ENERGY OPTIMIZATION IN WSN USING HEURISTIC OPTIMIZATION ALGORITHM

Dissertation submitted in fulfilment of the requirements for the Degree of

MASTER OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

By

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ABSTRACT

This dissertation explores the competing issues of energy consumption efficiency in wireless sensor networks. To achieve this, we considered Genetic Algorithm with Gravitational Search algorithm (GSA) in the selection of Cluster Head (CH) in such a way so that its energy is used uniformly with delayed disintegration of network. For this purpose, the LEACH algorithm random clustering approach has been replaced by GSA clustering. The GA_GSA based LEACH protocol has been compared with random LEACH, Max Energy LEACH and k-means algorithm. Total network system lifetimes are determined using a variety of small percentages of the available system nodes. Using a MATLAB programming, wireless sensor nodes are simulated, and power consumption algorithms are included in each node that take into consideration all aspects of power consumption in the operation of the node. Simulating different algorithm schemes on the same network system, same initial power sources, and routing protocol, an increase of overall system lifetime is demonstrated. The performance of GA_GSA_LEACH cluster based routing protocol shows some differences by varying life pattern among nodes and number of dead nodes. Max Energy LEACH perform better in network disintegration criterion but it give less network life as compared to GA_GSA based LEACH.

DECLARATION STATEMENT

I hereby declare that the research work reported in the dissertation entitled "ENERGY OPTIMIZATION IN WSN USING HEURISTIC OPTIMIZATION ALGORITHM"
in partial fulfilment of the requirement for the award of Degree for Master of Technology in Computer Science and Engineering at Lovely Professional University, Phagwara, Punjab is an authentic work carried out under supervision of my research supervisor Mr. Rajendra Aaseri. I have not submitted this work elsewhere for any degree or diploma.

I understand that the work presented herewith is in direct compliance with Lovely Professional University's Policy on plagiarism, intellectual property rights, and highest standards of moral and ethical conduct. Therefore, to the best of my knowledge, the content of this dissertation represents authentic and honest research effort conducted, in its entirety, by me. I am fully responsible for the contents of my dissertation work.

Signature of Candidate

Bhawana Saini

11510023

SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the M.Tech Dissertation entitled **"ENERGY OPTIMIZATION IN WSN USING HEURISTIC OPTIMIZATION ALGORITHM"**, submitted by **Bhawana Saini** at **Lovely Professional University, Phagwara, India** is a bonafide record of his / her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree.

Signature of Supervisor
Rajendra Aaseri

29-04-2017

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LIST OF ABBREVATION

WSN	Wireless Sensor Network
CH	Cluster Head
BS	Base Station
MAC	Medium Access Control
TDMA	Time division multiple access
DD	Direct diffusion
MANET	Mobile ad hoc network
RFID	Radio-frequency identification
LEACH	Low-energy adaptive clustering hierarchy
PEGASIS	Power-Efficient Gathering in Sensor Information Systems
TEEN	Threshold sensitive Energy Efficient sensor Network
APTEEN	Adaptive Threshold sensitive Energy Efficient sensor Network
SEP	Stable Election
EECS	Energy Efficient Clustering Scheme
DEEC	Distributed Energy Efficient Clustering
HEED	Hybrid Energy Efficient Distributed clustering
H-HEED	Heterogeneous Hybrid Energy Efficient Distributed clustering
GA	Genetic Algorithm
GSA	Gravitation Search Algorithm

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Checklist for Dissertation-III Supervisor

Name: _____ UID: _____ Domain: _____ Registration No: _____Name of student:_____

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- ☐ Front pages are as per the format.
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- ☐ Color prints are used for images and implementation snapshots.
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CHAPTER 1
INTRODUCTION

1.1 Wireless Sensor Networks

Wireless Sensor Networks are made up of numerous small electronic devices called nodes which gather the information from their environment nearby and then send the collected information to base station where further analysis and forecasting can be done. The analysed information is used to take managerial resolutions or business decisions. In multiple issues and numerous scenarios the sensor networks have become tool for information analysis. This has given the capability of remotely monitoring of a physical surrounding for a wide and distinct scenarios and different problem context. These tiny nodes are self-regulating which provide ability of distributed computing in the network.

With distributing computing the network can be made flexible or ductile to adopt several methods for deployment, security enforcement, and routing and information dissemination. Energy efficiency is an important aspect in WSN as nodes have a finite battery power. The various types of limitations make WSN and different protocols challenging and divergent. WSN has emerged as a completely different technology as compared to standard traditional internet architecture. WSN nodes are very tiny and occupy lower space and weight as compared to traditional networked devices. WSN easily scales to the order of thousands of nodes and requires minimal help from outside to build the network. The latest advancements in wireless have made the smaller and less expensive products which enhance communication speed significantly.

All nodes in WSNs have a battery with fixed power which makes energy conservation as basic need while creating architecture of WSN [1]. The objectives in the creation of WSNs have the capability of huge rate of information exchange among nodes in the network and base station and ability of minimizing the energy consumption. We need efficient routing protocols in WSNs to achieve these objectives. Therefore, several routing algorithms have been proposed [2].

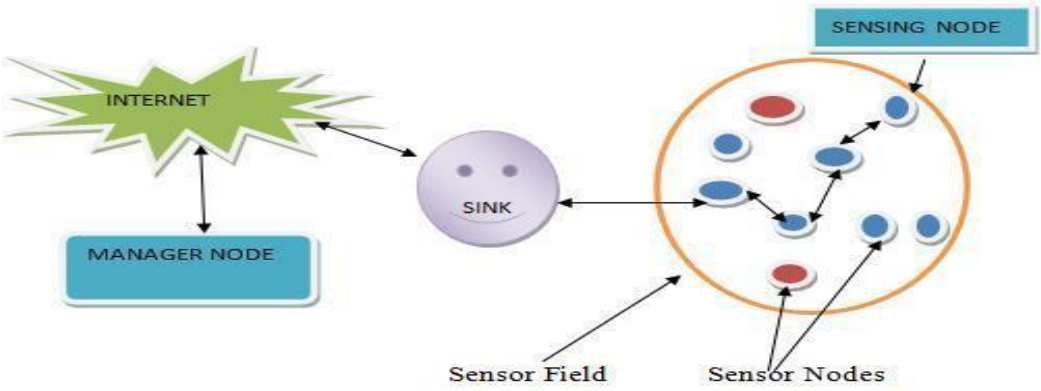

Fig 1.1 A typical sensor node

Cluster Based routing protocols composed of two layer architecture. One layer is responsible for section of cluster head and the other handles routing. A cluster head (CH) is one which is performs collection of information from rest nodes, gathering or pre-processing of information and then dispatching the processed information to the base station.

1.1.1 Information Aggregation in WSN

In a huge network with thousands of sensor nodes, the information coming from the individual node does not make perception when compared to the information aggregated from clusters of nodes. Here, the raw information from multiple nodes will be buffered or processed and aggregated in one node which acts as an aggregator. Information aggregation considerably lowers down the cost of transmission and as a result keeps the network available for a longer time period and provides optimal bandwidth usage.

1.2 Components and Characteristics

Wireless Sensor Networks made up of abundant nodes deployed on a wider area range. They have furnished with various sensors like optical, thermal or mechanical to monitor the properties of the physical environment, where they are located. Figure 1 shows a typical WSN with nodes scattered in the field. Hardware, software for making up a sensor is the three perspectives for understanding the components of WSN and the network that is collection of many sensor nodes.
While designing a wireless sensor network a following key factor should be kept in mind:

Table 1.1 Designing Factors

Key Factors	Description
Network connection	Wireless communication among nodes and base station to share information.
Area coverage	Deployment site of nodes for monitoring and information collection
Node deployment	To meet the desired goals of performance we should deploy nodes
Fault tolerance	In the condition of failure how far nodes can provide functionality
Network lifetime	Maximum numbers of sensor nodes passes
Information aggregation	Aggregated information management like remove duplicity as to take effective decisions
Clustering	To grouping sensor nodes on basis of similar role with a head
Routing	A network path determination for a packet
Network dynamics	Due to sensor node failure or its mobility changes in the topology of wireless sensor network.

1.2.1 WSN Hardware

A **Sensing Unit:** For information collection.

A **Processing Unit:** Information processing.

A **Communication Unit:** Information storage.

A **Power Unit:** Used to perform the required tasks.

A sensor node consists of above mentioned units. There port is assembled by the nodes and afterward dispatch that data to the handling centred called as "Sink". The principle issue in the WSN is to grow the system life expectancy by

effectively use their little battery control. The following are some ways which are characterized to use the energy in a proficient way:

1 Sensor node deployment
2 Clustering with optimised energy
3 Scheduling of energy in information gathering
4 Routing Protocols which are energy efficient

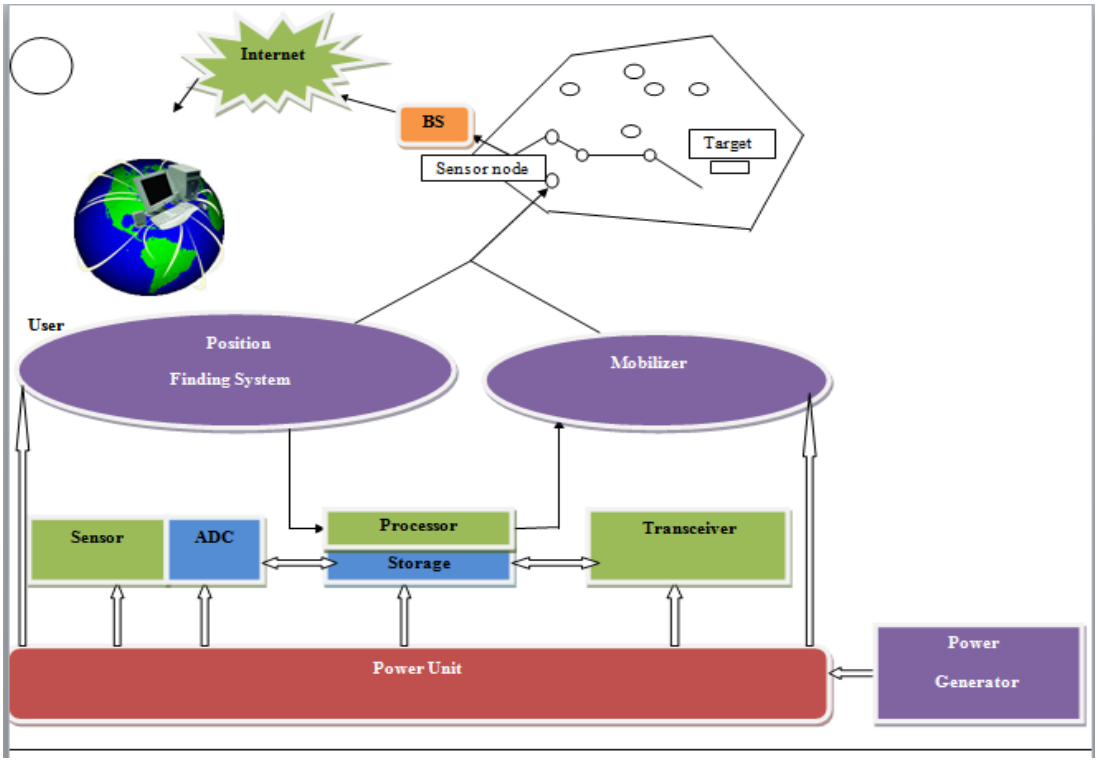

Fig 1.2 A wireless sensor network

1.2.2 WSN Software

In WSNs among detecting, utilization and correspondence, the element of communication devours the most extreme energy [1]. One approach to reduction energy utilization because of correspondence is to force a productive medium-access control (MAC) convention. The MAC convention administers receiving wire exercises and is in charge of solid associations which can lead us to an effective and crash free system. Energy effectiveness, gadget administration and proficient asset usage are three fundamental elements that ought to be considered while planning MAC layer convention [1]. There are numerous MAC conventions

that have been produced however a large portion of the present MAC outlines for WSNs are named TDMA convention [3].

1.3 Classification of Routing Protocols

Two broad categories of routing protocols can be defined as hierarchical and flat. Where equal roles are assigned to all members with each having same kind of functionality is known as Flat Routing while on contrast, in hierarchical routing nodes are assigned distinct roles [4] and formation of clusters occurred. Some of the major limitations and challenges facing the existing protocols are to satisfy the new WSNs requirement can be listed as the following:

1. **Limited Energy Resources:** With the mobile infrastructure, the finite battery power needs to be managed, thus energy aware protocols are highly required. Even if we work on lifespan of battery only still as long as the battery become empty the sensor node become dead.
2. **Lower Information Rates:** The major struggles are the limited information rates. The frequency that is used effect on the information to be transmitted. This justifies that wired networks are faster than the wireless networks.
3. **Communication failures:** Error rate is high in wireless networks than their wired equivalent. Electronic waves are used to send packets and these waves can be distracted by unexpected occurrence events of reflection, refraction, diffraction or scattering.
4. **Security issues:** Wireless networks are more attack prone. Many unwanted and external users can enter the networks for attacking the system.

1.3.1 Flat and Hierarchical Routing Protocols

Organize steering conventions are coordinating directing components and additionally keeping up the basic part of system in WSNs. There are three sorts of system structure: level steering [6], progressive directing [8, 9] and area based steering [5, 7 and 10]. Nonetheless, with a specific end goal to center in our general vicinity of research, we examined just two of them (level and progressive

steering conventions).

Flat Routing: Where rise to parts are relegated to all individuals with each having same sort of usefulness is known as Flat Routing.

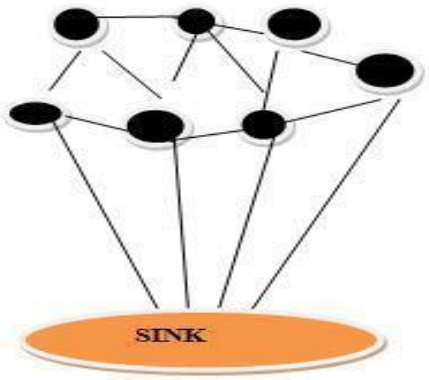

Fig 1.3 Flat protocol

Along these lines, questions are sent by base station to various piece of the detecting field. This system is called data driven directing [2]. Turn (Sensor Protocols for Information through Negotiation) [3] and DD (Direct Diffusion) [11] can be two cases. In these conventions energy is monitored by exclusion of tedious data.

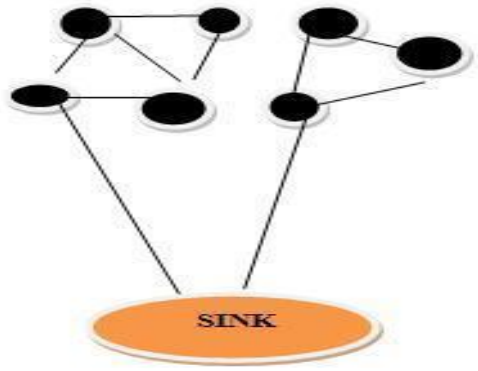

Fig 1.4 Hierarchical protocol

Group Based or Hierarchical Routing: In this approach, nodes assume isolated and unmistakable parts while data transmission. While couple of nodes sense the objective zone then again different nodes are in charge of preparing and

correspondence. In various levelled steering one layer take a shot at determination of group head while the second layer deals with directing. A definitive point of every one of these conventions is outlining and picking group heads such that the energy is used. Group based Routing is a doable answer for limiting energy use in WSNs. Inside a group, administration of part nodes and task of errands to them is finished by group head which result to lessening in repetitive data transmission. Energy utilization profoundly brought down in this steering technique since the aggregate data messages at the base station is limited by data conglomeration which is performed by group head.

1.4 WSN and other Technologies

MANET is a superset of WSN yet arrangement of MANET can't be connected to WSN. The between node data stream is distinctive in both. The MANET node has expansive assets which enable node to-node correspondence. Then again, WSN's settled range correspondence requires data move through different bounces of nodes before going at goal. The MANET node is considerably costlier than that of WSN. MANET can't be sent on wide range zones on complexity; WSN nodes are less expensive and can cover more extensive land regions. MANET is associated with built up framework yet WSN require no earlier foundation.

In today's life the cost of equipment is dropping and the span of gadget capriciously contracting. WSN has taking after the comparative pattern and approach to WSN future relies on upon its low cost, sensible execution and secure operation.

In Figure correlation of WSN is finished with different advances, as far as registering force and cost per unit from the most to minimum. RFID has both the qualities as least and its capacity is constrained for distinguishing proof of items. With the extra ability to handle the data Smart Card is taken, a stage up from RFID. WSN is between Smart Card and MANET innovation.

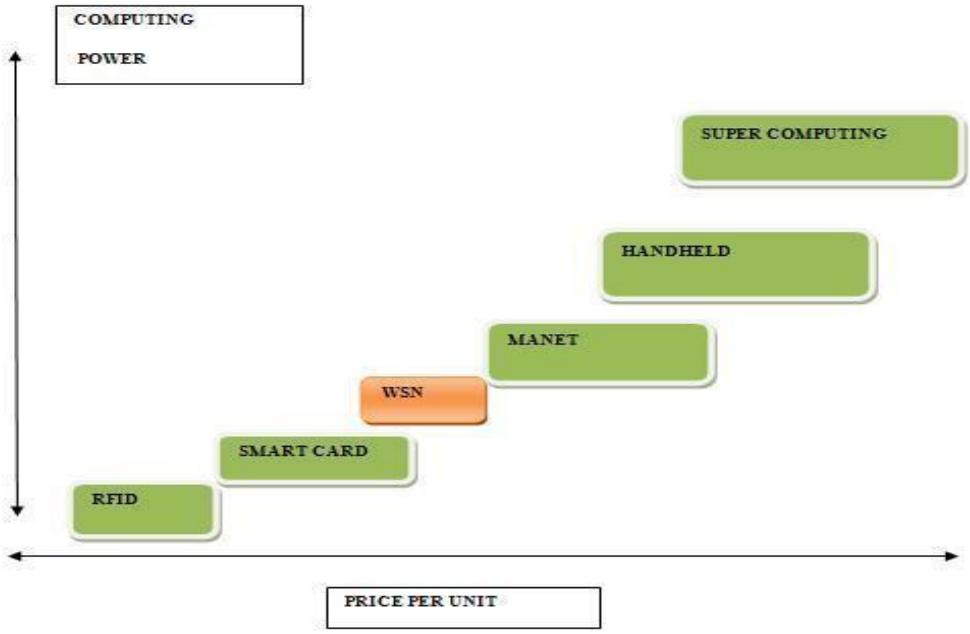

Fig 1.5 Comparisons of WSN with other technologies

Examination of WSN to alternate remote arranged gadgets is done in more confined in five ways:

1 **Scalability**: Scalability implies the system can develop with no confinement.

2 **Energy**: Another issue in WSN is its settled energy. Batteries in the nodes can't be supplanted.

3 **Communication**: We have to discover a strategy for correspondence which can furnish security with energy protection**.**

4 **Adaptation to internal failure**: The principle test is preservation of constrained assets while giving the adaptation to internal failure while to arrange and furthermore the disappointment of sensor nodes ought not influence the general errand.

5 **Routing**: Node arrangement, energy enhancement, and so forth assume an essential part in outlining of directing conventions for WSN.

CHAPTER 2
REVIEW OF LITERATURE

2.1 Introduction

WSNs are battery driven can't be energized. In multi-jump organizes every node demonstrations both as a transmitter and a recipient. It demonstrates that power disappointment of single node can bring about a huge impact on the system. The most vital plan issue in WSN is versatility. The sensor nodes in a field may reach out to hundreds or thousands. In that capacity, any steering convention ought to have capacity to work with enormous system. The circumstances because of which nodes gets fizzle is less power, natural unsettling influence or obstruction or whatever other physical harm. The MAC and steering conventions ought to give different courses to continue transmitting the data to the base station.

By virtue of WSNs, the traditions work to achieve the objective of limiting imperativeness usage and to broadening the framework future. The reviews as to with WSN gathering traditions can be found in [12]. The clustering traditions for WSNs can have two isolated arrangements as deterministic and probabilistic. In probabilistic batching traditions, a centred point transforms into a CH with a particular probability. The EEHC [13], HEED [14] and EECS [29], fall in the probabilistic class and PEGASIS [15], and TASC [30] are ordered in the deterministic class.

2.2 Literature Review

A remote sensor course of action includes hundreds or an expansive number of centres'. It has been demonstrated that Leach is a energy gainful coordinating computation. It subjectively picks a few centred points as Cluster Heads and the assurance of CH relies on upon likelihood.

LEACH: Low Energy Adaptive Clustering Hierarchy (LEACH) displayed by **Wendi B. Heinzelman** of MIT as a grouping based convention that utilise irregular developments of neighbourhood group base station (CH) to disseminate

the energy stack equitably among the nodes in the system [3]. The LEACH deals with the idea of fusing data combination to decrease the measure of data that must be transmitted to construct station and in light of restricted coordination to bring the components of adaptability and vigour for systems. The system's grouping is modified powerfully and occasionally. Filter takes all individuals, as they can convey to a base station with transmission at high power. This presents the procedure of cycles/rounds. Filter convention experiences different rounds.

Each cycle/round can be finished as:

A. Cluster setup stage

B. Steady state stage

A. Cluster setup stage

Every node takes a self-choice it is possible that it ought to end up noticeably a group head or not for current preparing round. The node takes its choice done by means of choosing an arbitrary incentive in the vicinity of 0 and 1.The threshold is set as:

$$T(n) = p/(1 - p\left(r \bmod \left(\frac{1}{p}\right)\right) \text{ if n belongs to G}$$

Where,

p is the node's probability taken as a head of the cluster

r is number of rounds that already occurred

G is the group of participants that never got chosen as cluster-heads in the last 1/p rounds

Nodes which are being elected as heads of the cluster in round r shall not be taken as cluster head for upcoming 1/p rounds. The nodes with value are higher than the fixed predefined (threshold) will take itself as the head.

Then an advertisement message is broadcasted by CH to tell all nearby, that who is appointed as the new cluster-head

B. Steady state stage

Amid the Steady-state stage, every node can kill its radio. The CH gets the data from part. On opposite CHs need to precede with their correspondence status generally so the data can be gotten from others. In the wake of accepting data CH will total it and afterward forward further.

Favourable circumstances in the LEACH convention are:

1. Most broadly utilized various levelled directing calculations.

2. Filter convention recent partitions the aggregate remote sensor arranges into many groups. Any node that filled in as a CH in present round can't be chosen as the CH once more; in this manner every node can share the heap similarly which is forced on Cluster heads

3. The group head node is haphazardly chosen and possibility of each node to be chosen as group head is equivalent inferable from which energy utilization of entire system is found the middle value of. In this manner LEACH will delay the system life cycle.

Issues inside the LEACH convention are:

1) The group head node is haphazardly chosen in LEACH convention. There are a few inadequacies inferable from the probability of each node to be chosen as group head is same. After various rounds, the node with or containing more noteworthy outstanding energy and the node with littler residual energy have same probability or likelihood to be picked as group head. On the off chance that the node which has littler outstanding energy is picked as group head, it'll come up short on the energy and more bite the dust rapidly, because of which system's vigour can be influenced and life of the system turn out to be short.

2) The standard LEACH Protocol partitions groups haphazardly, also brings about uneven conveyance of groups basically. In the end the partitioned groups won't not be the least complex or best. For instance a few groups have a considerable measure of nodes than others while a few groups have less nodes. Some group heads inside the moderately focal of groups though a few groups heads might be in the edge of groups far from individuals. These wonders will bring about increment

in energy utilization and have brutal effect on the aggregate execution of the system.

3) In relentless state, group head ordinarily send data to the sink or base station straightforwardly, Cluster head that is more remote from the sink speak with the sink specifically generally spend an a lot of energy though transmission. In this manner it'll crash prior thus of it comes up short on energy. Especially amidst the growth of the measurements of the system, these impacts are a considerable measure of discernible and affect the system life genuinely.

LEACH-F: LEACH-F is the enhanced adjustment of LEACH tradition with limited bundles and rotating group heads [4].The improvement of clusters is done just once which are settled, and quite recently the position of gathering head turns among the nodes. There is no set-up overhead toward the begin of each round. Channel F does not allow the development of new centre points to the structure.

LEACH-C: **W.B. Heinzelman et al**, proposed application specific tradition outline which is known as LEACH Centralized (LEACH-C) [13]. It is a change over the LEACH tradition. Channel C, uses a united clustering computation and a comparable persevering state arrange as LEACH. Deplete is less capable than LEACH-C since LEACH-C passes on around 40% a greater number of data per unit essentialness than LEACH.

E-LEACH: Energy-LEACH (E-LEACH) [16] upgrades the gathering head portion strategy in LEACH. It takes the waiting imperativeness of centre point and stamps it as the essential metric which picks whether the centre point should be a CH or not after the first round. If every centre has a comparable probability for transforming into a CH that mean centre can be discretionarily picked as CHs, in the best in class rounds. That mean centre have greater imperativeness will transform into a CHs instead of centre points with less essentialness.

V-LEACH: V-LEACH [17] is another type of LEACH tradition which expects to reduce essentialness use. The essential thought driving V-LEACH is that other than having a CH , there is a negative behaviour pattern CH that overpowers the position of CH when it passes on. By this, group centre data will

constantly accomplish the BS; no convincing motivation to pick another CH without fails.

Hu Junping, Jin Yuhui, Dou Liang et al, in [18] conspired a Time-based Cluster-Head Selection Algorithm for LEACH. We call this proposed convention as TB-LEACH. In this, the guideline of TB-LEACH is given with the flowchart and pseudo codes acknowledging TB-LEACH. Re-enactment comes about demonstrate that our calculation beats unique LEACH by around 20% to 30% as far as framework lifetime

Jinsuk Baek et al, [19] proposed a new mechanism for selection of cluster head and formation scheme for a cluster. In this scheme, every sensor node calculate its relative energy consumption. The outcomes of simulation justify that the suggested mechanism enhances lifespan of network and provides a pattern for well-balanced energy consumption compared to previously proposed schemes.

Elham Hajian et al, [20] proposed another system for the choice of course for information transmission. This philosophy depends on learning automata that chooses the course concerning separation from sink and energy parameters. Re-enactment comes about demonstrate that this technique has been extremely successful in expanding system lifetime.

Yuping Dong et al, [21] proposed applications for observation purposes in view of WSN. Two pivotal country security applications can be considered as Border security observing and fear based oppressor assault aversion. This calculation parities control utilization among nodes, and in this way draws out lifetime. Reproduction comes about check that our calculation beats the EECCR calculation proposed in.

. **Xu Long-long et al, [22]** present the remote sensor organize, and examine the issues in LEACH directing convention. It chipped away at adjusting energy utilization and dragging out the lifetime of sensor system by utilizing calculation. Imitating result demonstrates it is successful.

Xufei Mao et al, [23] demonstrates the sharp steering to improve the system throughput, by permitting nodes close-by that catch the transmission of nodes to take an interest in sending bundles, i.e. in forwarder list. We show a

energy productive shrewd steering system, indicated as EEOR. Broad reproductions in TOSSIM demonstrate that our convention EEOR performs superior to anything the notable ExOR convention.

PEGASIS

The Power-Efficient Gathering in Sensor Information Systems (PEGASIS) offered in [15] is a change over the LEACH convention. It depends on an ideal chain adjacent. The possibility of the arrangement of group and choice of group head is disposed of in PEGASIS. On place of various nodes, a solitary node in the chain speaks with the base-station. The PEGASIS is made out of two stages: relentless and gathering. The unfaltering stage comprises of a chains developments rather than group. In the chain arrangement, an insatiable calculation is utilized where the BS and sensor nodes are worried among those one ends up representing the head.

In the information gathering stage, every node conveys the detecting information to the closest neighbouring node until the entire information accumulated and handled at head node from where it is send to the BS. In PEGASIS, the sensor nodes closest to each other are in the chain and they shape a way for transmission. Deferral is brought about in information transmission from the far off node in the chain.

S. Lindsey and C. Raghavendra [6] introduced Power Efficient Gathering in Sensor Information Systems (PEGASIS) protocol in 2002. It is an improved version of LEACH. Rather than forming clusters, it is based on forming chains of sensor nodes. One node is mainly responsible for routing the aggregated information to the sink. Every node aggregates the collected information with its own information, and then passes the aggregated data to the next ring.

The distinction from LEACH is to employ or use multi hop transmission and choosing or selecting only one node to transmit to the sink or base station. Since the overhead caused by dynamic cluster formation is eliminated, multi hop transmission and data or information aggregation is employed or used, PEGASIS outperforms the LEACH.

Advantages in the PEGASIS protocol are:

1. It is an improved version of LEACH.

2. This protocol is in position to outgo LEACH for different or various network sizes and topologies cluster formation in LEACH, and reduces the number or quantity of data/information transmission volume through the chain of information aggregation.

3. The energy load is distributed uniformly within the network. To prevent the subsequent early death of sensor node, all sensor nodes act as leader successively.

Problems in PEGASIS protocol are:

1. In PEGASIS sensor nodes usually or probably die early.

2. It is assumed that every sensor node are often able to communicate with sink directly, however nodes typically use multi-hop communication with the sink in practical cases. Moreover, long-range communication directly from the node to the sink will breed an excessive amount of energy consumption.

3. The communication manner suffers from excessive delays caused by the one or single chain for distant nodes and a high probability for any node to become a bottleneck.

4. It is a troublesome task for all nodes to maintain a complete database about the location of all other nodes within the network, moreover the network is not very scalable as all nodes should have global knowledge of the network and use the greedy rule or algorithm.

TEEN

In 2001, A. Manjeshwar and D. P. Agarwal [7] projected Threshold sensitive Energy Efficient sensor Network Protocol (TEEN) protocol. Nearer nodes form clusters, with a cluster heads to transmit the collected information to one higher layer. Forming the clusters, cluster heads broadcast 2 threshold values. 1st one is hard threshold; it is minimum possible value of an attribute to trigger a sensor node. Hard threshold permits nodes transmit the event, if the event happens within the range of interest. Thus a significant reduction of the transmission delay

happens. Unless an amendment of minimum soft threshold happens, the node doesn't send a new data packet. Using soft threshold prevents from the redundant information/data transmission. Since the protocol is to be attentive to the rapid changes in the perceived attribute; therefore, it is appropriate for time-critical applications.

Advantages in TEEN protocol are:

1. Supported by the thresholds, data transmission are often controlled commendably, i.e. , only the sensitive data we have a tendency to demand are often transmitted, so that it reduces the energy transmission consumption and improves the effectiveness and utility of the receiving data.

2. TEEN is complement for reacting to huge changes in the sensed attributes that is appropriate for reactive scenes and time decisive applications.

Disadvantages in TEEN protocol are:

1. It is not appropriate for periodic reports applications since the user might not get any data at all if the values of the attributes may not arrive at the threshold.

2. If CHs don't seem to be within the communication range of each other, the data may be vanished, because information transmission is accomplished only at CHs.

APTEEN

A. Manjeshwar and D. P. Agarwal [8] projected Adaptive Threshold sensitive Energy Efficient sensor Network Protocol (APTEEN) protocol in 2002. The protocol is a modification of TEEN aiming to capture time- critical events and periodic data collections together. The network architecture is same as TEEN. While forming clusters, the cluster heads circulate attributes, the threshold values, and therefore the transmission schedule to any or all nodes. Cluster heads are also responsible for data aggregation so as to decrease the size of data transmitted and the energy consumed.

According to energy dissipation and network lifetime, TEEN provides higher performance than LEACH and APTEEN because of the reduced number of transmissions. The main shortcomings of TEEN and APTEEN are overhead and

complexity of forming clusters in multiple levels, implementing threshold-based function etc. APTEEN is based on query system which permits 3 types of queries: historical, on-time, and persistent which can be employed in hybrid network.

Advantages:

1. APTEEN merges both proactive policies, which are same as that of LEACH, and reactive policies, which is same as that of TEEN. Subsequently, it is appropriate in each proactive and reactive application.

2. It embodies lots of flexibilities and set the count-time interval and the threshold values for the energy consumption by changing the count as well as the threshold values.

Disadvantages:

1. There exist supplementary complexity which is required to implement threshold functions and the count time.

2. Actually, each TEEN and APTEEN has the identical drawbacks of additional overhead and complexity of cluster construction in multiple levels.

SEP

In 2004, G. Smaragdakis, I. Matta and A. Bestavros [9] projected Stable Election Protocol (SEP) protocol. This protocol is also a further modification to the LEACH protocol. It's heterogeneous aware protocol, supported weighted election probabilities of every node to become cluster head according to their specific energy. This approach certifies that the cluster head election is arbitrarily selected and distributed based on the fraction of energy of every node assuring a uniform use of the nodes energy. In this protocol, 2 types of nodes (two tier in-clustering) and 2 level hierarchies were considered.

Advantage of SEP:

1. SEP does not require any universal knowledge of energy at each election round.

Disadvantages of SEP:

1. The shortcoming of SEP method is that the election of the cluster heads among the two type of nodes is not dynamic, which results that the nodes that are far away from the powerful nodes will die first.

EECS

In 2005, M. Ye, C. Li, G. Chen and J. Wu [10] projected Energy Efficient Clustering Scheme (EECS) protocol. It is a novel clustering scheme for periodical data collecting applications for wireless sensor networks. It elects cluster heads with more remaining energy through local radio communication. In the cluster head election phase, a stable number of candidate nodes are elected and compete for cluster heads according to the node residual energy. The competition method is localized and without iteration.

The process also produces a near uniform distribution of cluster heads. Moreover in the cluster formation phase, a unique approach is introduced to balance the load among cluster heads. However, on the other hand, it will increase the necessity of global knowledge regarding the distances between the cluster-heads and the base station.

Advantages

1. EECS builds balancing point between intra-cluster energy consumption and inter-cluster communication load based on energy and distance

2. Clustering is performed by dynamic sizing based on cluster distance from the BS. This addresses the problem that the clusters with a large distance to the BS require more energy for transmission than those with a shorter distance, and produce low message overhead and uniform distribution of CHs compared to LEACH.

Disadvantages

1. On account of single- in EECS, long-range transmissions directly from CHs to the BS may lead to huge energy consumption. Thus, it is not suitable for large-range networks.

2. EECS needs huge global knowledge about the distances between the CHs and BS, and therefore the task of the global data aggregation adds overheads to all sensor nodes.

3. EECS produces rather more control overhead complexity because all nodes must compete for becoming CHs.

DEEC

In 2006, Q. Li, Z. Qingxin and W. Mingwen [11] projected Distributed Energy Efficient Clustering Protocol (DEEC) protocol. DEEC protocol is a cluster based method for multi-level and 2 level energy heterogeneous wireless sensor networks. In this scheme, the cluster heads are chosen using the probability based on the ratio between residual energy of every node and the average energy of the network. The era of being cluster-heads for nodes are entirely different according to their initial and residual energy. The nodes with more initial and remaining energy have greater chances of the becoming cluster heads compared to nodes with low energy.

Advantages of DEEC:

1. DEEC doesn't need any of energy at each election round.

2. In contrast to SEP and LEACH, DEEC will perform well in multi-level heterogeneous wireless network

Disadvantages of DEEC:

1. Advanced nodes always punish in the DEEC, particularly when their residual energy reduced and when they come in the range of the normal nodes. During this position, the advanced nodes die rapidly than the others.

HEED

O. Younis and S. Fahmy projected [4] Hybrid Energy Efficient Distributed clustering Protocol (HEED) protocol in 2004. It extends the fundamental or the basic scheme of LEACH by using residual energy as primary parameter and network topology features such as node degree, distances to neighbours are only used as secondary parameters to shatter the tie between the candidate cluster

heads, as a metric for cluster choice to attain power balancing. The clustering process is split into a number of iterations, and in every iteration nodes that are not covered by any cluster head doubles their probability of becoming a cluster head. As these energy- efficient clustering protocols further enables each node to probabilistically and independently decide its role in the clustered network. Moreover they cannot guarantee optimal elected set of cluster heads.

Advantages of HEED protocol are:

1. It is a distributed clustering method that benefits from the use of the two important parameters for CH election.

2. Low power levels of clusters endorse an increase in spatial reuse while high power levels of clusters are needed for inter-cluster communication. This imparts uniform CH distribution across the network and load balancing.

3. In a multi-hop fashion, communication between CHs and BS provides more energy conservation and scalability in contrast with the single-hop fashion, i.e long range communication directly from CHs to the sink, as within the LEACH protocol.

Limitations with HEED protocol:

1. Tentative CHs that do not become final CHs leave some uncovered nodes. Based on implementation of HEED, these nodes are forced to become a CH and these forced CHs may not have any member associated with them or may be in range of other CHs. As a result, more CHs are generated than the expected number and this also responsible for unbalanced energy consumption in the network.

2. Similar to LEACH, the clustering in each round imposes significant overhead in the network. This overhead causes remarkable energy dissipation which results in decreasing the network lifetime.

3. HEED suffers from a subsequent overhead since it needs several iterations to form the clusters. Therefore at iteration, a lot of packets are broadcasted. 4. Some CHs, particularly near the sink, might die earlier because these CHs have huge workload.

H-HEED

Harneet Kour and Ajay K. Sharma, 2010 discuss about the H-HEED protocol. This protocol is basically used in heterogeneous wireless sensor network. H-HEED protocol is employed to extend the network life [2]. The impact of heterogeneity in terms of node energy in wireless sensor network has been stated. H- HEED (Heterogeneous Hybrid Energy Efficient Distributed) is the revised version of the HEED protocol in terms of non- homogeneity. Here the cluster head is chosen based on the fraction of residual energy to the utmost energy possessed by the sensor nodes. Head to head communication takes place and unlike energy levelled networks have been formed. The energy efficiency has been verified in terms of the energy needed for the transmission and reception of the data. Here the node substitution takes place in order to reenergize the network and to enhance the network life.

Advantages:

1. H-HEED protocol is superior version of HEED protocol in terms of heterogeneity.

2. It is used to extend the network lifetime; network is re-energized by node replacement technique.

Disadvantages:

1. H-HEED can't work or out perform well in the homogenous environment as DEC protocol can do so.

Swarm Intelligence Based Algorithm

Another class of calculations, propelled by swarm insight. These calculations depend on the correspondence of an enormous measure of cooperating operators parallel. A portion of the classifications are Ant based calculation, honey bee based calculation and thin based calculation and reasonable swarm improvement calculation.

Camilo in 2006 built up an Energy Efficient Ant-Based Routing calculation (EEABR) [24]. In each node, subterranean insect data is put away in

information structure, while the schema of directing table incorporates the past node, the forward node, the insect distinguishing proof and timeout esteem.

Saleem and Farooq in 2007, actualized colony steering convention for remote sensor systems [25] which are produced initially for wired systems.

Xiaoming Wang in 2008 built up an Ant Colony enhancement based Location-mindful Routing (ACLR) as another correspondence convention [38] called insect province streamlining based area mindful directing, which depends on the subterranean insect settlement advancement (ACO). The subterranean insect state improvement (ACO) construct directing plan that works in light of the standards of subterranean insect searching conduct, permitting a subterranean insect province to perform complex tasks.[26].

Colony is improvement is roused by the scout-enlist arrangement of bumble bees [27]. Ooze shape term is utilized for heterotrophic living being, at provinces and remote sensor systems.

As of now specified some time recently, a remote sensor system can be seen as a "state" of sensor nodes. These nodes are straightforward, with settled limit and rare assets, and can react at the same time. All things considered, they can perform straightforward assignments [28].

Xu in Ji in [29], proposed a PSO based system for grouping in LEACH.

CHAPTER 3

SCOPE OF THE STUDY

At present directing in WSNs is a hot research subject. Here, I have led an overview of the different most recent steering protocols in WSNs. We considered an examination of the directing protocols talked about in the exposition as far as grouping way, intra-group topology, group head determination. In spite of the fact that the exhibitions of these conventions are empowering for enhancing adaptability of extensive scale WSNs, a few issues stay to be considered. For clustering in information mining a few heuristic systems, for example, GA is being utilized effectively. These can be successfully utilized as a part of grouping of nodes in WSN environment where equi-dissemination of space and energy are the genuine attentiveness toward upgrading the lifetime of system.

We can further use the genetic algorithms and several heuristic optimisation techniques to enhance the performance of wireless sensors further. Nowadays everything is being operated and manufacture by the help of sensors and the optimisation is must. In dissertation I try to optimise the energy of sensors to increase the life span of sensors. By using genetic algorithm with search algorithms I try to optimise the network lifetime so that they can be utilised more effectively and efficiently.

CHAPTER 4

PRESENT WORK

4.1 Problem Formulation

Wireless Sensor Networks are made up of numerous small electronic devices called nodes which gather the information from their environment nearby and then send the collected information to base station where further analysis and forecasting can be done. The analysed information is used to take managerial resolutions or business decisions. In multiple issues and numerous scenarios the sensor networks have become tool for information analysis. This has given the capability of remotely monitoring of a physical surrounding for a wide and distinct scenarios and different problem context. These tiny nodes are self-regulating which provide ability of distributed computing in the network. With distributing computing the network can be made flexible or ductile to adopt several methods for deployment, security enforcement, and routing and information dissemination.

Energy efficiency is an important aspect in WSN as nodes have a finite battery power. The various types of limitations make WSN and different protocols challenging and divergent. WSN has emerged as a completely different technology as compared to standard traditional internet architecture. Several Energy efficient self-organization and initialization protocols are developed for increasing the efficiency of WSN. For example, a sensor system can be utilized for identifying the nearness of potential dangers in a military clash.

A large portion of battery energy is devoured by accepting and transmitting data. In the event that all sensor nodes transmit data straightforwardly to the BS, the uttermost node from BS will bite the dust early. Then again, among sensor nodes transmitting data through various jumps, node nearest to the BS tends to bite the dust early, abandoning some system territories totally unmonitored and bringing about system segment. Keeping in mind the end goal to augment the lifetime of WSN, it is vital for correspondence conventions to delay sensor nodes' lifetime by limiting transmission energy utilization, sending data by means of ways

that can evade sensor nodes with low energy and limiting the aggregate transmission control. This sort of system requires the adequacy of every sort of operation regarding energy. Increasingly the energy will be squandered, lesser the system life will be. A system is the system of associated sensors characterized as far as radio recurrence, extend determination and so on.

Every gadget accessible nowadays having some sensor consolidated in it, for example, portable PCs, mobiles and so forth. On account of this it is the testing advance region that requires plausibility as far as memory, power utilization, memory administration, security and so forth. The monetary and the innovative elements are additionally required to be investigated. The complexities of this sort of system additionally increment with the consideration of heterogeneity, condition, and sun based energy parameters and so forth. The testing territory in WSN incorporates the data arranged work, convention adjustment, security improvement and so on.

The protocol plays important role. These protocols are responsible for the efficient energy utilisation and to enhance the lifespan. LEACH (Low Energy Adaptive Clustering Hierarchy) and PEGASIS (Power-Efficient Gathering in Sensor Information System) are such typical hierarchical-based routing conventions. As we have already explained the various flavours of LEACH algorithm proposed in the last decades. Clustering is the main factor responsible for the energy consumption and energy conservation in LEACH algorithm. Our hypothesis also points to the same concept. We hereby propose to do clustering of WSN nodes in such a manner that transmission energy from the nodes to cluster head (CH) is minimized.

4.2 Objective of Dissertation

The proposed work is about to some heuristic based technique as a cluster algorithm such as Gravitational Search Algorithm (GSA) for finding an optimal clustering scheme instead of using some random method, thus less utilisation of energy and rounds of transmission to BS increased. For this, it will combine few parameters such as number of dead nodes, number of packets sends to base station distance as basic parameter for clustering. The proposed system is supposed to increase the overall network lifetime of WSN. The proposed scheme will use plain aggregation of information. So, we decide the following objectives for dissertation work:

1. To propose GSA based energy efficient cluster based routing scheme.
2. To simulate the proposal.
3. To verify and validate the results by comparing it with other flavour of LEACH algorithm.

4.3 Research Methodology

4.3.1 Leach in WSN

To simulate LEACH, a random 100-node networks with similar parameters used in [20]. We placed the BS at a large range from all other nodes.

Parameter Selection for Simulation

A list of parameters required for the implementation of LEACH with strategies of encryption has been discussed. The corresponding value is also specified for each parameter.

Table 4.1 Parameter setting for simulation.

Parameters	Description of Parameters	NET_MODEL
Length	Length of the field Area	100 m
Width	Width of the field Area	100 m
Num_Nodes	Total number of nodes	100
bsX	x coordination of base station	50 m
bsY	y coordination of base station	200 m
ctrPacketLength	Length of packet that sent for nodes to CH	200 bits
PacketLength	Length of packet that sent for CH to BS	6400 bits
initEnergy	Initial energy of each node	0.5nJ
transEnergy	Energy for transferring of each bit (ETX)	50 nJ/bit
recEnergy	Energy for receiving of each bit (ETX)	50 nJ/bit
fsEnergy	Energy of free space model	10e-12 J/bit
mpEnergy	Energy of multi path model	1.3e-15 J/bit
aggrEnergy	Data aggregation energy	5e-9 J/bit

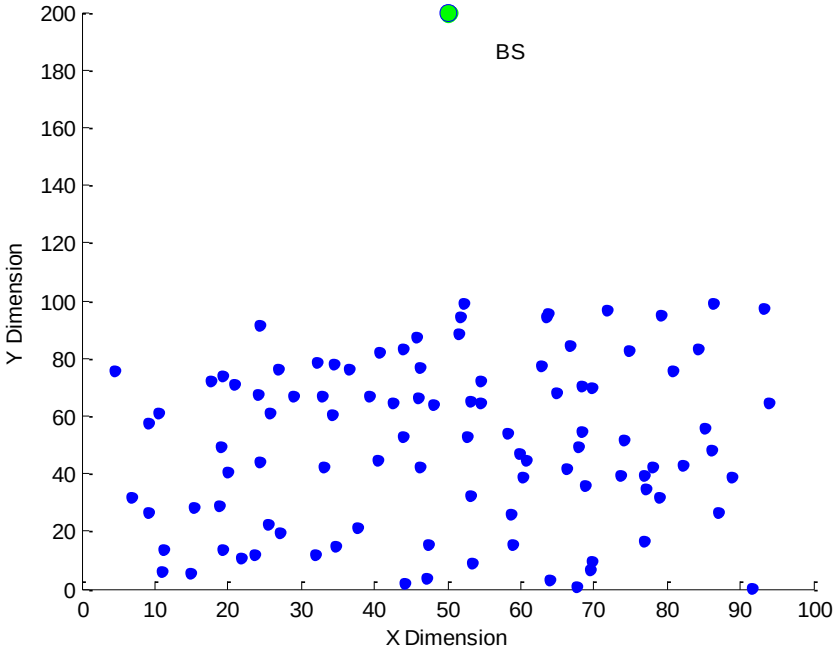

Figure 4.1 WSN Node Deployments

The algorithm for above deployment is described further. The algorithm has several steps. The algorithm includes network implementation steps, cluster setup phase of the nodes along with the steady state phase. It also repsonsible for the display of the number of packets send to the station and also display the number of dead nodes. The algortihm of random LEACH has been elaborated further in the pictorial form.

Step 1: Create the network architecture with desired parameters
Step 1.1 Create the field Area
Step 1.1.1 x and y Coordinates of the base station
BsX = x coordination of BS
BsY = y coordination of BS
Step 1.1.2 Create the node model randomly
x coordination of nodes
y coordination of nodes
Step 1.1.3 initially there are no cluster heads, only nodes 1 for 'N' =non-CH node, 2 for 'C' = CH node, 3 for 'D'= Dead node
Step 1.2 Energy Model (all values in Joules)
Specify Initial Energy of node
Specify Energy for transferring/receiving of each bit (ETX)
Transmit/receive Amplifier types
Energy free space;
Energy multi path
Information Aggregation Energy
Step 2: plot field area with its nodes and BS
Step 3: for each round
Step 3.1 Create the new node architecture using random leach/max_enrgy_Leach/K_Mean_leach algorithm in beginning of each round. Random leach algorithm in which nodes are selected CHs randomly and number of CHs is also variable. Max_ energy leach algorithm in which max. energy nodes are selected as CHs and CH is also fixed as p*live Nodes
Step 3.2: if (any cluster is formed during round)
Find Energy dissipation patterns for nodes
End if
End for
Step 4: Display number of packets sent from CH, energy dissipation per round and dead node pattern for each round.

Fig 4.2 Random LEACH Algorithm

4.3.2 Random Leach in WSN

In Random LEACH, each node has equal opportunity to be selected as cluster head (CH) with a probability *p*. the probability function is normal distribution function spread over every 10 rounds. It doesn't care about the energy a node is having. To become cluster head a node must be live and should have sufficient energy to send information to BS. After selection of cluster heads every node selects its cluster head on the basis of distance. It selects its cluster head which is closest to its position. The following algorithm shows the LEACH.

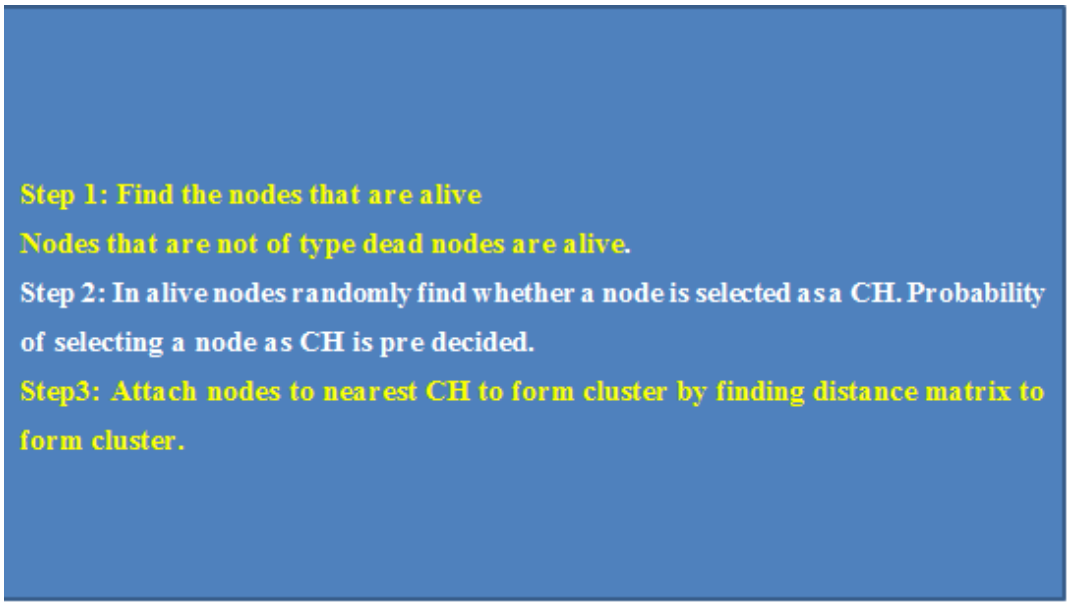

Fig 4.3 Max Energy Leach in WSN

4.3.3 Max Energy Leach in WSN

In contrast to Random LEACH, Max Energy LEACH selects cluster head (CH) to those nodes which as the maximum energy. In this algorithm first all nodes are sorted as per their energy status in each round and then first k nodes are selected as CH. After selection of cluster heads every node selects its cluster head on the basis of distance. It selects its cluster head which is closest to its position.

4.3.4 K-means LEACH Algorithm

In this algorithm idea is to select cluster in such a way that their intra distance is minimum which ensures that less communication energy is consumed and WSN can run more rounds. K-means [27] is one of the simplest unsupervised learning algorithms that solve the well known clustering problem. The procedure follows a simple and easy way to classify given information set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids should be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given information set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early group age is done. The following algorithm specifies the concept of maximum LEACH.

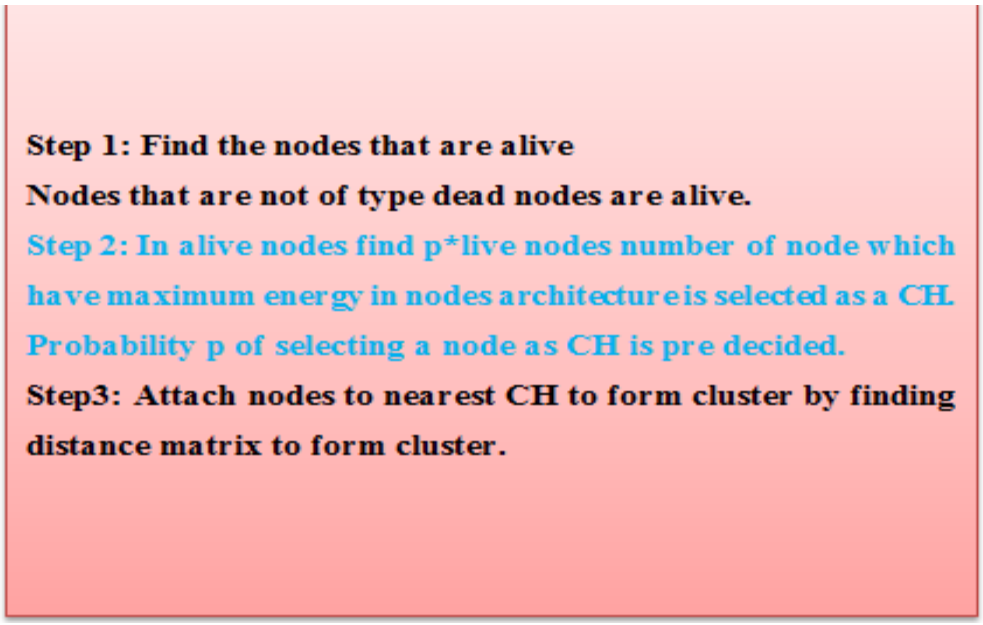

Fig 4.4 Maximum LEACH

At this point we need to re-calculate k new centroids as centre of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same information set points and the nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done. In other words centroids do not move any more. Finally, this algorithm aims at minimizing an objective function, in this case a squared error function. The objective function

$$J = \sum_{j=1}^{k} \sum_{i=1}^{n} \left\| x_i^{(j)} - c_j \right\|^2 \quad \text{,} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.5)$$

where $\left\| x_i^{(j)} - c_j \right\|^2$ is a chosen distance measure between a information point $x_i^{(j)}$ and the cluster centre c_j, is an indicator of the distance of the *n* information points from their respective cluster centres. Although it can be proved that the procedure will always terminate, the k-means algorithm does not necessarily find the most optimal configuration, corresponding to the global objective function minimum.

The algorithm is also significantly sensitive to the initial randomly selected

cluster centre. The k-means algorithm can be run multiple times to reduce this effect. The algorithm is composed of the following steps:

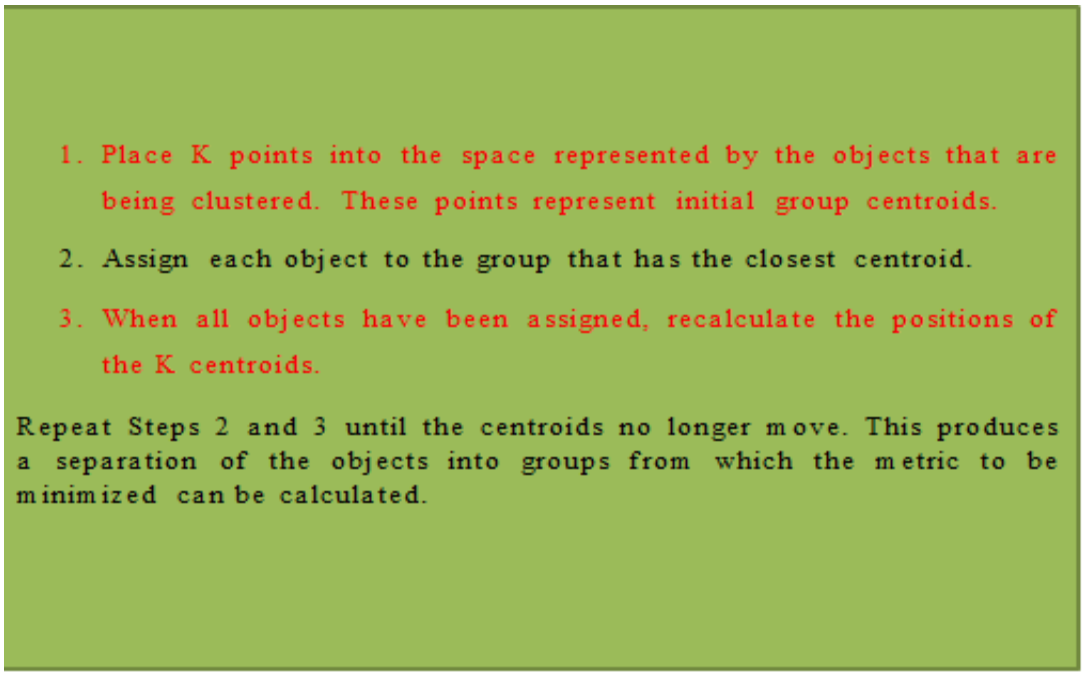

Figure 4.5 K-means Algorithm

K-means is a simple algorithm that has been adapted to many problem domains. As we are going to see, it is a good candidate for extension to work with fuzzy feature vectors.

The algorithm for this is given below:

Step 1: Find the nodes that are alive

Nodes that are not of type dead nodes are alive.

Step 2: In alive nodes using some standard clustering algorithm such as k- means or k-medoid for spatial distribution of nodes in clusters.

Step 3: In the next step, from each cluster CH is chosen on the basis of surplus energy, its position in cluster and its distance from Base Station, a node is having. So this scheme involves both things spatial distribution as well as energy distribution in the network architecture which may ultimately improve the network life and its quality.

4.3.5 Gravitational Search Algorithm

Gravitational Search Algorithm (GSA) is another latest search algorithm developed by Rashedi et.al in 2009. The GSA is based on the Newtonian law of gravity and the law of motion [Rashedi2009]. Here agents are considered as objects and their performance are based on its masses. All the objects attach to each other by a force called gravitational force and this force causes the global movement off all objects to object with heavier masses. The gravitational force between two particles is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. The heavy masses will correspond to good solutions and move more slowly and conversely light masses correspond to poor solutions and move towards heavy masses much faster. This guarantees the exploitation step of the algorithm.

In the GSA, consider a system with m masses in which position of the ith mass is defined as follows:

$$X_i = \left(x_i^1, \dots x_i^d, \dots x_i^n\right), i = 1, 2, \dots, n \quad \text{.....(4.1)}$$

where x_i^d is position of the ith mass in the dth dimension and n is dimension of the search space. At the specific time 't' a gravitational force from mass 'j' acts on mass 'i', and is defined as follows [19]:

$$F_{ij}^d(t) = G(t)\frac{M_{pi}(t)\times M_{aj}(t)}{R_{ij}(t)+\epsilon}\left(x_j^d(t) - x_j^d(t)\right) \quad \text{.....(4.2)}$$

where Mi is the mass of the object I, Mj is the mass of the object j, G(t) is the gravitational constant at time t, Rij (t) is the Euclidian distance between the two objects I and j, and ϵ is a small constant. The total force acting on agent I in the dimension d is calculated as follows:

$$F_i^d(t) = \sum_{i\neq j}^{m} r_j F_i^d(t) \quad \text{.....(4.3)}$$

where randj is a random number in the interval [0,1]. According to the law of

motion, the acceleration of the agent i, at time t, in the dth dimension, $a_i^d(t)$ is given as follows:

$$a_i^d(t) = \frac{F_i^d(t)}{M_{ii}(t)} \quad \text{(4.4)}$$

Furthermore, the next velocity of an agent is a function of its current velocity added to its current acceleration. Therefore, the next position and the next velocity of an agent can be calculated as follows:

$$V_i^d(t+1) = rand_i \times v_i^d(t) + a_i^d(t) \quad \text{(4.5)}$$

$$x_i^d(t+1) = x_i^d(t) + v_i^d(t+) \quad \text{(4.6)}$$

where randi is a uniform random variable in the interval [0, 1]. The gravitational constant, G, is initialized at the beginning and will be decreased with time to control the search accuracy. In other words, G is a function of the initial value (G_0) and time (t):

$$G(t) = G(G_0, t) \quad \text{(4.7)}$$

$$G(t) = G_0 e^{-\propto \frac{t}{T}} \quad \text{(4.8)}$$

This means that better agents have higher attractions and moves more slowly. Supposing the equality of the gravitational and inertia mass, the values of masses is calculated using the map of fitness. The masses of the agents are calculated using fitness evaluation. A heavier mass means a more efficient agent. The gravitational and inertial masses are updating by the following equations:

$$m_i(t) = \frac{fit_i(t) - worst(t)}{best(t) - worst(t)} \quad \text{(4.9)}$$

$$M_i(t) = \frac{m_i(t)}{\sum_{j=1}^{n} m_j(t)} \quad \text{(4.10)}$$

where fit i(t) represents the fitness value of the agent i at time t, and the best(t) and

worst(t) in the population respectively indicate the strongest and the weakest agent according to their fitness route. The proposed GSA approach for test case generation problem can be summarized as follows:

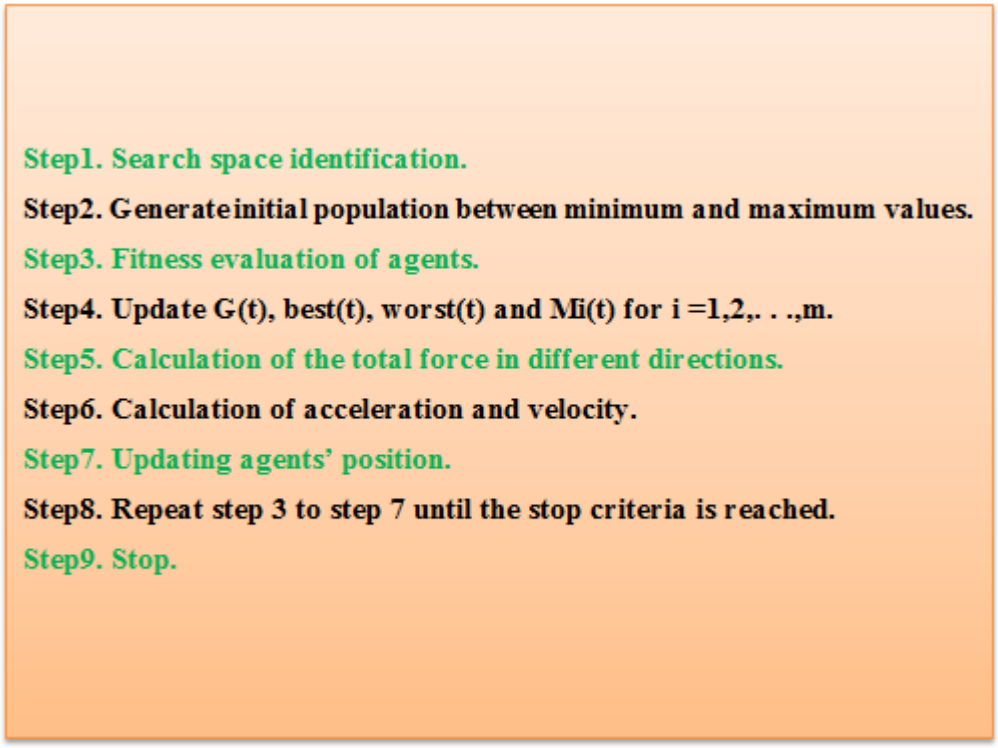

Fig4.6 GSA Algorithm

4.3.6 GSA-LEACH

In GSA-LEACH, Nodes are clustered in a fixed number of clusters (usually 10% of total live nodes). After that from each cluster a node is selected as CH based on its residual energy. The node which is having highest residual energy is chosen as CH.

The following algorithm shows it.

Step 1: Find the nodes that are alive

Nodes that are not of type dead nodes are alive.

Step 2: Cluster all the nodes in predefined number of clusters using GSA algorithm.

Step3: From each cluster Node with highest residual energy is chosen as CH.

Step4: Each node sends information to its CH and in turn each CH sends information to BS.

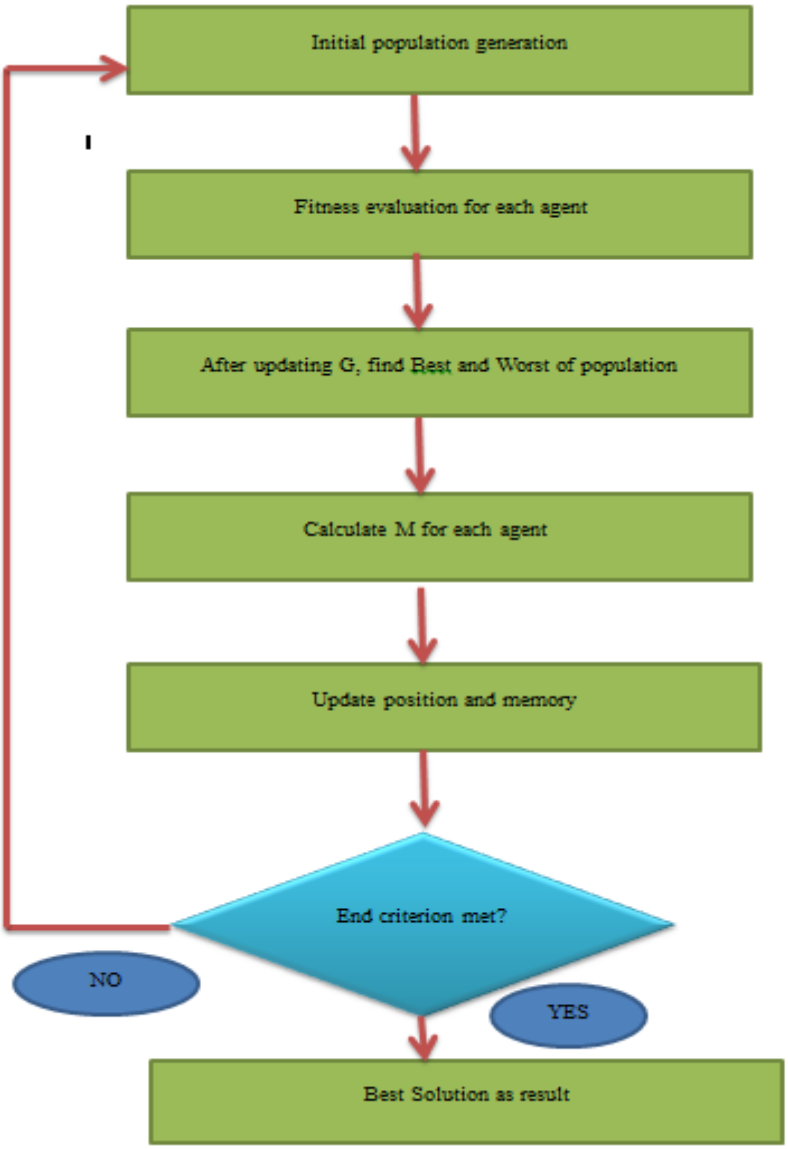

Figure 4.7 Gravitational search algorithm work flow

4.3.7 Genetic Algorithm

GA is a versatile technique that can be utilized to take care of hunt and improvement issues .It depends on the hereditary procedure of natural life forms. In contrast with different methods, GA all the more firmly underlines worldwide pursuit and enhancement, rather than the neighbourhood variations. GA begins improvement with a few arrangements. Every hopeful answer for a particular issue is called an individual or a chromosome and contains a straight rundown of

qualities. A populace is first arbitrarily instated, and every individual speaks to a point in the pursuit space and in this way a conceivable answer for the issue. GA then uses three fundamental administrators (determination, hybrid, and change) to control the hereditary synthesis of a populace. Determination is a procedure by which the people with the most noteworthy wellness values in the present era are repeated in the new era.

The hybrid administrator produces two off springs (new competitor arrangements) by recombining the data from two guardians. There are two master cessing ventures in this operation. In the initial step, a given number of intersection destinations are consistently chosen, alongside the parent individual haphazardly chose. In the second step, two new people are shaped by trading exchange determination matches between the chose locales. Change is an irregular adjustment of some quality values in a person. The allele of every quality is a possibility for change, and the transformation likelihood decides its capacity [9]. In the new era, the populace is more adjusted to the earth than the past era, and the development proceeds until meeting a streamlining paradigm. In the wake of disentangling the last individual, an ideal arrangement can be gotten [39].

4.3.8 Hybrid of genetic algorithm and gravitational search algorithm with LEACH

Despite the fact that GSA has been turned out to be an effective ideal calculation, in the wake of merging, GSA loses its capacity to investigate and winds up noticeably inert. Interestingly, GA can discover new arrangements with hybrid and change administrators when confronting untimely meeting however GA has issues in finding a correct arrangement [30]. Consequently, to handle untimely merging of GSA, GA_GSA_LEACH, which join GSA's standard speed and position refresh rules with GA's thoughts of hybrid and transformation, is displayed. GA_GSA_LEACH utilizes GA for era bouncing to keep away from GSA stalling out in the neighbourhood optima issue. That is to state, it coordinates GA's worldwide advancement and GSA's quick union by binding together hybrid and transformation administrators of GA and speed-relocation recipe of GSA to take care of enhancement issues all the more efficiently and effectively.

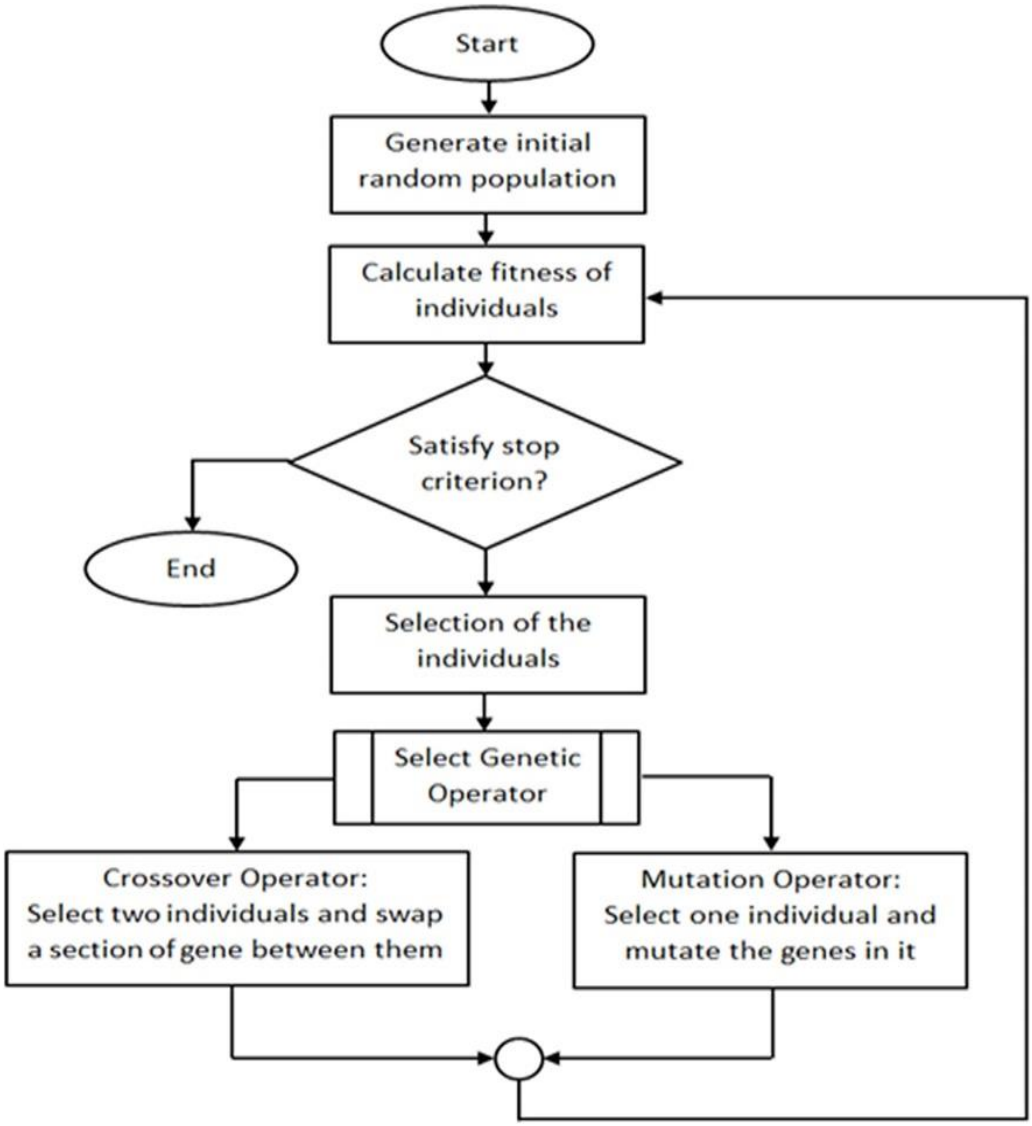

Fig 4.8 GA flow chart

GA_GSA_LEACH has three primary strides. Most importantly, produce a populace P′ from the first populace P as per the hybrid and transformation operations of GA. Furthermore, produce the following populace era P as indicated by the conditions of GSA.

Algorithm for GA_GSA_LEACH

Initialize population position $P = [\, p_1; p_2; : : : ; p_N \,]$
Initialize velocity $V = [\, v_1; v_2; : : : ; v_N \,]$
repeat
Evaluate agent fitness
(GA method) Perform GA crossover and mutation operations to generate new population P'
Update $G(t)$, **best**(t), **worst**(t) **and** $M_i(t)$ **for** $i = 1; 2; : : : ; N$
Calculate the total force in different directions
Calculate acceleration and velocity
Update agent's position P
Until the stopping criterion is met
Output the optimization results.

At long last, the best arrangement is returned in the wake of meeting the streamlining basis. As indicated by the above examination, the half and half of GA quicken the hunt capacity of GSA by joining the worldwide enhancement of GA with the quick neighbourhood pursuit of GSA. The meeting velocity of neighbourhood hence expanded, and the GSA no longer has a tendency to get `stuck' at nearby optima also. In the meantime, the inquiry precision makes strides. In this paper, genuine coding is utilized to maintain a strategic distance from the encoding and unravelling forms and enhance computational efficiency.

CHAPTER 5

RESULTS AND DISCUSSION

Five algorithms have been implemented in this thesis. In first algorithm i.e. Random LEACH algorithm is implemented where CHs are selected randomly based on a probability function. We have taken this probability as 10%. It is further improved by using a fair distribution of energy by selecting maximum energy nodes to be CHs. In this method a fix number of CHs are selected based on the number of nodes that are living. This algorithm is called Max_Energy_LEACH. Another modification is made in third algorithm where nodes are clustered based on inter distance by using a standard algorithm such as K-means. Finally we have implemented our GSA based proposed algorithm. We measure algorithms' efficiency by assessing total no. of rounds up to which network survives. A network is assumed to be live if more than 20% nodes are alive with total energy greater than zero. At last we implemented the proposed algorithm GA_GSA with more optimised solution.

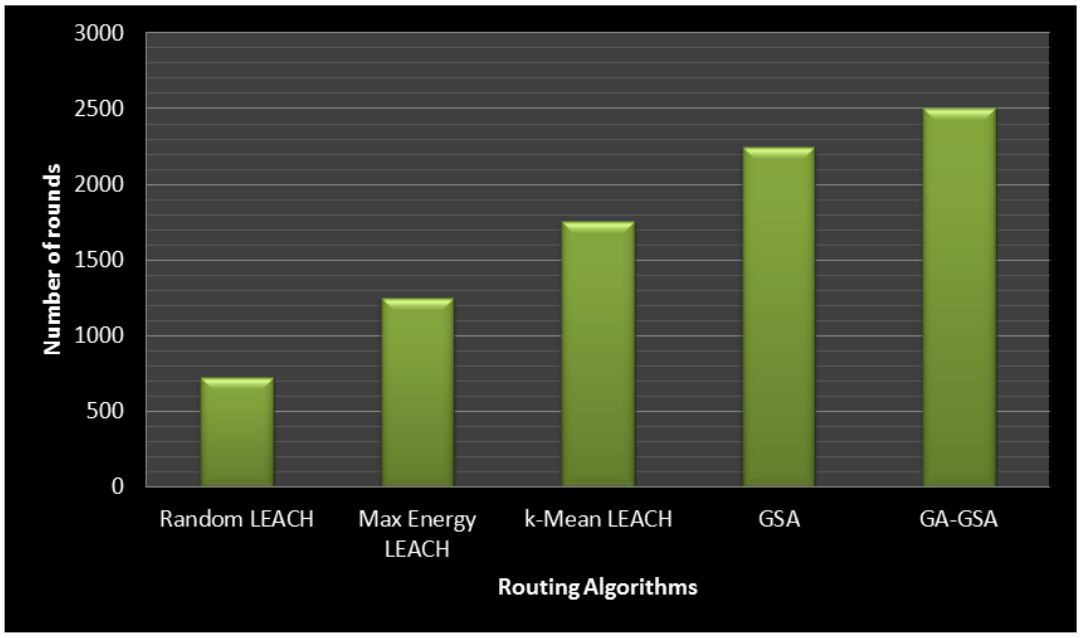

Fig 5.1 Number of rounds

Table 5.1 Number of rounds

WSN Routing Algorithm	**Network Life (in rounds)**
Random LEACH	727
Max Energy LEACH	1249
K-means LEACH	1756
GSA LEACH	2249
GA GSA LEACH	2500

In the table it is clearly shown that GSA clustering based LEACH algorithms perform far better as compared to other methods if we consider the no of rounds covered by the algorithms. The GSA algorithm performs nearly three times better than random LEACH and nearly 50% better than max energy LEACH in both of network model.

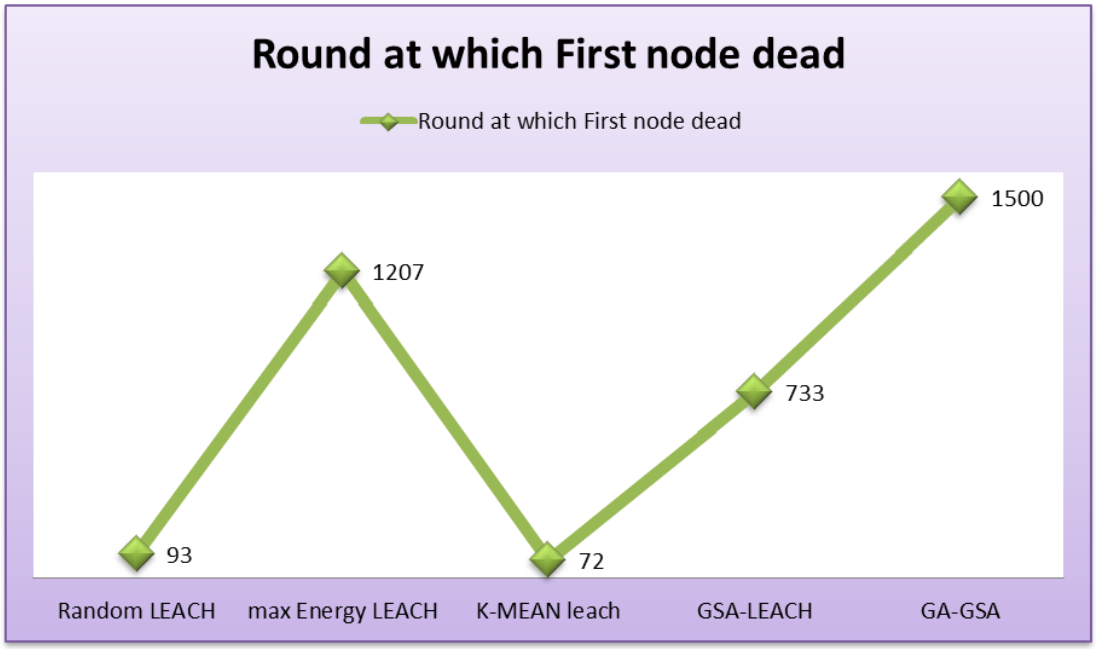

Fig 5.2 Round at which first node dead

If we consider a network, dead if 50% nodes are dead then Max Energy LEACH is performing better than K-means based LEACH and nearly equal to GSA variants LEACH. Random LEACH has performed worst in every situation. If we consider 80% node criterion for network life then the GSA algorithm performs better.

Table 5.2 Round at which first node dead

WSN Routing Algorithm	**Rounds in which first Node Dead**
Random LEACH	93
Max Energy LEACH	1207
K-means LEACH	72
GSA LEACH	733
GA GSA LEACH	1500

We can easily say that the GSA based algorithms is much better than random LEACH and K-means LEACH. Nearly 300% network life improvement is recorded for over simple LEACH and 50% over max Energy LEACH and K-means. If we compare the no of dead nodes as per our simulation results Max energy LEACH seems to perform better, but there nodes once start dying accelerates network decay very fast. On one front random LEACH and Kmeans-LEACH algorithms are lacking i.e. network disintegration. In these algorithms, first node is dead very early. Even GSA is not performing well if we consider this parameter. This is the grey area which needs to be addressed in future research.

If we consider no of packets sent to BS then Max Energy LEACH and GSA LEACH is clearly winner. Both have sent highest no of packets to BS but if we consider the ratio between packet sent and no. of rounds performed by the algorithm then Max Energy LEACH is clear winner in this.

Now let's compare the best algorithm among four with our proposed algorithm i.e. GSA_LEACH vs. GA_GSA_LEACH. GA_GSA_LEACH algorithms perform far better as compared to other methods if we consider the no of rounds covered by the algorithms than it is near about 89.96% more than previous algorithm. I f we consider the number of round at which the first node is dead is 1500 which also 48.86 % more than previous one. The network lifetime is increased, the energy consumption is also decreased in comparison to the pervious LEACH based GSA.

Now let's compare the various parameters for better understanding and formulation of these implemented algorithms.

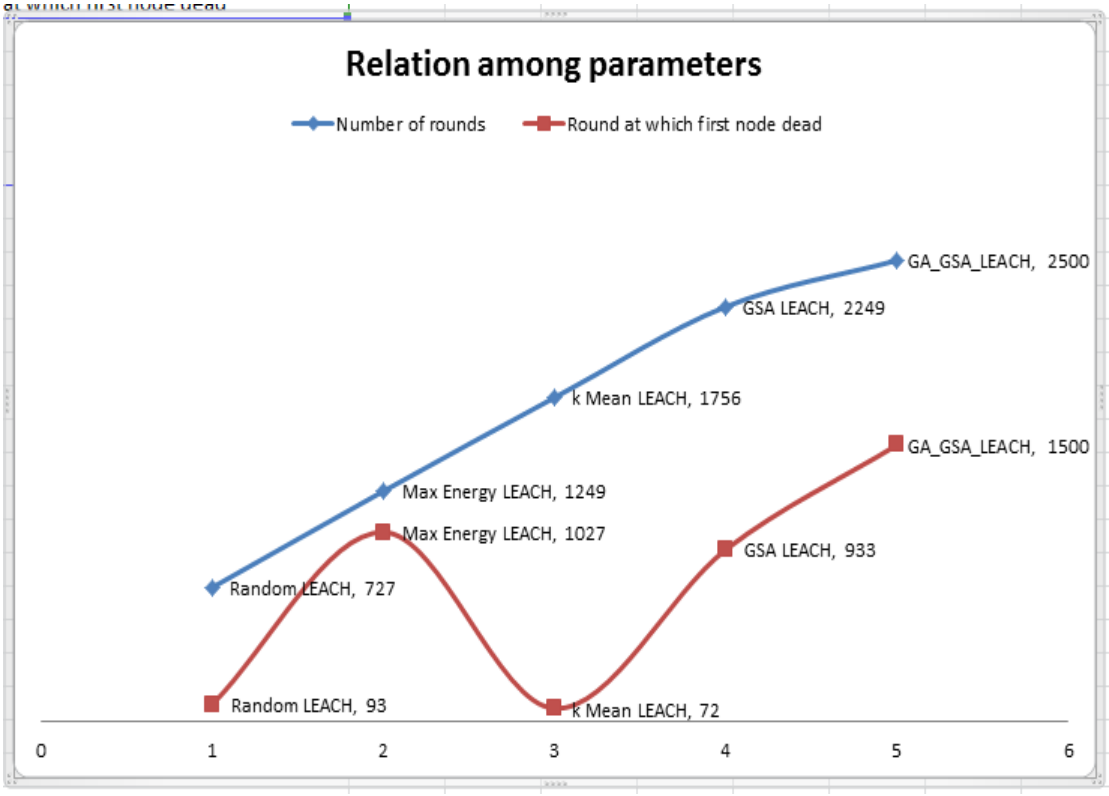

Fig 5.3 Relation among parameters

Here it is clear that as the number of rounds increased to the base station we can do a lot of data aggregation for taking decisions. The later the nodes start passing away the more is the effective network. In both cases the performance is highest in GA_GSA_LEACH. The number of rounds are highest with the late starting of passing thus it gives the long lifespan of network.

In end we can conclude that the proposed GA_GSA_LEACH is the best algorithm which gives the best solutions. GA_GSA_LEACH gives out the optimised results for the energy utilisation and network life span.

The deployment and end results of flavours of LEACH are shown below:

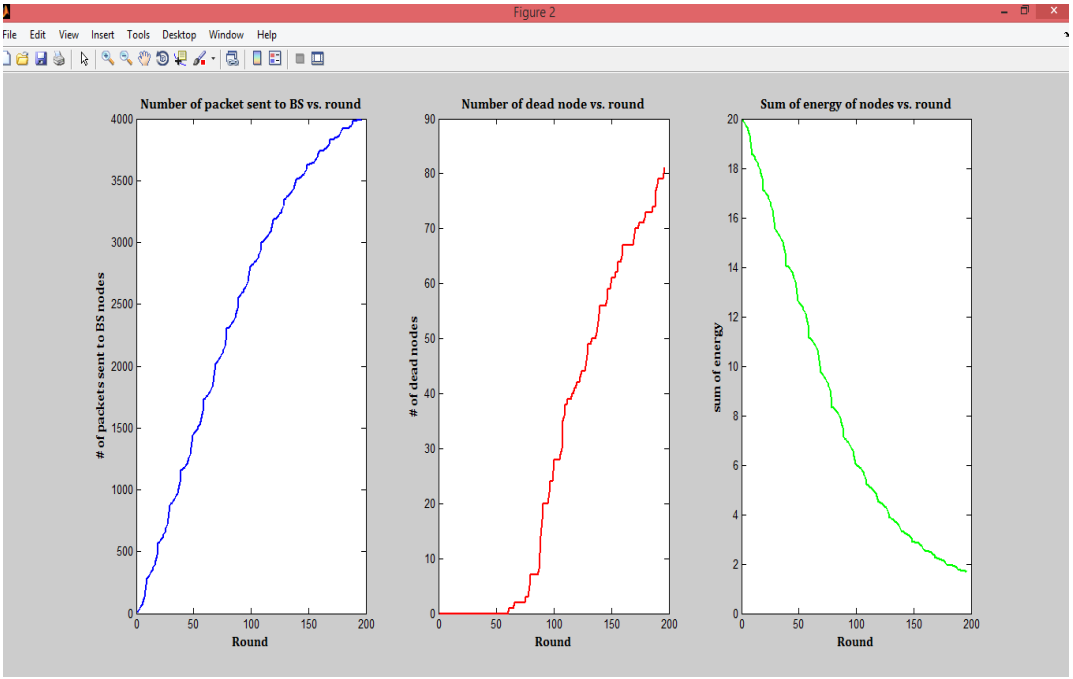

Fig 5.4 Random Leach in WSN

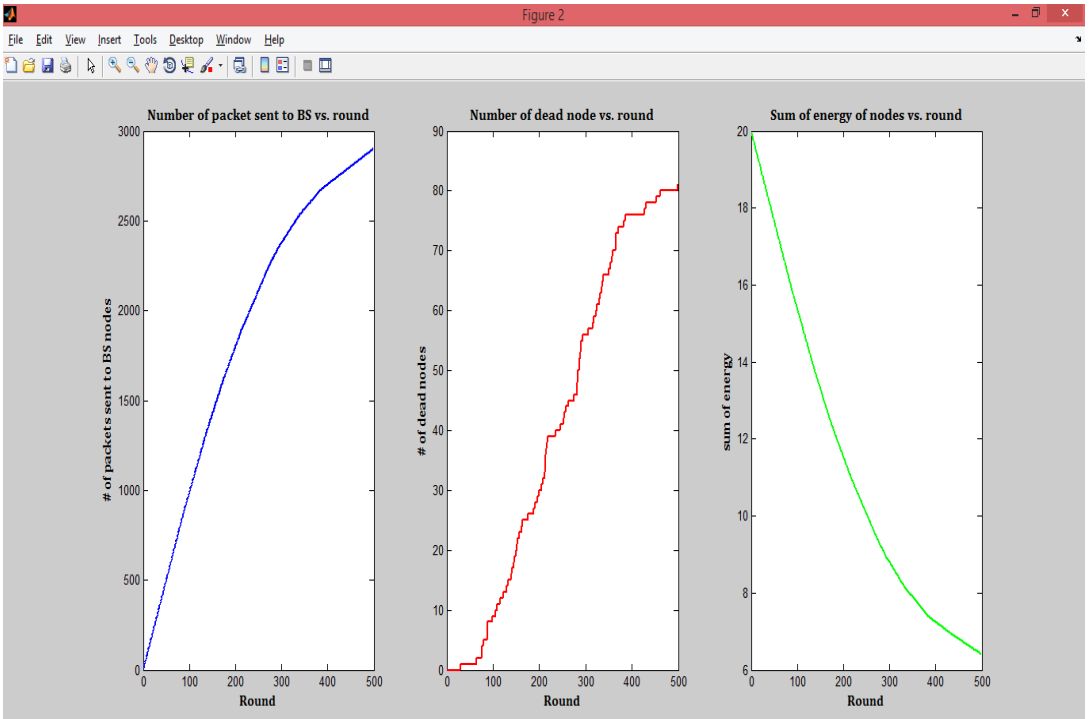

Fig 5.5 K-means LEACH Algorithm

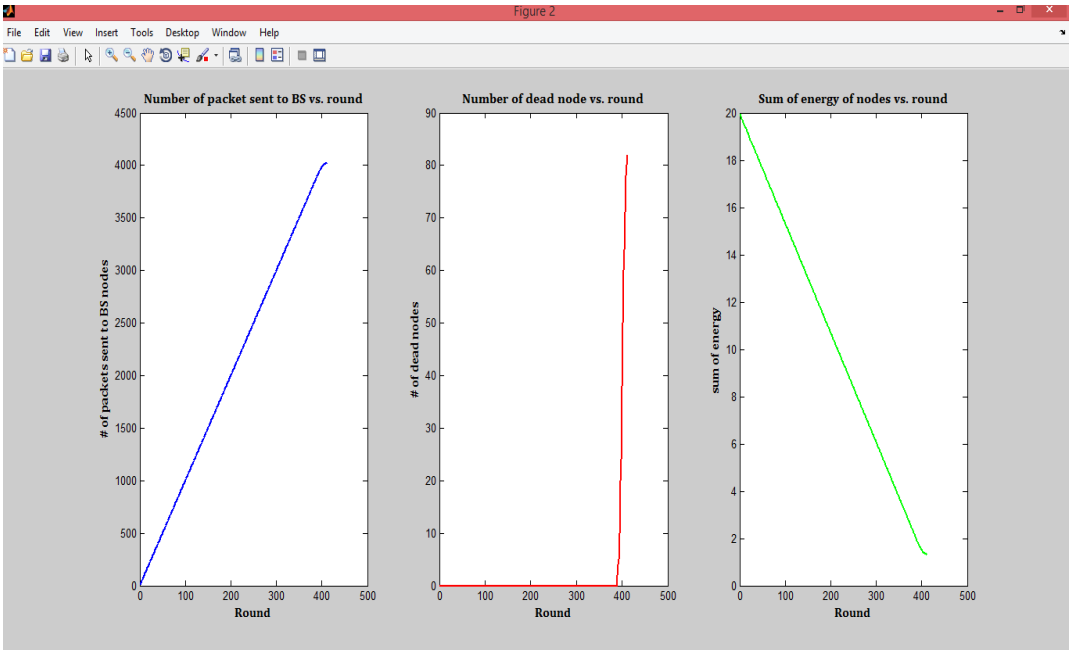

Fig 5.6 Max Energy Leach in WSN

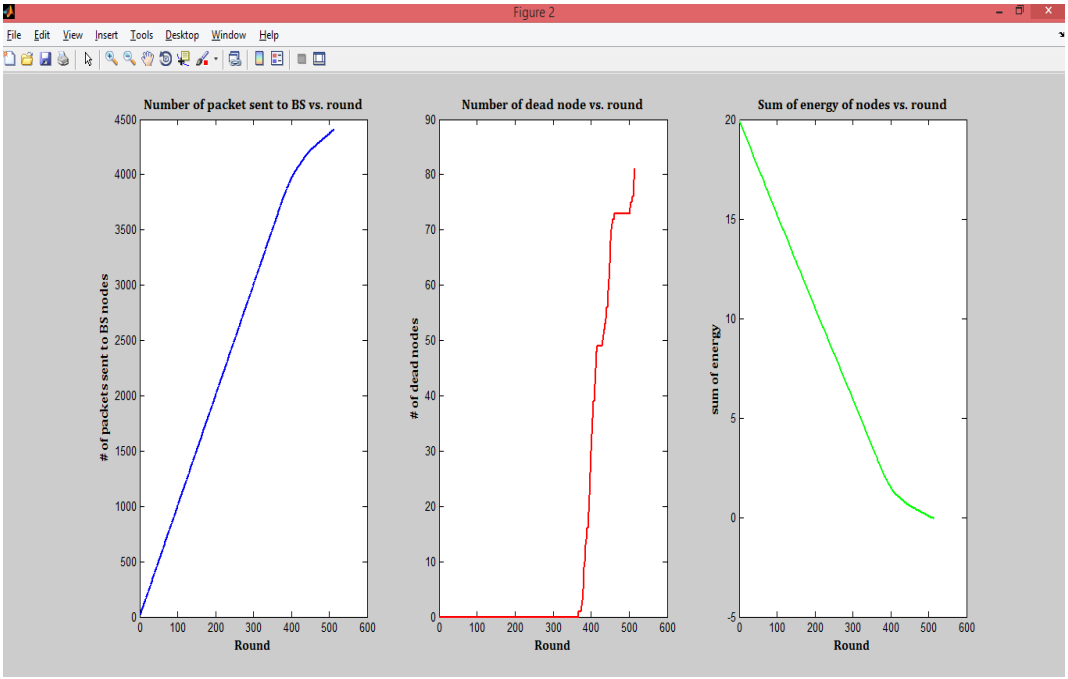

Fig 5.7 Gravitational Search Algorithm with LEAC

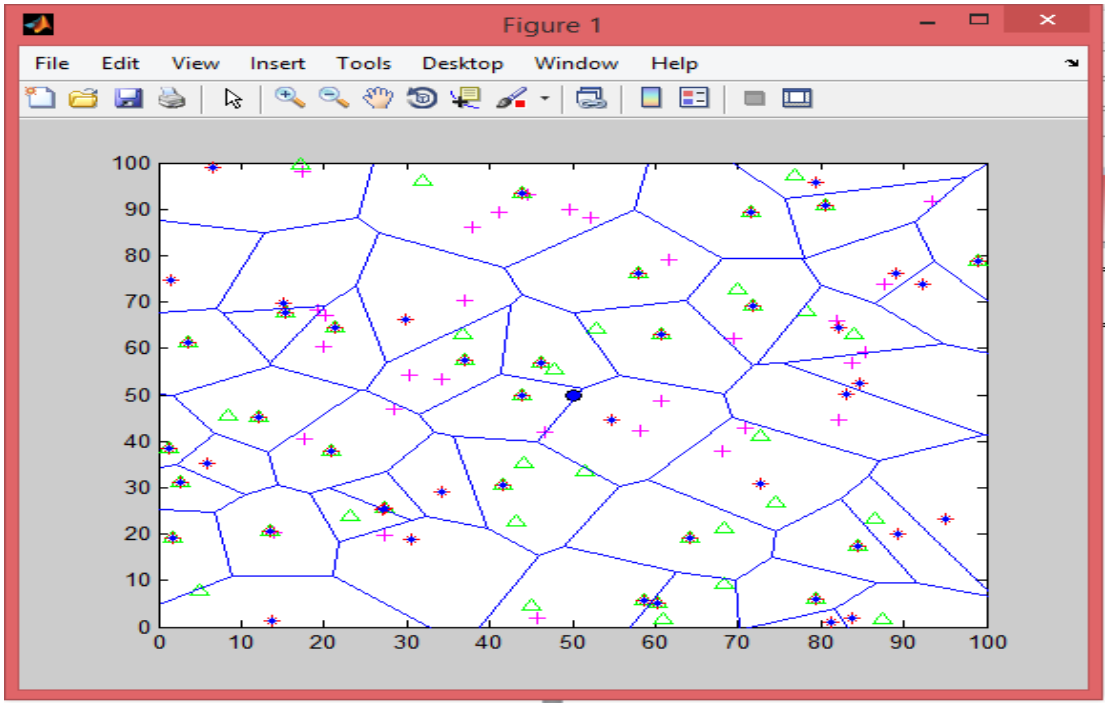

Fig 5.8 Node deployment of GA_GSA_LEACH

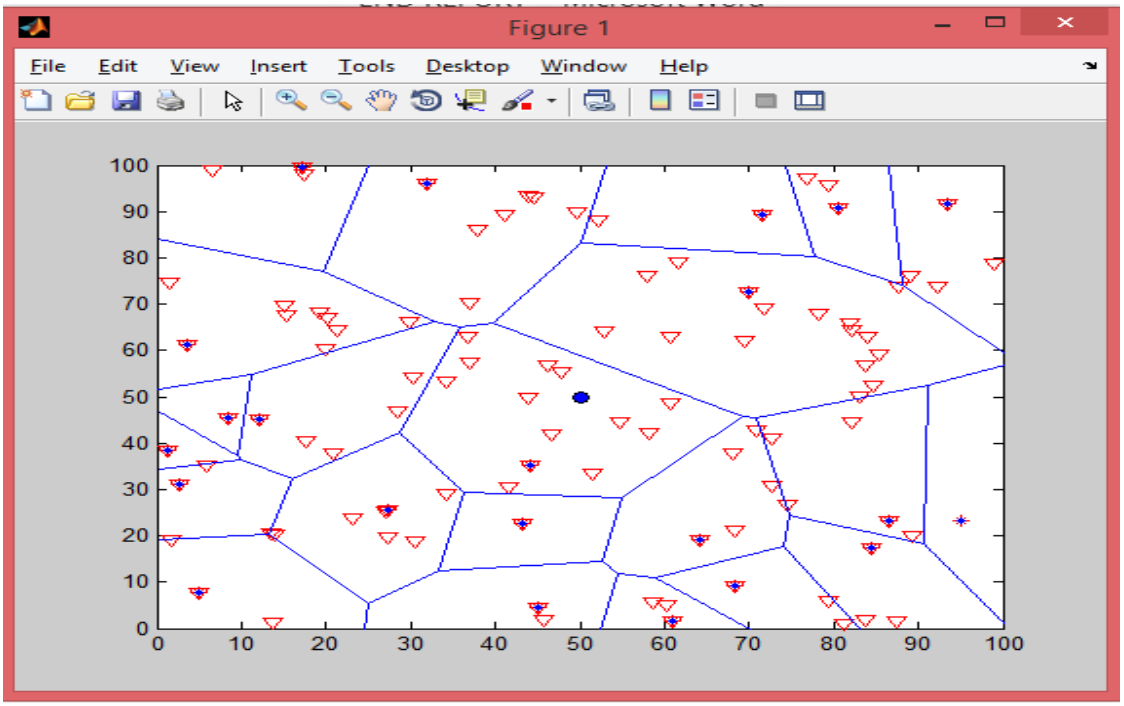

Fig 5.9 Node deployment of GA_GSA_LEACH

CHAPTER 6
CONCLUSION AND FUTURE SCOPE

6.1 Conclusion

The network life, no of dead nodes and no of packet sent to BS affect performance of routing algorithm in WSN. The performance of cluster based routing protocol shows some differences by varying life pattern among nodes and number of dead nodes. From our experimental analysis we conclude that GA_GSA_LEACH algorithm gives better performance in network life overall but could not restrict early network disintegration in case of lightly dense area. Max Energy LEACH perform better in network disintegration criterion but it give less network life as compared to

GA_GSA_LEACH. IN GA_GSA_LEACH which is made of both types of search capabilities performs better than other methods.

For GSA_LEACH vs. GA_GSA_LEACH. GA_GSA_LEACH algorithms perform far better as compared to other methods if we consider the no of rounds covered by the algorithms than it is near about 89.96% more than previous algorithm. I f we consider the number of round at which the first node is dead is 1500 which also 48.86 % more than previous one. The network lifetime is increased, the energy consumption is also decreased in comparison to the pervious LEACH based GSA.

6.2. Future Scope

We have improved the network life but one thing; we have observed that node starts dying early which is an area of concern in GA_ GSA_LEACH in dense network area. This can be addressed by considering other parameters of nodes' characteristics such as remaining node energy in addition to distance between them while clustering them. This technique may delay early node death problem. To prove the affectivity of GA_GSA_LEACH algorithm we also need to experiment with different positions of Base Station.

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APPENDIX

Acceleration: Acceleration, in physics, is the rate of change of velocity of an object with respect to time. An object's acceleration is the net result of any and all forces acting on the object, as described by Newton's Second Law. The SI unit for acceleration is metre per second squared. Accelerations are vector quantities (they have magnitude and direction) and add according to the parallelogram law. As a vector, the calculated net force is equal to the product of the object's mass (a scalar quantity) and its acceleration.

Area coverage: In telecommunications, the coverage of a radio station is the geographic area where the station can communicate. Broadcasters and telecommunications companies frequently produce coverage maps to indicate to users the station's intended service area.

Base station: In the area of wireless computer networking, a base station is a radio receiver/transmitter that serves as the hub of the local wireless network, and may also be the gateway between a wired network and the wireless network. It typically consists of a low-power transmitter and wireless router.

Clustering: Clustering is the task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). It is a main task of exploratory data mining, and a common technique for statistical data analysis, used in many fields

Cluster Head: A senor node. It is responsible for collecting data from member nodes inside the cluster. It is also responsible for aggregating and delivering data to base station. A node in a cluster that is responsible for collecting data from the sensors in its cluster and relay these data to the Base Station. The role of Cluster Head usually rotates between nodes in the cluster.

Cross Over: In genetic algorithms, crossover is a genetic operator used to vary the programming of a chromosome or chromosomes from one generation to the next. It is analogous to reproduction and biological crossover, upon which genetic algorithms are based. Cross over is a process of taking more than one parent solutions and producing a child solution from them.

Fitness Function: In particular, in the fields of genetic programming and genetic algorithms, each design solution is commonly represented as a string of numbers (referred to as a chromosome). After each round of testing, or simulation, the idea is to delete the 'n' worst design solutions, and to breed 'n' new ones from the best design solutions. Each design solution, therefore, needs to be awarded a figure of merit, to indicate how close it came to meeting the overall specification, and this is generated by applying the fitness function to the test, or simulation, results obtained from that solution.

Fault Tolerance: Fault tolerance is one of the most important wireless sensor networks requirements. It ensures that the network continues to function correctly even when some components fail. In fact, fault tolerance is a need in this type of networks due to sensor node characteristics, radio communications and hostile environments in which these networks are deployed.

Genetic Algorithm: The genetic algorithm is a method for solving both constrained and unconstrained optimization problems that is based on natural selection, the process that drives biological evolution. The genetic algorithm repeatedly modifies a population of individual solutions. At each step, the genetic algorithm selects individuals at random from the current population to be parents and uses them to produce the children for the next generation. Over successive generations, the population "evolves" toward an optimal solution. You can apply the genetic algorithm to solve a variety of optimization problems that are not well suited for standard optimization algorithms, including problems in which the objective function is discontinuous, no differentiable, stochastic, or highly nonlinear. The genetic

algorithm can address problems of *mixed integer programming*, where some components are restricted to be integer-valued.

Gravitational search algorithm: Gravitational search algorithm (GSA) is an optimization algorithm based on the law of gravity and mass interactions. This algorithm is based on the Newtonian gravity: "Every particle in the universe attracts every other particle with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them".

Handheld: Handheld is a computing device small enough to hold and operate in the hand. Typically, the device has a either flat screen display with a small numeric keypad or alphanumeric keyboard, or a touchscreen providing a virtual keyboard and buttons (icons) on-screen. Many such devices can connect to the Internet and interconnect with other devices such as car entertainment systems or headsets via Wi-Fi, Bluetooth or near field communication (NFC). Integrated cameras, digital media players, mobile phone and Global Positioning System (GPS) capabilities are common.

Heuristic: In computer science, artificial intelligence, and mathematical optimization, a heuristic is a technique designed for solving a problem more quickly when classic methods are too slow, or for finding an approximate solution when classic methods fail to find any exact solution. This is achieved by trading optimality, completeness, accuracy, or precision for speed. In a way, it can be considered a shortcut. A heuristic function, also called simply a heuristic, is a function that ranks alternatives in search algorithms at each branching step based on available information to decide which branch to follow. For example, it may approximate the exact solution.

Network Lifetime: Generally defined as the time during which the network is operational. In other words the lifetime of network is defined as the operational time of the network during which it is able to perform the dedicated task. This is defined as the maximum duration of time during which deployed sensors have the capability of monitoring the phenomena of interest.

Manets: A mobile ad hoc network (MANET), also known as wireless ad hoc network or ad hoc wireless network, is a continuously self-configuring, infrastructure-less network of mobile devices connected wirelessly.

Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each must forward traffic unrelated to its own use, and therefore be a router. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic

Mutation: Mutation is a genetic operator used to maintain genetic diversity from one generation of a population of genetic algorithm chromosomes to the next. It is analogous to biological mutation. Mutation alters one or more gene values in a chromosome from its initial state. In mutation, the solution may change entirely from the previous solution. Hence GA can come to a better solution by using mutation. Mutation occurs during evolution according to a user-definable mutation probability. This probability should be set low. If it is set too high, the search will turn into a primitive random search. The classic example of a mutation operator involves a probability that an arbitrary bit in a genetic sequence will be changed from its original state.

Newton law: Newton's first law states that every object will remain at rest or in uniform motion in a straight line unless compelled to change its state by the action of an external force. This is normally taken as the definition of inertia. The key point here is that if there is no net force acting on an object (if all the external forces cancel each other out) then the object will maintain a constant velocity. If that velocity is zero, then the object remains at rest. If an external force is applied, the velocity will change because of the force. The second law explains how the velocity of an object changes when it is subjected to an external force. The law defines a force to be equal to change in momentum (mass times velocity) per change in time. Newton also developed the calculus of mathematics, and the "changes" expressed in the second law are most accurately defined in differential forms. (Calculus can also be used to

determine the velocity and location variations experienced by an object subjected to an external force.) For an object with a constant mass m, the second law states that the force F is the product of an object's mass and its acceleration

Rfid: Radio-frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's interrogating radio waves.

Routing: Routing is the process of selecting a path for traffic in a network, or between or across multiple networks. Routing is performed for many types of networks, including circuit-switched networks, such as the public switched telephone network (PSTN), computer networks, such as the Internet, as well as in networks used in public and private transportation, such as the system of streets, roads, and highways in national infrastructure.

Sensor Nodes: A sensor node, also known as a mote (chiefly in North America), is a node in a sensor network that is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network.

Smart Card: A smart card, chip card, or integrated circuit card (ICC) is any pocket-sized card that has embedded integrated circuits. Smart cards are made of plastic, generally polyvinyl chloride, but sometimes polyethylene terephthalate based polyesters, acrylonitrile butadiene styrene or polycarbonate.

WSN: A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes