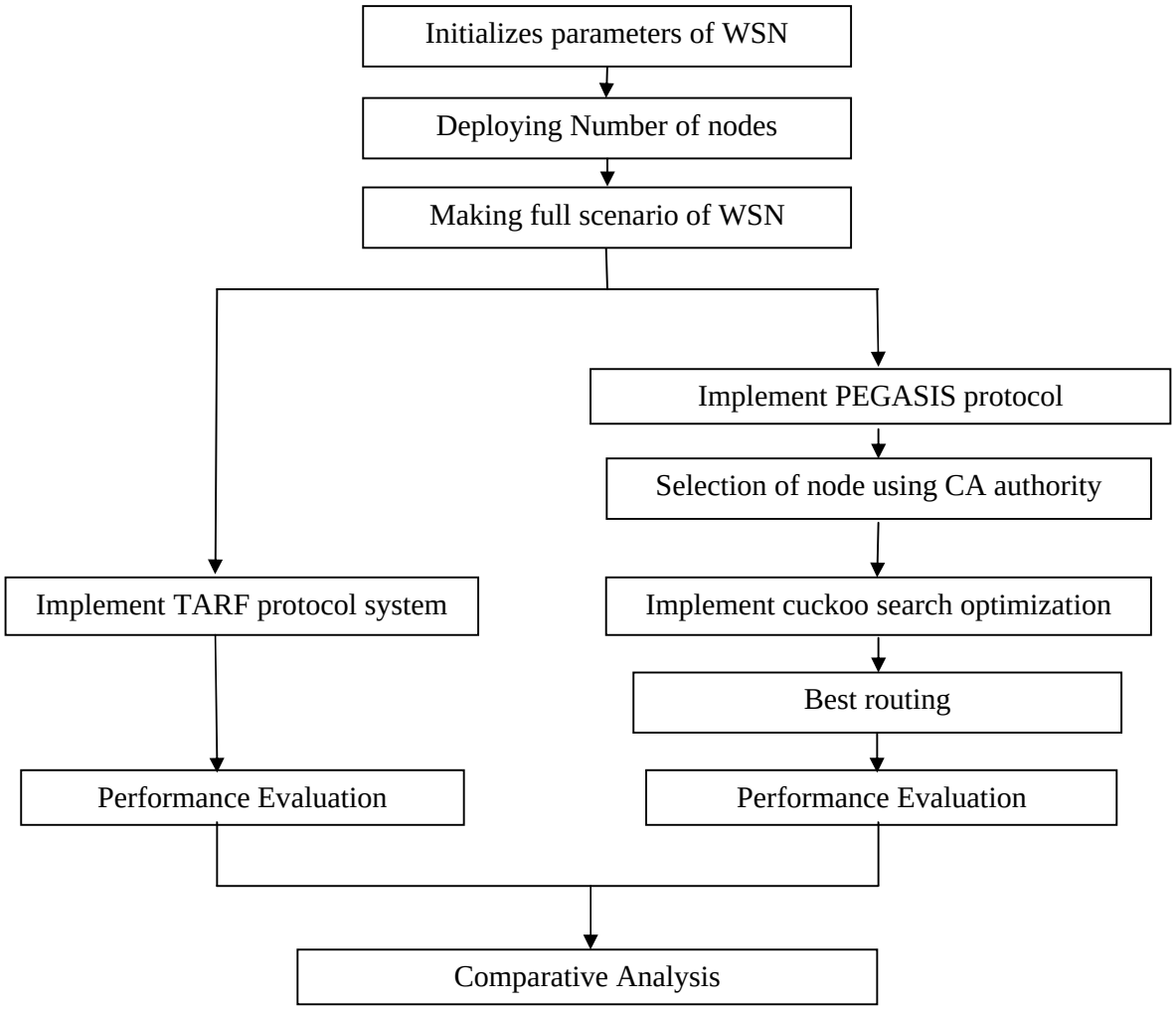

Fig 3.2 Flowchart of approach & applicability of methodology followed

The above flowchart shows the stepwise approach & applicability of the methodology followed. Firstly, initialize WSN parameters & nodes are deployed for simulation. Then TARF is implemented & evaluate the performance analysis. On other side, first of all implement PEGASIS protocol then using cuckoo search optimization for selecting best route. Evaluate the analysis & compare with the performance of TARF.

3.4 AIM & OBEJECTIVE

a) With the number of rounds improving number of alive nodes.

b) To analyze and developing high energy efficiency routing protocol with PEGASIS.

c) On the basis of cuckoo search define opportunistic routing.

d) To use MATLAB simulator tool for simulation of results.

3.5 RESEARCH METHODOLOGY

Our focus will be on just beginning a better solution to this problem as to solve data transmission in MATLAB simulator.

We will do implementation in five phases.

1st phase- This phase contains the study of already existing techniques.

2nd phase- In this phase, we simulate the TARF protocol with how it is integrated with the existing protocols, incorporated TARF into collection of tree routing protocol (CTP). This implementation gives that how much data transmission is done by these two and the number of dead nodes.

3rd phase- In this phase, we implement the PEGASIS protocol, which gives the information how chain is made while transmission.

4th phase- We implement our proposed strategy dynamically and also compare it with already existing techniques.

5th phase- In this phase, we finally purpose the solution for energy efficiency and number of alive nodes under PEGASIS protocol by implementing CUCKOO optimization technique.

CHAPTER 4: RESULTS and DISSCUTIONS

4.1 Work Plan with Timeliness

Table 4.1 Work Plan of Research

Stage of the Dissertation	No of days/weeks needed
STAGE ONE: Reading and Research	
a) Choose a topic "Trust aware secure routing framework for WSN"	1st week of September
b) Reading the research papers in the field of chosen topic	Up to 1st week of October
STAGE TWO: Detailed Plan	
a) Formulate and Construct the detailed plan of Dissertation	2nd week of October
STAGE THREE: Initial Writing	
a) Study of already exiting techniques	3rd week of October to 2nd week of November
b) Undertake additional research where necessary & literature survey	3rd week of November
STAGE FOUR: First Draft of Dissertation 1	
a) Compile & collect sections into first draft of discretion, simulate by using MATLAB	4th week of November
b) Undertake any additional editing and research	1st week of December
STAGE FIVE: Detailed Study & Final Draft	
a) Detailed Study of Trust Aware Routing & Energy Efficient Protocol PEGASIS	Up to last week of December
b) We will implement the chain based energy efficient protocol PEGASIS	In the month of January
c) We will implement our purposed strategy dynamically also compare with already existing & studying cuckoo	1st week of February to 1st week of March

optimization technique	
d) We will finally purpose solution for energy efficiency by implementing cuckoo approach on PEGASIS protocol	2nd week of March to 1st week of April

4.2 SIMULATION MODEL

4.2.1 MATLAB

MATLAB stands for matrix laboratory. Originally, MATLAB was written to provide easy access to matrix software developed by EISPACK (Eigen system package) & LINPACK (linear system package) projects. MATLAB is a high level fourth generation programming language. It is developed by mathworks in 1984. It has number of math functions and built in commands which are helpful in mathematical calculations, creating plots and performing numerical methods. It gives us an interactive environment for visualization, designing and interactive explosion. It also provides us to analyzing the data, developing algorithms, creating new models and applications.

4.2.2 Key features of MATLAB

- A high level language for application development, numerical computations and visualization.
- It gives an interactive environment for designing, problem solving and interactive exploration.
- It has development tools for improves code quality, maximize performance and maintainability of the performance.
- It provides linear algebra mathematical function, Fourier analysis, statics, filtering, optimization, numerical integration and solving ordinary differential equations.
- It provides build-in graphics for visualize the data & tools for creating custom plots.
- Functions for integrating MATLAB based algorithms with external languages & applications are also provided by MATLAB: such as Java, C, .NET & Microsoft excel.

4.2.3 USES OF MATLAB

- In science & engineering MATLAB is used as a computational tool.
- Use in image & video processing
- Signal communication & processing
- Testing & measurement
- Control system

a) Graphical interface of MATLAB

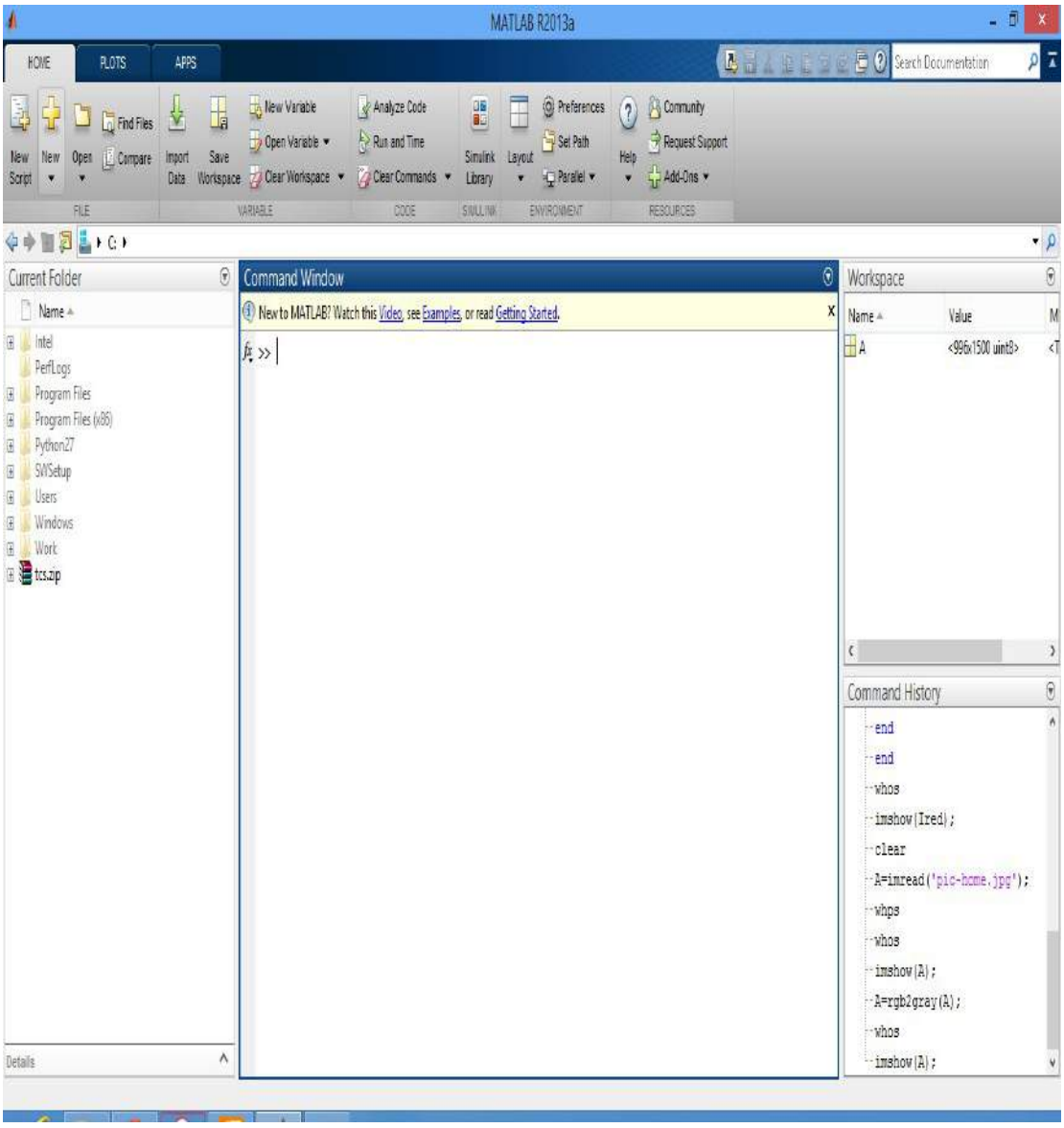

Fig 4.1 Graphical interface of MATLAB

4.3 RESULTS & DISSCUSTIONS

4.3.1 PEGASIS protocol

4.3.1.1 RADIO MODEL FOR PEGASIS

The basic standard model, where radio dissipates E_{elec}=50nj/bit to run the circuitry of both transmitter & receiver. For the transmitter amplifier $\in_{amp}$=100pj/bit/m^2. Due to channel transmission an energy loss r^2 is considered. To reach the intended recipient, the radio has power control & can expand the minimum required energy. The following equations are used for a k-bit message & to calculate transmission and receiving costs a distance d.

For transmission:

$$E_{tx}(k,d)=E_{tx\text{-}elec}(k)+E_{tx\text{-}amp}(k,d)$$

$$E_{tx}(k,d)=E_{elec}*k+ \in_{amp}*k*d^2$$

For receiving:

$$E_{rx}(k)=E_{rx\text{-}elec}(k)$$

$$E_{rx}(k)=E_{elec}*k$$

4.3.2 CUCKOO SEARCH ALGORITHM

4.3.2.1 CUCKOO SEARCH EQUATION

New solutions are obtained with the following equation:

$$X_i^{t+1}=x_i^t+ \alpha \oplus Lev'y$$

Lev'y describes the random walk to obtaining the new solutions. α is the step size which is adjusted according to the scale of problem of interest. Lev'y flight is a random walk and the step size of lev'y also random with the distribution as follows:

$$Lev'y \sim u= L^- , \quad (1<\lambda \leq 3)$$

4.3.2.2 RASTRIGIN FUNCTION

Rastrigin function is non-convex function. This is used for testing problem for optimization algorithms. Firstly it was proposed by the Rastrigin as a 2-dimenional function.

Equation for Rastrigin function:

$$f(x) = An + \sum_{i=1}^{n} [\dot{xi^2} - A\cos(2\pi xi)]$$

Where A=10 & xi € [-5.12, 5.12]

It has a global minimum value at x=0.

4.4 SIMULATIONS

In this thesis work, chain based approach is used which is based on the enhanced PEGASIS. Cuckoo search is used to implement PEGASIS for energy efficiency & network life. This simulation focuses on the number of alive sensor nodes and the energy efficiency of the network. For different algorithms network average energy & cost per iteration are the important indications to measuring the performance. In this simulation, 100 nodes are placed randomly in 100*100 area.

Figure 4.2 describes chain formation with pegasis protocol.

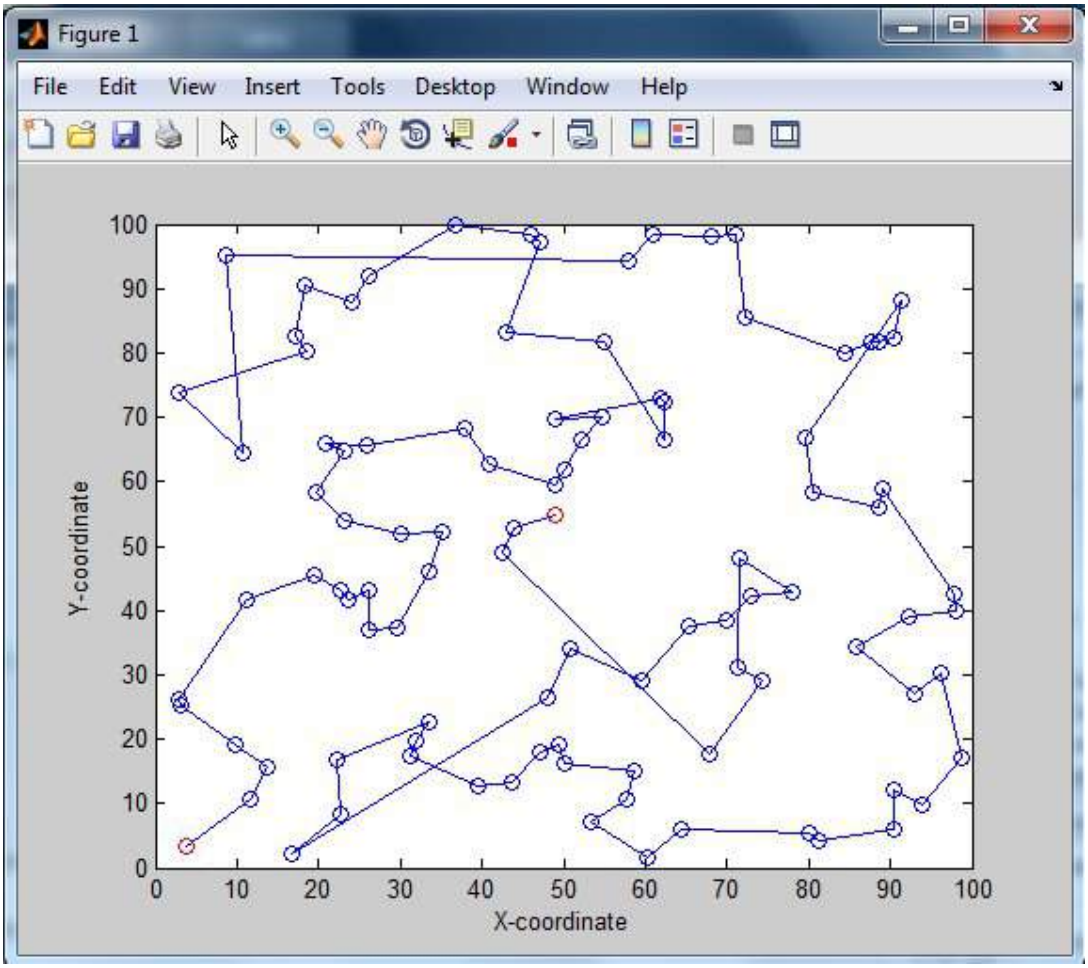

Fig 4.2 chain formation with pegasis

4.2 Table Simulation parameters

PARAMETERS	VALUE
Number of nodes	100
Area	100*100
Transmitted energy (E_{tx})	50nj/bit
Received energy (E_{rec})	50nj/bit
E_{fs}	10pj/bit
E_{mp}	0.0013pj/bit
E_o	0.5
R_{max}	2500
Da	0.6
E_{da}	5nj/bit

Figure 4.3 describes the total number of nodes in a network.

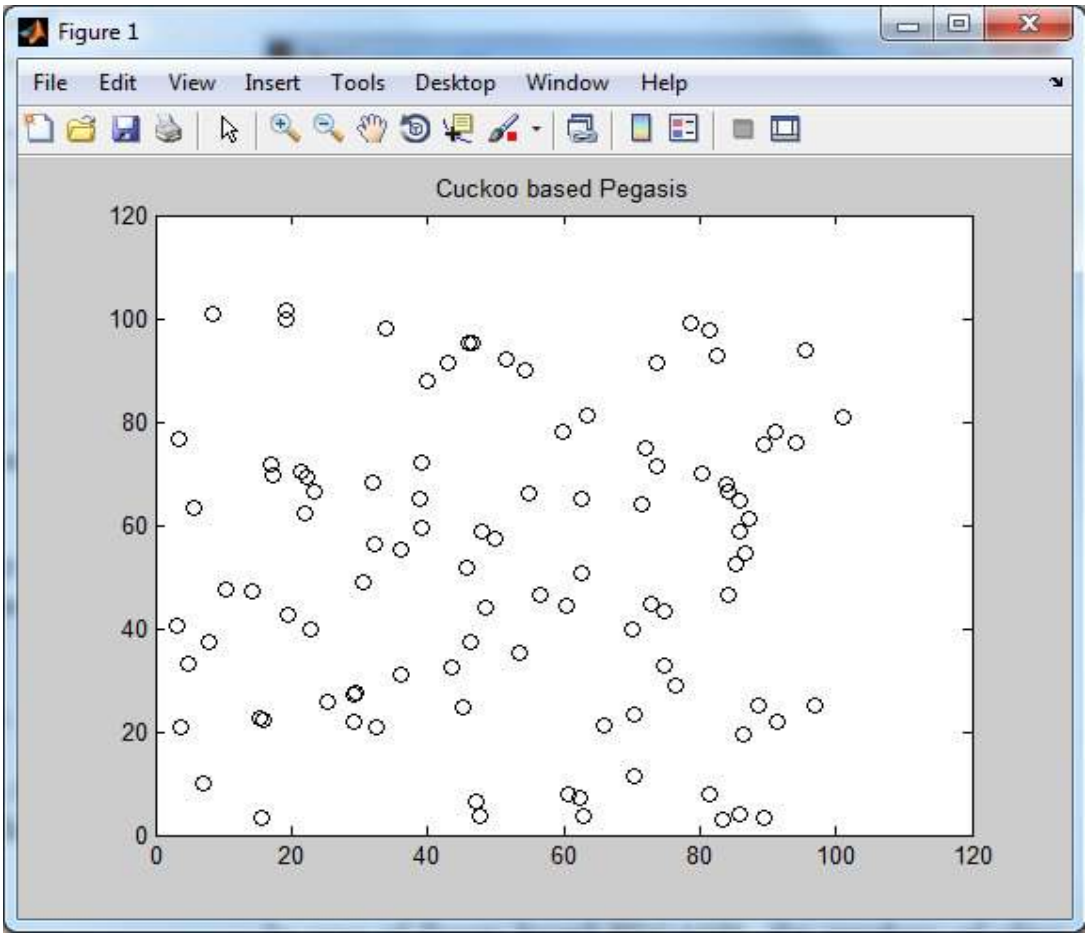

Fig 4.3 randomly deployed sensor node

Table 4.3 initially parameters used for Cuckoo

Number of cuckoos	50
Minimum number of eggs	2
Maximum number of eggs	4
Maximum iterations	100
Maximum number of cuckoos	200

This figure 4.4 describes the enhanced pegasis chain formation based on cuckoo search.

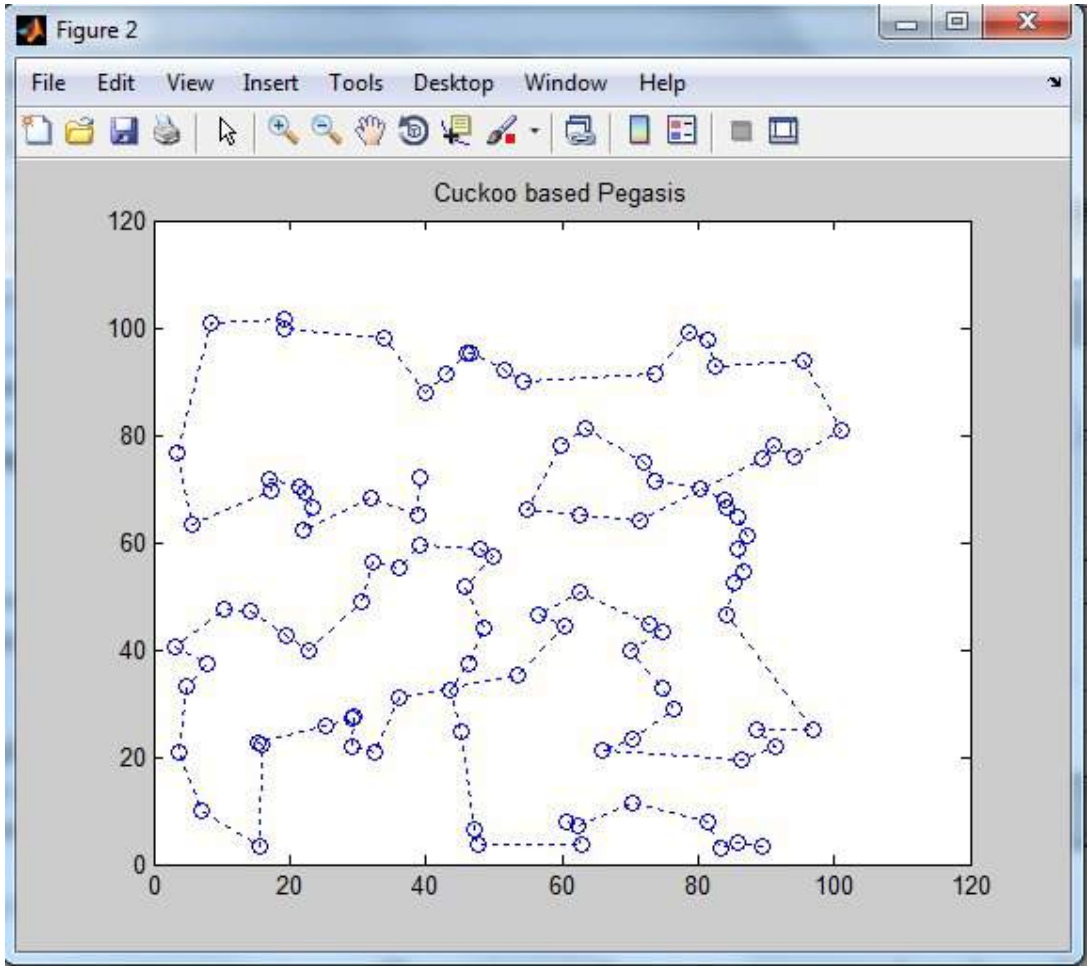

Fig 4.4 chain formation in cuckoo based PEGASIS

In figure 4.5 the total number of alive nodes of a network varying with the number of rounds. The number of alive nodes in cuckoo based pegasis is larger than from the pegasis protocol network in each round.

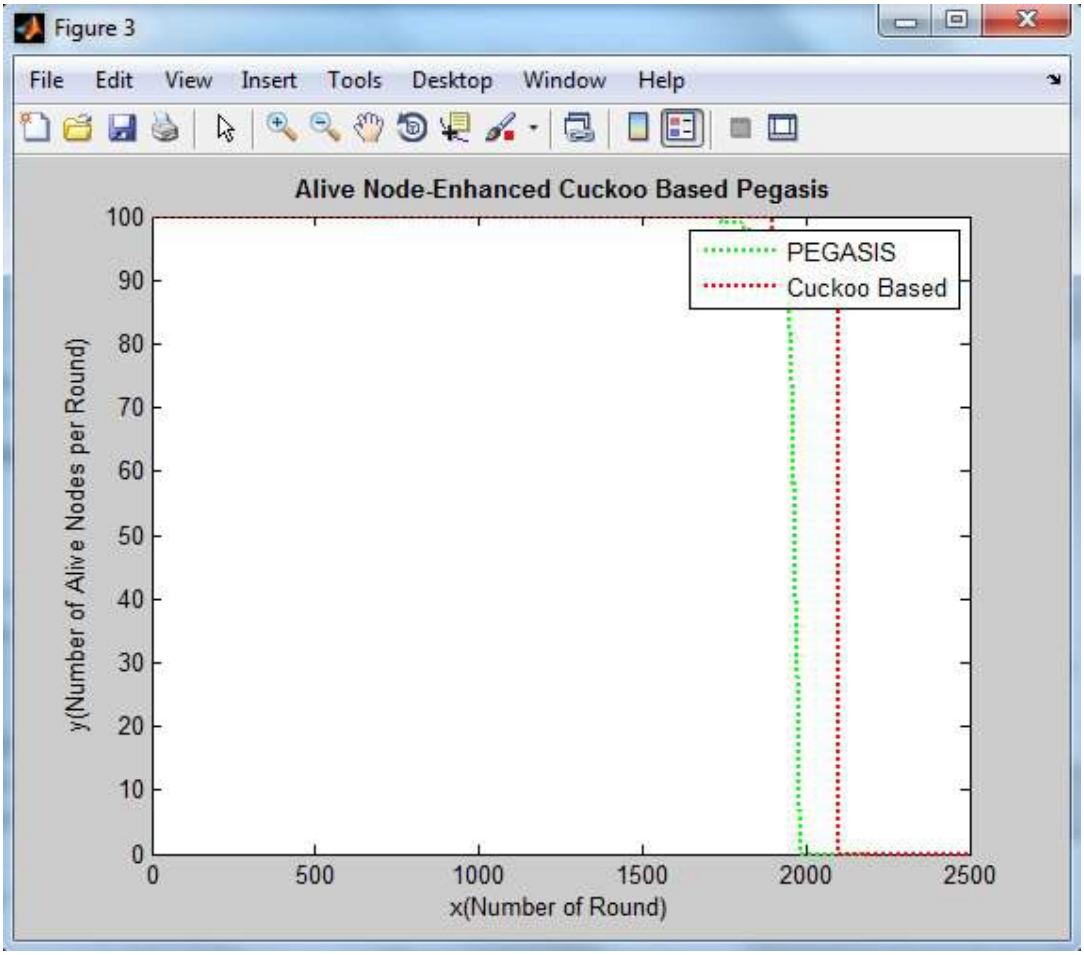

Fig 4.5 number of alive nodes according with number of rounds

Table 4.4 Network lifetime comparison

Percentage	PEGASIS	CUCKOO
80	1795	1980
100	1990	2110

Figure 4.6 describes the proposed work, in which the energy consumption is less in cuckoo based fom the eariler work done.

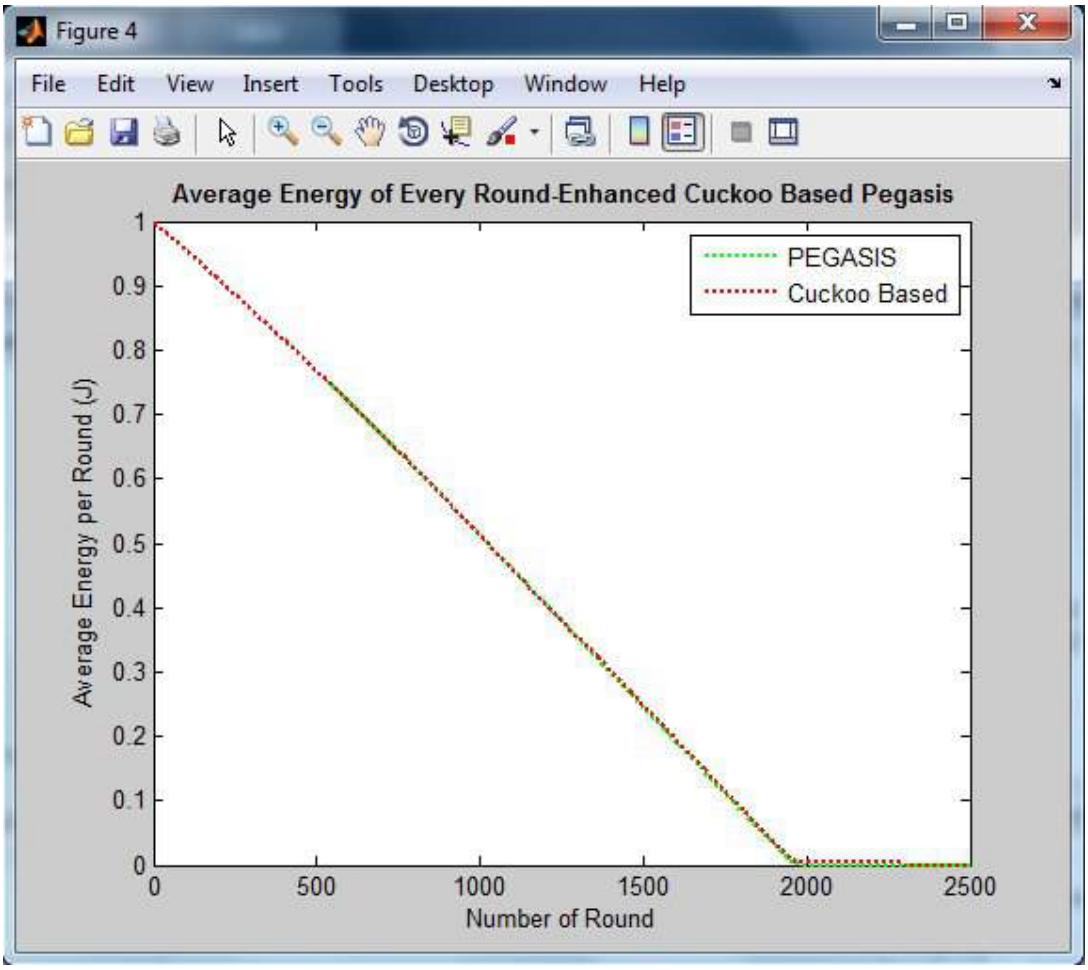

Fig 4.6 average energy of every round

4.5 BASE PAPER IMPLEMENTATION

MATLAB is used to evaluate the performance of TARF and CTP. In our simulation model network consists from random 35 nodes with 300*300 rectangular areas. The graph between the dead nodes and time shows that the dead nodes in CTP are higher as compare to TARF, in fig 4.7 At 1000 CTP shows that it has large no of dead nodes as compare with TARF. On the other side the data transmission in TARF is higher as compare to CTP, fig shows at 1000 data transmission rate of CTP is approx 4500 but TARF has data transmission rate higher. After some time the data transmission rate of CTP & TARF becomes zero.

Table 4.5 Simulation Parameter

Parameter	Value
Number of nodes	35 nodes
Initial energy of node	0.5j
Transmitter electronics, ETX	50nj/bit
Receiver electronics, ERX	50nj/bit
Emp	0.0013pj/bit
Efs	10pj/bit
Area	300*300m
Eagg	5nj/bit

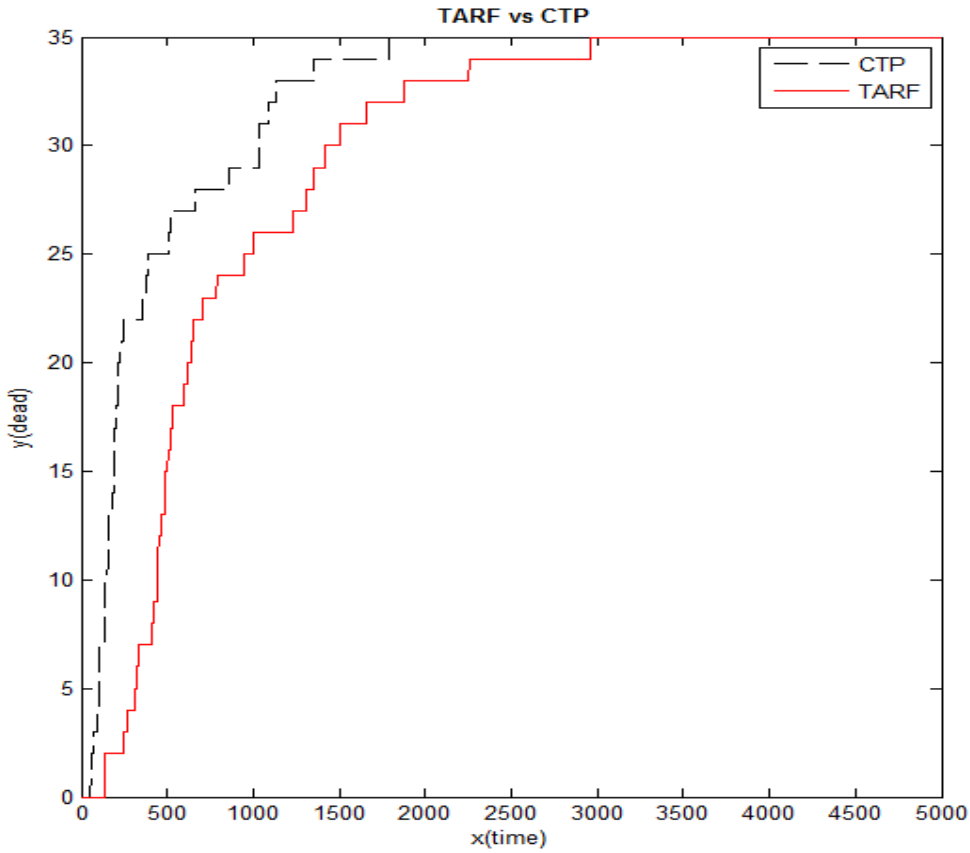

Fig 4.7 Graph shows the dead nodes between TARF&CTP

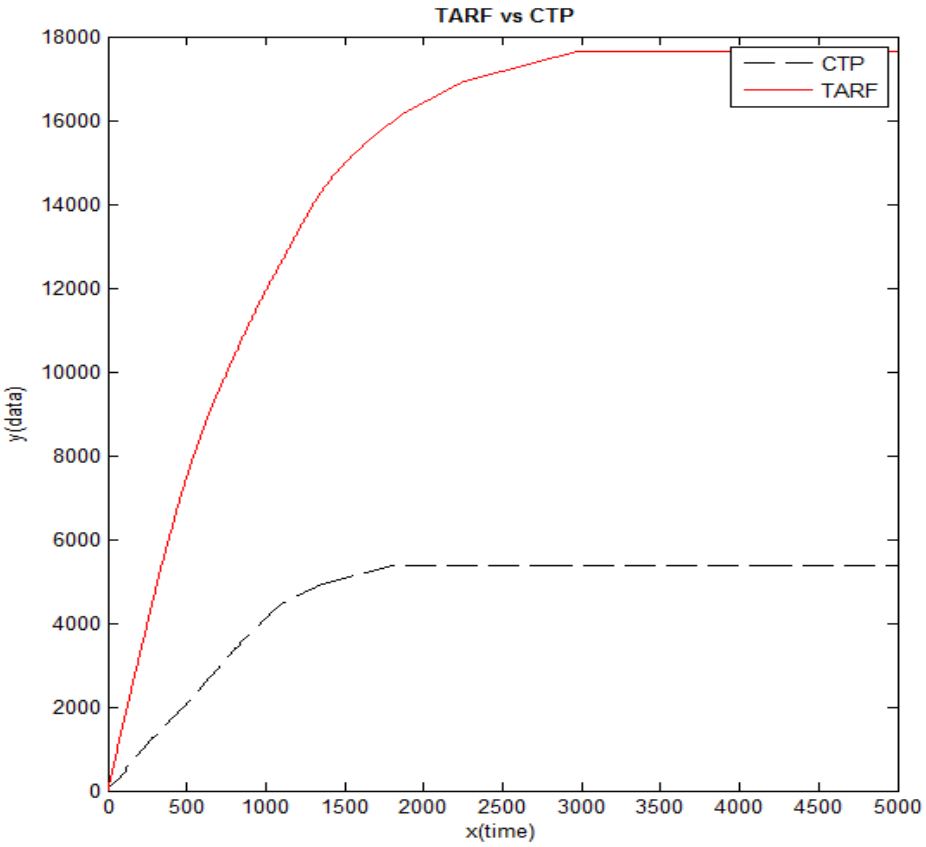

Fig 4.8 Graph shows the data transmission between TARF & CTP

Base paper implementation comparison with the proposed strategy:

Base paper simulation results shows that dead nodes in CTP are higher than TARF with the number of iterations all alive nodes are dead. The proposed strategy results shows that large number of alive nodes exist which increases the network lifetime.

On other side the data transmission rate is higher in TARF than CTP but, with the increases of iterations it also becomes zero. In proposed strategy, the energy consumption of the network reduces. Hence, energy efficiency is higher in compare with earlier.

CHAPTER 5: CONCLUSION & FUTURE SCOPE

5.1 Conclusion & scope

From this study, concluded that wireless sensor network consist from number of sensor nodes to form a large network. Environment conditions like sound, temperature, pressure, direction, speed etc are measured by WSN. In WSN lots of energy wastage in sensor nodes which decreases the networks lifetime. The lifetime of the network directly depends upon the transmission, in each transmission how much energy is spent. To increases the lifetime of the network a chain based PEGASIS protocol used. Which is an energy efficient protocol; this reduces the delay present in the network and enhancing the energy efficiency of the network. In each chain only single node is selecting as a cluster head. Cluster head knows all the information of their chain members. PEGASIS protocol with cuckoo search optimization algorithm increases the number of alive node and energy efficiency of the network. At the end, we can conclude that the proposed work enhances the performance of system which can be used in future work for further improvement of WSNs.Further in future work, to enhance the protocol by improving the more number of alive nodes for efficient network life.

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CHAPTER 6: APPENDIX

LIST OF ABBERAVATIONS

WSN	Wireless Sensor Network
PEGASIS	Power Efficient Gathering in Sensor Information Systems
LEACH	Low energy adaptive clustering hierarchy
CS	Cuckoo Search
MCS	Modified Cuckoo Search
BCS	Binary Cuckoo Search
ICS	Improved Cuckoo Search
OSI	Open System Interconnection
TARF	Trust Aware Secure Routing Protocol
CTP	Collection of Tree Routing Protocol
EETDRP	Energy Efficiency Trust Dynamic Routing Protocol
EEPB	Energy Efficient PEGASIS Based Protocol
IEEPB	Improved Energy Efficient PEGASIS Based Protocol
MATLAB	Matrix Laboratory

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