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ENERGY SAVING IN WIRELES SENSOR NETWORK WITH FUZZY GENETIC ALGORITHM

Mohammed EISAY SASI ALAREEFI

Master of Science

Supervisor

Asst. Prof.Abdullahi Abdu IBRAHIM

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Mohammed EISAY SASI ALAREEFI

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The thesis titled "ENERGY SAVING IN WIRELES SENSOR NETWORK WITH FUZZY GENETIC ALGORITHM" prepared and presented by "Mohammed EISAY SASI ALAREEFI" was accepted as a Master of Science Thesis in Electrical and Computer Engineering.

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Asst. Prof. Dr. Abdullahi Abdu IBRAHIM

Supervisor

Thesis Defense Jury Members:

Asst. Prof.Dr. Abdullahi Abdu IBRAHIM	School of Engineering and Natural Sciences, Altinbas University	__________________
Asst. Prof.Dr.	School of Engineering and Natural Sciences, Altinbas University	__________________
Asst. Prof.Dr.	, University	__________________

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Mohammed Eisay Sasi Alareefi

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ABSTRACT

ENERGY SAVING IN WIRELES SENSOR NETWORK WITH FUZZY GENETIC ALGORITHM

Eisay Sasi Alareefi, Mohammed

M.Sc, Electrical and Computer Engineering, Altınbaş University,

Supervisor: Asst. Professor Dr. Abdullahi Abdu IBRAHIM

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In this thesis, we describe the basic concepts related to the topic of the dissertation. Considering that in this dissertation, the optimization of energy consumption in wireless sensor networks has been done with the help of fuzzy and genetic algorithms of collective intelligence. In this thesis the genetic algorithm and fuzzy logic is investigated in the filed of the wireless sensor network. As simulation result shows the performance of genetic algorithm based on fuzzy logic is high life time. In this thesis, genetic algorithm and fuzzy logic are examined in the file of wireless sensor network. The simulation result showed that the performance of the fuzzy logic based genetic algorithm was better than the LEACH method.

Keywords: wireless sensor network, fuzzy logic, genetic algorithm

TABLE OF CONTENTS

Pages

LIST OF TABLES

Pages

LIST OF FIGURES

Pages

LIST OF ABBREVIATIONS

WSN	Wireless Sensor Network
MEMS	Micro Electro Mechanical Senor
HEDA	Higher Education Data Architecture
QoS	Quality of Service
CH	cluster head
LEACH	low energy adaptive clustering hierarchy
PEGASIS	Power-Efficient GAthering in Sensor Information Systems
ANCAEE	A Novel Bunching Algorithm for Energy Efficiency in Wireless Sensor Networks

1. INTRODUCTION

1.1 BACKGROUND

a Wireless sensor organization (WSN) is an organization of PCs small ("hubs"), outfitted with sensors that work together in a typical assignment or more errands. wireless sensor networks are comprised of a gathering of sensors with certain delicate capacities and wireless execution, which permit specially appointed organizations to be framed, without pre-set up actual framework or focal organization. The wireless sensor organization, are independent sensors spatially disseminated to screen physical or natural conditions like temperature, sound, pressure, and so forth and to agreeably ignore your information the organization to different areas. The most current organizations are bidirectional, which permit checking of sensor action.

Nowadays, Micro Electro Mechanical Senor (MEMS) have been developed world wide to increase efficiency of the system and these type of sensors are mostly used in military, aerospace, medical equipment and etc due to increased production of wireless sensor nodes. Wireless sensor network comprises of wireless sensor hubs that have distinctive useful units, for example, power unit, memory unit, correspondence unit, and detecting unit. Sensor units are worked at radio wave frequencies. Little energy batteries are utilized to enact the Sensor units in wireless sensor organization and this batteries are not battery-powered by and large and substitution of batteries are likewise more convoluted during on the web activity. Ordinarily life season of wireless sensor network is for the most part relies upon power wellsprings of the sensor units. To improve the energy utilization of the sensor units adequately, the bunching methods have been created in wireless sensor organization. In a clustering technique, wireless sensor network is separated into different groups known as clusters. One node is selected in each group and the selected node act as a chief node which is used for communication purpose with base station or sink. This chief node called as a cluster head. Transmission process of data from node to base station and base station to node is added energy consuming process then data processing in all nodes. We should provide control mechanism to communication devices for improve the energy conservation in nodes because energy consumed for transmitting one bit information over 100 meters which is identical to energy consumed for processing one thousand number of instruction code in processor. To reduce the energy consumption, cluster head approach is used.

Nowadays, simulation technology has been successfully used for modeling, designing and managing various types of intelligent systems, and in this regard, various tools and techniques have been created, for example, event-based simulation technique, which is based on It is the performance of many modern simulators.

The application of simulation in communication networks also has a 15-year history that is still growing. The reasons for using simulation in this field can be summarized in two cases:

1. The emergence and expansion of complex technology networks

2. Creating special network simulation tools and software

Network simulation software provides the ability to simulate communication networks without the need for coding, usually through graphical interfaces.

Existence of simulated elements corresponding to real elements (routers and switches, etc.) in such cases, in addition to increasing accuracy, increases the ease and speed of the simulation process, and thus for users unfamiliar with the technique. Programming is very convenient.

1.1.1 Necessary characteristics for network simulators

Features that network simulators should have are:

1.1.2 Flexibility in modeling

The user must be able to add new types of common network resources such as nodes, links and protocols to the set in the simulator.

1.1.3 Ease of modeling

Existence of graphical interface and the possibility of modeling in a structured way, so that complex models are designed based on simple models, and also the ability to reuse the modules is a feature that accelerates the simulation process.

1.1.4 Quick implementation of models

Processing time is very important in large simulations for networks with a large number of nodes, which requires proper memory management.

1.1.5 Ability to illustrate

Graphical representation of network elements exchanging messages with each other greatly helps to fix simulation errors and understand how it works. In some emulation software, the illustration is performed simultaneously with the emulator and in others after it and in the form of Play Back.

1.1.6 Ability to repeat and repeat the simulation

The purpose of the simulation is mainly to investigate the effect of one or more parameters (for example, average packet length or buffer capacity) on network performance and therefore reproducibility is a necessary condition for these softwares.

In general, it should be noted that the creation of an accurate and valid network simulator requires the use of simulation technology along with network knowledge and its protocols. However, in addition to the above features, some capabilities will add value to any simulator tool. The following can be mentioned:

1- Existence of pre-prepared internal modules corresponding to network elements and protocols.

2. The existence of a random number generator and in more advanced forms the ability to create quantities with different random distributions because most of the events in a simulation process, including the production and delivery of packets or damage to them, are random processes. To be.

3- Supporting users to timely updates (especially in the case of new protocols) along with complete and clear documentation.

4- Presenting reports of network efficiency parameters (output rate, productivity, transmission delay, ...) in the form of figures and curves along with the possibility of performing statistical operations on the results is another positive feature of a simulator.

1.2 NS SIMULATOR (V2)

The start-up of this software dates back to before the VINT project. After being selected as a simulation tool, the VINT project has gained seriousness and speed. The latest version of NS 2.1b8 is available on the Internet.

NS interior architecture

NS2 is a type of event management simulator that promotes simulation by tracking events during discrete times. This simulator is object-oriented in both C ++ and OTCL programming environments. The NS is based on a model called VuSystem. It works, which we will briefly explain below.

1.3 VUSYSTEM MODEL

Network simulators mainly consist of two parts with different tendencies:

1. A group of building blocks that simulate elements such as nodes, links, queues, traffic generators, and protocols.

2. An interface commonly referred to as the Simulation Description Language or SDL, which is responsible for connecting the above building blocks together in the simulation process.

In the case of these two parts, there is a fundamental problem facing network simulator designers. While for the building blocks, efficiency and speed of execution is the main goal.

SDL requires flexibility and ease of configuration, and achieving these two goals with a single programming environment is difficult.

Therefore, the VuSystem model proposed by David Wetherall at MIT considers the solution to be using two separate programming environments for the above two parts. According to this model, building blocks with a compiled language (for example C ++) and their interface They are implemented in an interpreter environment (such as OTCL).

The designers of the NS-2 have succeeded in applying the VuSystem model to their simulator by using a set of objects called two-piece objects. According to this model, the NS-2 consists of a set of objects that communicate in two dual compiler / interpreter environments by calling each other methods.

The most modern networks are bidirectional, which allow monitoring of sensor activity.

A portion of these applications are recorded underneath and after that inspected in detail:

- Environment and nature checking
- Inventory following
- Medical development
- Military applications
- Industrial checking
- Seismic recognition
- Smart spaces
- Traffic control
- Acoustic recognition

Cluster in WSN is shown in figure 1.2.

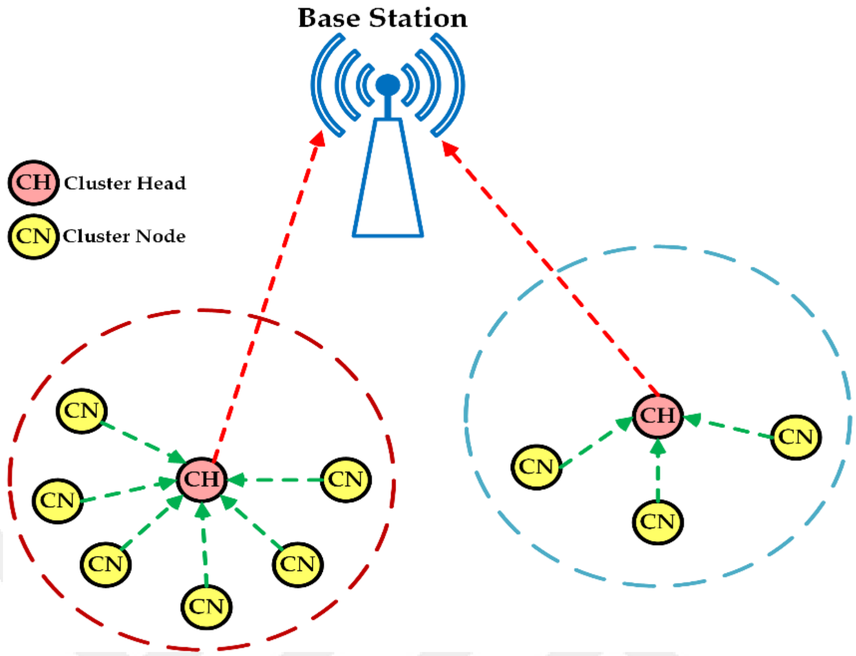

Figure 1. 2: Cluster in WSN

During the time spent information collection, bunch heads likewise performs information pressure by taking out any information excess caused because of detecting of limited information by group individuals [1]. One-jump correspondence design for bunched remote sensor organizations is shown in figure 1.3.

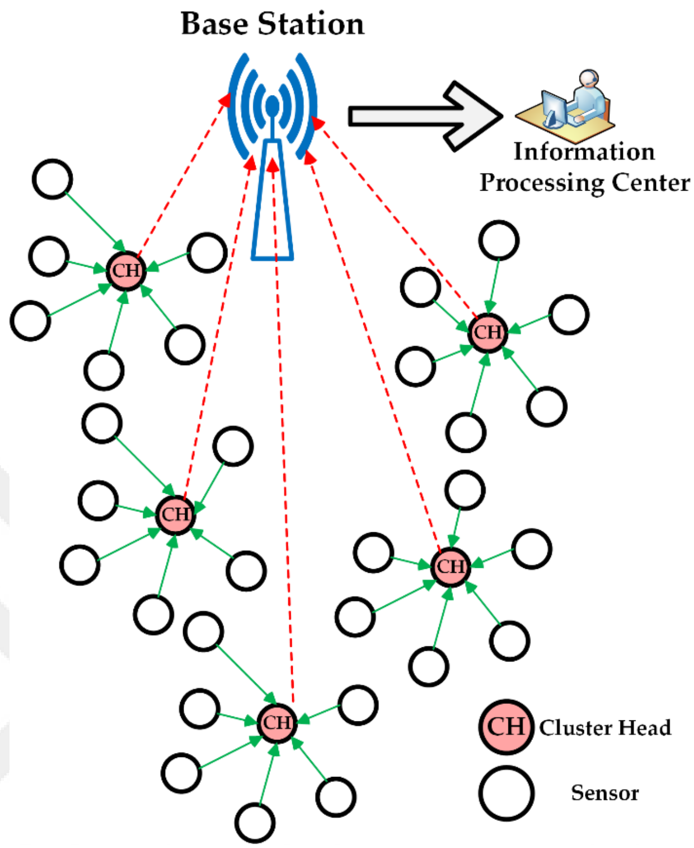

Figure 1. 3: One-jump correspondence design for bunched remote sensor organizations

2. LITERATURE REVIEW

2.1 BACKGROUND

It is essential to perceive malicious nodes in the occurrence of noise, events and faults and to separate them from the rest of the wireless network.

Shensheng Tang et al.2011, We considered the progression of infection spread in WSNs utilizing plague models. We inspect both the customary SI plague model and its altered adaptation for WSNs. The customary SI display does not give any against infection insurance to WSNs because of no hostile to infection support system. To defeat this shortcoming, we proposed an altered SI show by utilizing the rest method of WSNs to perform framework upkeep. The altered SI model can enhance the system against infection ability without causing any additional equipment exertion and flagging overhead. We determined the express answers for both the conventional SI show and the changed SI demonstrate, which can catch both the unique and worldly elements of the infection spread process. Since the system might be liable to infection assaults with various infectivity at various circumstances. Numerical outcomes and reproductions are performed and the accompanying outcomes are acquired:

• by fitting parameter arrangement, the infection spread can be adequately controlled by the changed SI display

• both the TNP and the PNP plans can accomplish arrange security regarding the difference in infectivity and they are confirmed to be practical [2].

NajmehKamyabpour et al. introduces another approach for limiting the aggregate vitality utilization of remote sensor organize applications in light of the Hierarchy Energy Driven Architecture. Specifically, we recognized segments of each piece of HEDA (Higher Education Data Architecture). We extricated a model for every one of the constituents and segments as far as their predominant variables (or parameters). They proposed a plan for the aggregate vitality cost work as far as their constituents. Reenactment comes about for lifetime and lingering vitality of an example connect with various sensor range, transmission span and irregular and specific systems exhibited. This work just recommends a blueprint demonstrate for every constituent; a nitty gritty vitality show for every one of the constituent of HEDA is to be contemplated. This work distinguished various overwhelming parameters of every vitality parts, be that as it may, not all highlights of WSNs have been thought about and they ought to be investigated and examined altogether [3].

Hai-Ying Zhou et al. Flow WSN explores concentrates more on correspondence conventions than on vitality utilization demonstrating. Conventional vitality examination strategy is to conclude the vitality utilization statuses of nodes and systems in light of the hypothetical vitality utilization information or hypothetical models of framework parts. A large portion of the current vitality models just break down the vitality status of correspondence module, being absence of concentrate the general vitality utilization from the perspective of nodes. By displaying the vitality utilization of various hub segments in various activity modes and state changes, this paper proposes another hub vitality demonstrate in view of the occasion trigger system. This model can be utilized to break down the vitality status of WSN nodes and frameworks, to assess the correspondence conventions and to convey nodes and build WSN application [4]. Energy-Efficient Clustring Protocol for WSN is shown in figure 2.1.

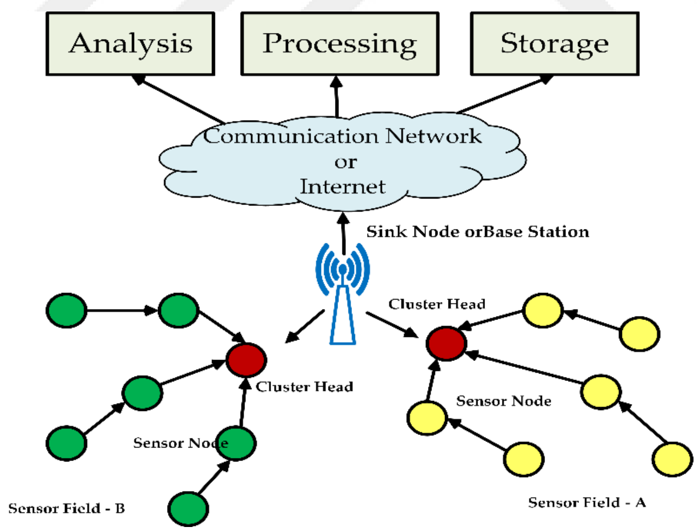

Figure 2. 1: Energy-Efficient Clustring Protocol for WSN [5].

Bimal Kumar Mishra,NehaKeshri et al. Propelled by the compartmental organic pandemic model, they proposed an e-SEIRS-V demonstrate for the assaulting conduct of worms in sensor nodes. Generation number is acquired to comprehend the spreading and blurring of the worms in the sensor field. We set up that the sans worm balance is all around asymptotically steady, if multiplication number is short of what one. Runge– Kutta– Fehlberg strategy is utilized to understand and reenact the arrangement of conditions created. With the assistance of MATLAB, a broad reenactment is performed to approve the created show. An effective effect of inoculation gave to the sensor nodes is obviously seen over uncovered and irresistible. Examination of recouped and immunized class as for time [6].

Vasaki Ponnusamy et al. WSNs comprise of restricted battery fueled nodes set to detect the objective. Supplanting or energizing these nodes is relatively unthinkable as the introduced target territories are frequently hard to get to. The discoveries demonstrate that immediate transmission experience the most elevated vitality took after by multihop correspondence and grouping. Portable correspondence utilize the minimum vitality contrasted with different components. Coordinate transmission is doable when the base station and sensor nodes are inside close impendence as aggregate vitality utilization is relative to the separation. In a more extensive system, coordinate transmission won't be a reasonable decision as nodes will devour more vitality and will in the long beyond words. For more extensive systems, multihop can be a practical arrangement as this correspondence guarantees conveyance of information to the base station. In any case, one potential issue with multihop correspondence concerns nodes that are nearer to the base station; these nodes have a tendency to be intensely used and will in the long run reason steering opening close to the base station. Bunching is another vitality effective convention proposed by analysts, where a group head is utilized to hand-off information to the base station. Grouping performs superior to multihop and coordinate correspondence as far as vitality usage. This is on the grounds that group head choice enables other sensor nodes to just detect and transfer information to the base station as opposed to steering information from different nodes (as in multihop) [7].

Awasthi Shashank, Ojha Rudra Pratap et al. We built up a numerical model to portray the spreading and controlling exercises of noxious flags in remote sensor arrange comprises of customary differential conditions to ponder the impact of treatment progression of worm transmission. We infer the articulation for fundamental proliferation R0 for deciding the worm vanishes totally. The neighborhood secure qualities of worm free harmony and endemic balance are set up by utilizing the Jacobian lattice. It is build up that if R0, is not exactly or equivalent to one, at that point worm can be killed and the framework turns out to be locally and all around asymptotically steady and when R0 >1, the endemic harmony will be locally and internationally asymptotically steady [8].

2.2 FEATURED ROUTING PROTOCOLS

Although individual sensor nodes have limited capabilities, WSN is built with the goal of being energy efficient, self-organizing, scalable, and capable. Building on these challenges is focused, but relatively little work has been done on safety issues related to sensor networks. Scarcity of resources, special development and special scale of WSNs have made security communication a challenging issue. Balance the computational and communication overheads required to implement them. WSNs are ideal for identifying environmental, biological, and chemical modifications in a wide range of contexts, but creating faulty warning signals can completely undermine the system. As Wood and Stankwich point out, if safety is weak, sensor networks will be useful for limited controlled environments. The wide range and overall success of sensor networks is directly related to their safety resistance. The schematic of the WSN routing protocol is shown in figure 2.2.

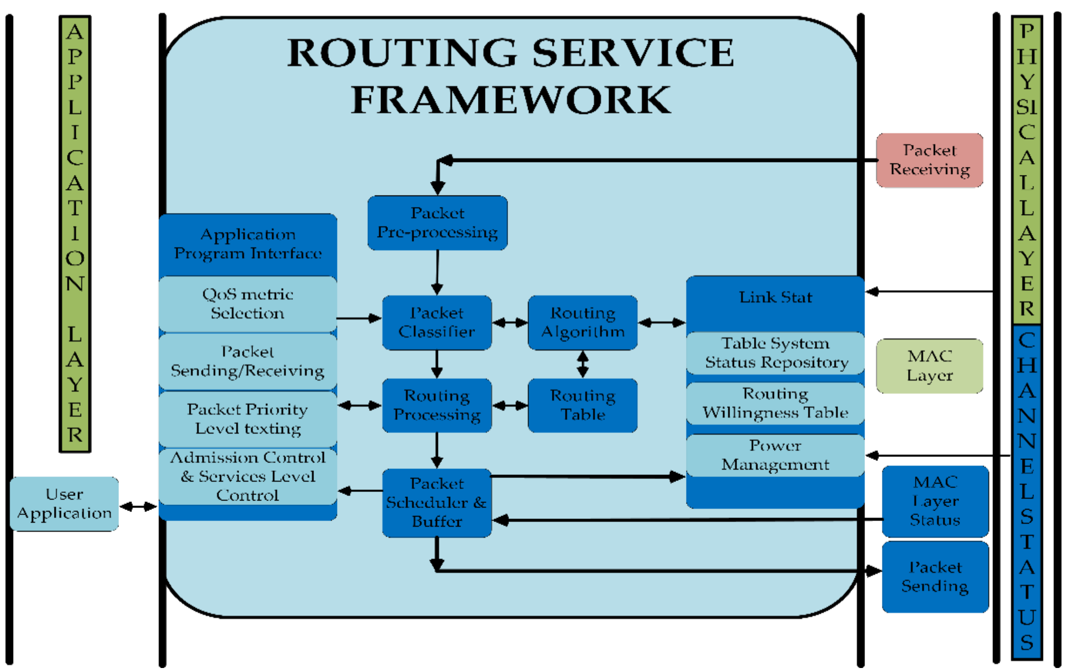

Figure 2. 2: The schematic of the WSN routing protocol [9].

2.2.1 Energy efficient protocols

Chamam and Pierre [10] have kept an eye on two central issues in far off sensor frameworks, explicitly extended framework lifetime moreover, less imperativeness dispersing. In 2011 Li et al. [11] have inspected the twofold improvement issue of lifetime and adapting to develop a summarized control use show. The twofold level improvement issue was disentangled using the point computation. In 2013, Habibi et al. [12] have proposed a smoothing out technique to review the facilitate transmission's tendency in a given center arrangement or then again in a pleasant transmission. The ideal telecom control and the ideal force regards for the supportive transmission stage were recognized and the whole technique can deal with this current reality issues. Ghaderi et al. [13] have handled the base essentialness coordinating issue in distant arranges by offering answers for pseudo-polynomial versatile quality additionally, its connected e-ideal conjecture. Gupta et al. [14] have associated an essentialness powerful homogeneous gathering procedure on the distant sensor framework to extend the framework lifetime. Additionally, the Dijkstra's most short way computation was familiar with perform course improvement in the gathered framework. Rahat et al. [15] have displayed a novel multi-target coordinating progression for the sensor work frameworks to assemble the frameworks' lifetime. The request space with the most concise way pruning and an outline decline method was used to separate the courses doubtlessly. The ideal courses were got using the extraordinary estimation. Hsu et al. [16] have developed a deft based controlling model to enlighten the essentialness usage issue in the lowered sensor frameworks.

2.3 DELAY-LESS PROTOCOLS

Chang et al. [17] have changed the subterranean insect settlement advancement based versatile steering and proposed the local ACO-based fell versatile directing for upgrading the stack adjusting and execution. The postpone dispersion of the created strategy has additionally been examined. Alanis et al. [18] have focussed on directing in remote multi-bounce systems furthermore, proposed an ideal quantum-helped calculation, called non-commanded quantum iterative advancement calculation. The conclusion to-end defer parameter was considered to enhance. Tang et al. [19] have proposed a cost-mindful secure directing calculation to expand arrange lifetime and security. The normal postponement of different security parameters was tended to.

2.4 SECURE PROTOCOLS

Long et al. [20] have tended to the issue of source area security and built up another directing plan, called tree-based diversionary. Find the stowaway technique has created counterfeit source courses to ensure the source area and diversionary courses have saved protection in the non-problem area. They have additionally distinguished another bearing focused assault in the remote sensor systems.

2.5 RELIABLE PROTOCOLS

In spite of the dependability of the steering convention said to be described in light of basically mistake, the reasons for blunder vary in different perspectives. They depend on the unwavering quality of the topology, interface between the nodes, convention stream and some more. However, the inconsistency on the previously mentioned perspectives prompts mistake in the imparting messages. The unwavering quality of conveyance proportion in remote sensor systems has additionally been examined utilizing a multi-target calculation, known as unique multi-objective steering calculation. In 2011, Basan and Jaseemuddin [21] have thought about the normal parcel convey proportion for concentrate the execution of the proposed fundamental directional MAC conventions and the physical obstruction, with a specific end goal to build up a shading struggle chart reflection. The Voronoi shaped for clustering method is shown in figure 2.3.

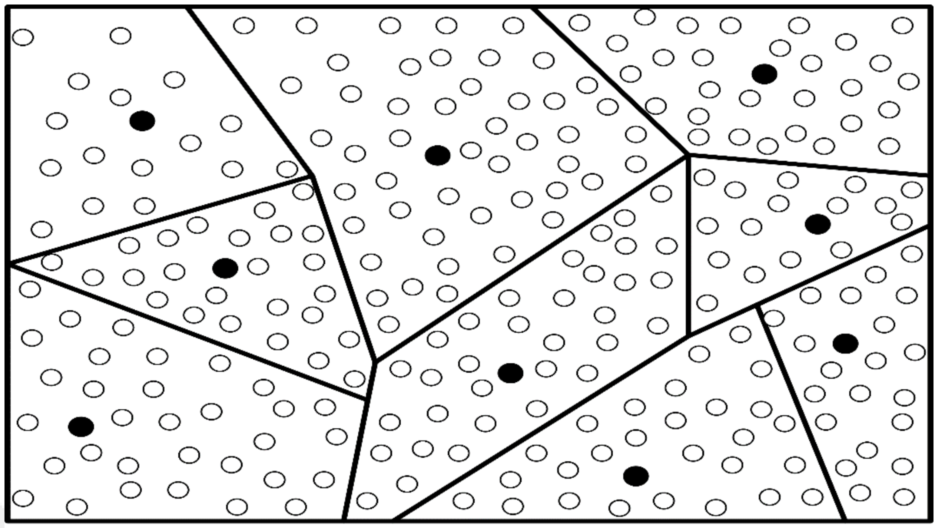

Figure 2. 3: the clustering as Voronoi [22]

In addition, because of the way that every one of the hubs attempt to get to the normal transmission media in the meantime, genuine postponements will happen because of crash avoidance instruments. Also, in outcome of steering circles and numerous courses, repetitive vitality utilizations will come about. Along these lines, as far as averting repetitive vitality utilization amid information transmission, bunching approach gives extremely huge picks up by methods for disentangling the correspondence and upgrading the adaptability. The goal is to locate the ideal technique for sorting out the hubs into bunches and choosing the most fitting hub as the CH in each bunch so as to accomplish vitality productivity by acknowledging load adjust among the hubs. Numerous investigations have been proposed about bunch based WSNs. Drain, is one of the first what's more, major investigations directed on WSNs and has prompted numerous ensuing examinations about bunching. As in LEACH, CH assurance is done once in a while yet not at each round. Alternately with Filter, CH assurance isn't done randomly, anyway is to some degree made by a cream boundary which is a mix of the leftover imperativeness levels of the centers and an expense regard called the ordinary least reachability control. This is the total imperativeness ate up by every one of the various centers in the gathering if the recently referenced center point advances toward turning out to be CH. Zhu et al. have proposed a plan (ZHU) in which batching is basically performed by utilizing Hausdroff Distance. The essential worldview that is considered in the midst of CH decision stage is the excess essentialness level of the center points. Likewise, if the extra essentialness levels are same, by then the closeness off the centers is thought of. Between bunch coordinating is performed by techniques for utilizing set up Bellman-Ford's most restricted way approach. Subsequently, various center points hearing the assertion give up the resistance. Between bunch correspondence is another test to be considered in pack based frameworks. Data passed on close to the completion of the intra-correspondence stage should be given to the sink by the CH. Notwithstanding the examinations specified above there have been a few different investigations on bunch based sensor systems. The following area gives insights about the techniques and models used in the framework while dissecting the effects of various auxiliary minor departure from vitality utilization [23]. Tao Liu, Qingrui Li, Ping Liang et al. mention that, Grouping quite diminish the vitality utilization of every autonomous sensor in a remote wireless sensor arrange (WSN), and furthermore expands the correspondence stack on bunch heads. On account of the uneven vitality used among group heads, the problem areas issue will emerge when utilizing the multihop sending model for the intercluster correspondence. Unequal grouping is a viable method to adjust the vitality utilization of bunch heads. In [23, 24] they show an Energy-Balancing unequal Clustering Approach for Gradient-based directing (EBCAG) in remote sensor systems. It parcels the hubs into groups of unequal size, and every sensor hub keeps up a slope esteem, which is characterized as its base jump check to the sink. The span of a group is chosen by the slope estimation of its bunch head, and the information accumulated from the bunch individuals ought to take after the bearing of sliding angle to achieve the sink. Reenactment comes about demonstrate that EBCAG adjusts the vitality utilization among the bunch heads, and fundamentally enhances the system lifetime [25]. Clustring in WSN is shown in figure 2.4.

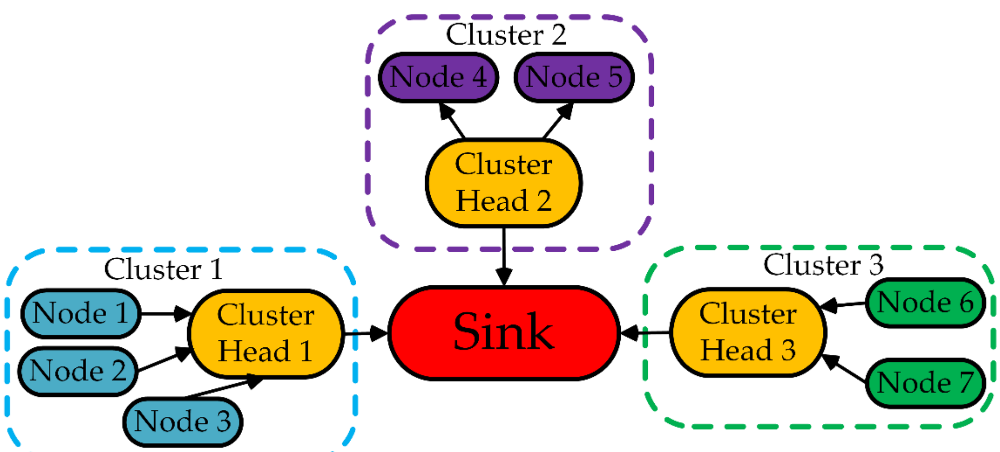

Figure 2. 4: Clustering in WSN [25].

3. METHODOLOGY

3.1 FUZZY LOGIC

Fuzzy logic is a relatively new technology that performs conventional methods for designing a system that requires relatively complex mathematics and probabilities using fuzzy values and laws that aim to make system design simpler, more accurate, and more efficient. Fuzzy logic control systems are very suitable because of their transparency in decision making as well as the presentation of results and work reports. In classical logic, expressions are expressed in binary terms (either zero or one, white or black, yes or no), but fuzzy logic expresses Boolean correct statements with the right degree.

The fuzzy inference system consists of an input and a processing system and an output. The initial step maps the inputs to the fuzzy membership functions to the correct degree. The second step is to summon the processing on each rule and the results accordingly. Finally, the final step presents the combined output results as output values.

The membership function of a fuzzy set is, in a special case, a curve that indicates how each point in space is mapped to the degree of membership, or the degree of membership between zero and one. A much more common form for membership functions or fuzzy tags is triangle representation; Of course, other membership functions such as trapezoidal and bell membership functions are also used depending on the type of work. As mentioned earlier, the processing step, called the inference engine, is based on a set of fuzzy rules in the form of IF-THEN expressions, of which the IF part is the part preceded and the THEN part is called the sequence. Is. An example of a fuzzy if-then rule is this: If the repetition is low, the shift priority is so high that the expressions "priority" and "repetition" are linguistic variables, and the expressions "low" and "very high" are linguistic expressions. Each language phrase corresponds to a membership function.

3.2 CLUSTER SIZE

A standout among the most fundamental challenges experienced in WSNs is the issue territory issue. As communicated above, since sensor nodes are especially little devices, their advantages have confined points of confinement. A similar requirement is in like manner honest to goodness for the correspondence scope traverse. Sensor nodes far from the sink can't transmit their data particularly to the sink. What's more, passing on the data particularly which is as a general rule single-bounce transmission isn't supported in light of the fact that the essentialness used in the midst of data transmission is exponentially relative by the detachment. In this way, multi-skip correspondence is supported in WSNs. Regardless of the way that multi-skip correspondence is all in all useful, another basic test to be considered is known as the issue zone issue. Nodes closer to the sink exhibition like a hand-off what's more, pass on the data drawing closer from the remote nodes to the sink is shown in figure 3.1. Thusly, the greater part of the data movement disregards a set number of nodes that will make these nodes quickly exhaust the battery, which is known as the issue region issue.

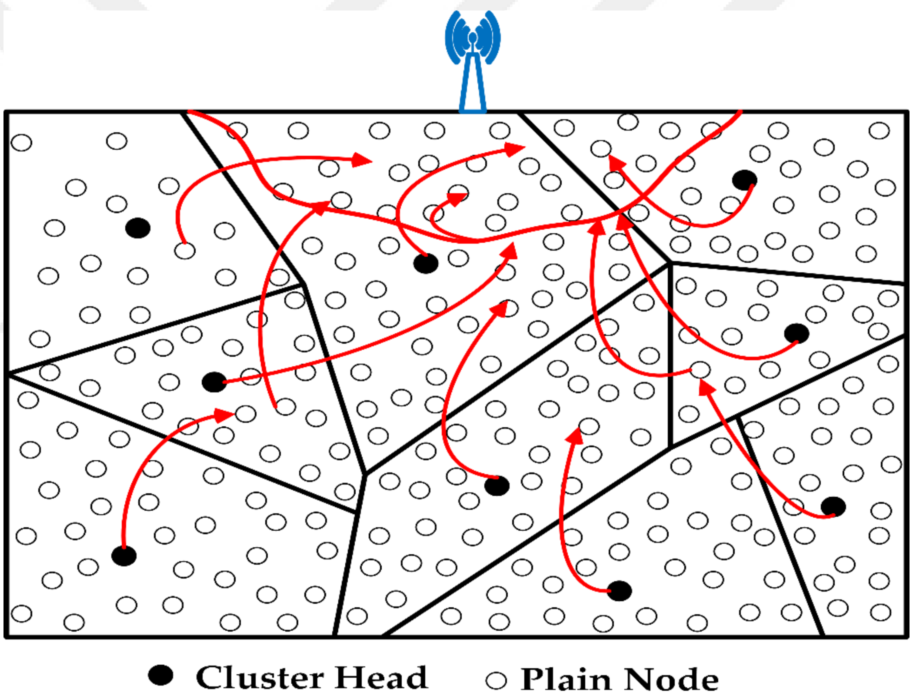

Figure 3. 1: Hot-spot problem [26]

LEACH is an energy-saving routing protocol for WSNs; It was proposed by Heinzelman, Chandrakasan and Balakrishnan [23]. In this protocol, the sensor nodes form random clusters and the cluster heads act as exit nodes. Since the transmission of information will be made only from the cluster heads (CH) rather than all sensor nodes, energy will be saved. In this protocol, the optimum CH number is estimated at 5% of the total number of nodes [27].

In the LEACH protocol, the selection of the cluster header is done in two steps. These are called setup phase and working phase. During the setup phase, each node generates a random number between 0 and 1. If the random number is less than the threshold, this node is CH. The threshold value is found using the formula below.

$$T(n) = \{ \frac{p}{1 - p\left(r \bmod \frac{1}{p}\right)}, if\ n \in G \} \quad (3.1)$$

In the equation, p is the ideal level of bunch heads and r is the current round, G is the gathering of hubs that have not been CH in the last round. The sensor hub chose as CH in the past round isn't chosen as CH until any remaining hubs in the organization are in the group header.

During the operational phase, the nodes send their data per cluster using a TDMA (Time Deviation Multiple Access) schedule. TDMA scheduling allocates time slots to each node. CH then collects the data and sends it to the master station [27]. The Simple operation on the screen Seen is shown in figure 3.2.

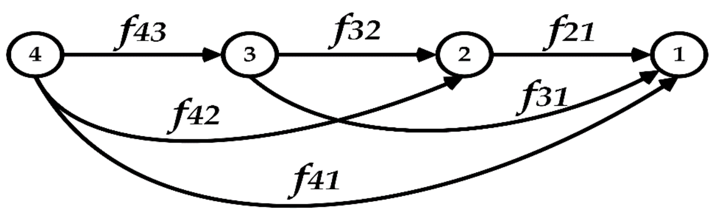

Figure 3. 2: Simple operation on the screen Seen [28].

3.3 CLUSTERING

The capabilities of cluster heads play a very important role during the clustering process. The capabilities of CHs can affect the clustering process in terms of the stability and lifetime of the sensor network. Some features are given below to distinguish the clustering process.

Node Type: Some nodes are preselected as cluster heads that depend solely on energy and computational resources. Others may have been chosen based on their capabilities and proximity to the base station. Mobile cluster heads (CH) can be used for cluster balancing providing better network performance. Mobility of CHs within networks is assigned based on the targets defined in the clustering scheme. In case of need more than mobile cluster heads, they can be easily repositioned in the network. The role of cluster heads (CH) in the network is to collect information from sensor nodes and send it to the base station.[28].

3.4 PACKET STRUCTURES

Length of an Intra-amass bundle is 52 bytes that takes 1625µs to send with the used radio information rate. As is known, WSNs are information driven applications, not id-based like other standard systems. That is, information accumulation focus doesn't manage the ID of the information source. It is in a way worried about the substance. ID is basically needed amidst sending tasks inside the geography. Thusly, there is no convincing motivation to apply normal, tedious IP or MAC addresses in the midst of in-mastermind sending. It is satisfactory to portray short in-compose exceptional areas for sending purposes. Since all nodes are considered their land spots of themselves and their neighbors, and it is in like manner expected that two specific nodes don't cover, these relative two dimensional masterminds constitute the ID of the nodes. Intra-group parcel structure is introduced in figure 3.3.

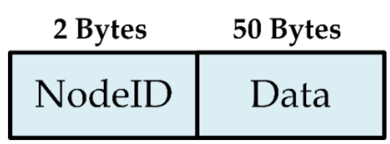

Figure 3. 3: Intra-Cluster packet structure

Construction of an Inter-Cluster Packet is portrayed in figure 3.4.

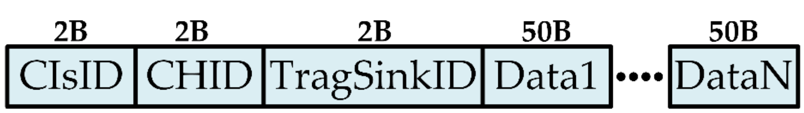

Figure 3. 4: Between Cluster bundle structure

As demonstrated in figure 3.4, the initial 6 octets of the Inter-Cluster parcel are fixed for each Inter-Group pack. ClsID and CHID openings contain the IDs of the owner bundle and the relating CH. Along these lines, when the totaled parcel touches base at the information gathering focus, this data distinguishes the locale to which that bundle has a place. For each cycle, another sensor hub is chosen as a CH. Geography is essentially detached into bunches reliably and forever and each pack portrays its target sink at the beginning of its lifecycle, that is, the closest one as for within reason for the bundle. Remaining pieces of the Inter-bunch bundle incorporates the data passed on by each plane center point in the pack. Since the amount of hubs varies for each pack, an overall formula recognizing the total length of an Inter-Cluster package is according to the accompanying [23]:

$$LngthInterClsPck = 48 + (LngthIntraClsPck * NumOfNodes) \quad (3.2)$$

The sensing area subdivision for non-uniform node distribution is shown in figure 3.5.

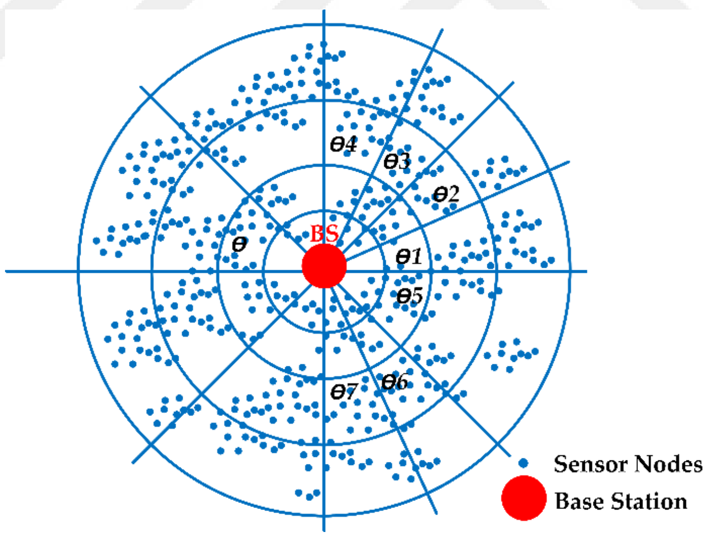

Figure 3. 5: sensing area subdivision for non-uniform node distribution [23].

In recent year, cluster head selection, in wireless sensor network is most ongoing research among the world wide researchers. In this thesis, Genetic Algorithm (GA) combined with Fuzzy Logic System and Particle Swarm Optimization method proposed for selection of cluster head in wireless sensor network for improve the life time of the wireless sensor network and reduce energy consumption of the nodes as well as weighted trust evaluation is used for detect the malicious node in the wireless network. The effectiveness of the proposed technique will be compared with LEACH, GA and Fuzzy methods.

3.5 GENETIC ALGORITHM

As we know, living things have a very complex vital and hereditary structure; To this day, many of the secrets of this hereditary system are still out of reach of various sciences. What is examined in this section is the use of a special algorithm based on the genetic system of living organisms to solve difficult optimization problems.

When a child is born to a parent, he or she has many of the characteristics of a parent. Although some of his characteristics come into being completely independently and are formed within him, but in most characteristics he inherits from his parents inherently. The interesting point here is that in fact since each parent has some characteristics (note that there is no discussion about the good or bad of these characteristics and only their inheritance is important) and also They lack others. In practice, the result of combining the genetic systems of the two is expected to be much better than either. Of course, it should be noted that this is just a simple theory and in the real world other parameters may be effective in this inheritance, but in the discussion of genetic algorithms, according to the explanations provided, most of this goal is considered.

3.5.1 Basic concepts in genetic algorithm

Hereditary calculations depend on Darwin's hypothesis of development, and the response to the issues settled by the hereditary calculation is bit by bit improving. The hereditary calculation begins with a bunch of answers that are addressed by chromosomes. This arrangement of answers is known as the underlying populace. In this calculation, the appropriate responses acquired from one populace are utilized to create the following populace. In this interaction, it is trusted that the new populace will be superior to the past populace. The determination of certain answers from every one of the appropriate responses (guardians) to make new answers or similar youngsters depends on their reasonableness. It is regular that more fitting answers have a superior possibility of duplicating. This interaction proceeds until the predetermined condition is met (like the quantity of populaces or the pace of progress of the reaction).

3.5.2 Overview of genetic algorithms

The general steps of the genetic algorithm are shown below. As can be seen, the basic principles of genetic algorithm are very general. Therefore, there are many different factors for different issues that need to be considered. The first question is how to create a chromosome? Or what kind of coding to choose?

The two most important operators and the basis of the genetic algorithm are the combination and mutation operators. The next question is how to select parents to combine parents to create new children? This can be done in different ways. But the main idea in all of them is to choose better parents in the hope that better parents will produce better children. The problem here is that if the new population is created only through new offspring, this process will lead to the deletion of the chromosomes of the previous generation. To prevent this from happening, the best answer of the previous generation is always passed on to the new generation without any changes.

General steps of genetic algorithm:

1. Production of a primary population consisting of n chromosomes

2. Investigation of the evaluation function f (x) for each x chromosome in the population

3. Create a new population based on repeating the following steps:

3-1- Selection of two parent chromosomes from a population based on their suitability

3-2- Considering a certain amount for the possibility of applying the combination operator and then performing the combination operation on the parents in order to create children (if no new combination is made, the children will be the same parents)

3-3- Considering the possibility of mutation and then change of children in any place

3-4- Replacing new children in the new population

4. Using the new population for future implementations of the algorithm

5. Stop running the algorithm if you see the stop conditions and return the best answer in the current population

6. Go to step 2

3.5.3 Coding

Instead of working on the parameters or variables of the problem, the genetic algorithm deals with their coded form. Common coding methods in genetic algorithms are:

1. Binary coding
2. Leap coding
3. Value coding
4. Tree coding

Now all four coding methods introduced above are explained.

1) Binary coding

This encoding is the most common type of encoding. In this method, each chromosome is a string of bits containing 0 and 1. Binary coding can cover many situations. Figure (3.6) shows an example of binary coding.

Chromosome A	1 5 3 2 6 4 7 9 8
Chromosome B	8 5 6 7 2 3 1 4 9

Figure 3. 6: An example of binary coding

On the other hand, this type of coding is not normal for many problems and it is often necessary to make corrections after the combination and mutation operators.

2) Leap coding

This type of coding can be used for sequential issues such as the traveling salesman (TSP) problem or task scheduling (JS) problem. In mutant coding, each chromosome is a string of numbers. Figure (3.7) shows an example of this type of coding.

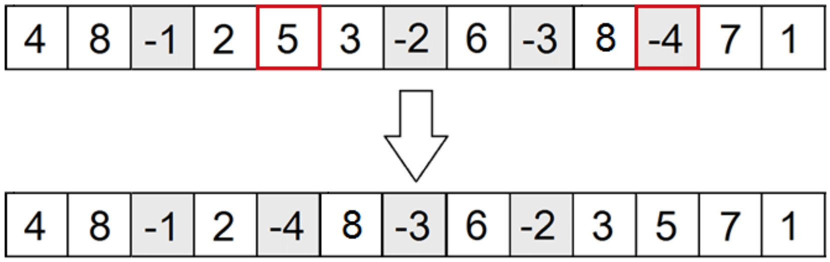

Figure 3. 7: An example of mutant coding

Mutation coding is only useful for sequential problems. Even for these problems, sometimes the combination and mutation operators have to be modified to create compatible chromosomes.

3) Value coding

This type of coding is used in problems where complex values such as real numbers are used. Using this type of coding for such issues is very difficult. In value coding, each gene on a chromosome has a special value. This parameter can be a number, a letter or a word. This type of coding requires the development of new shift operators and mutations for specific problems. Figure (3.8) shows an example of value coding.

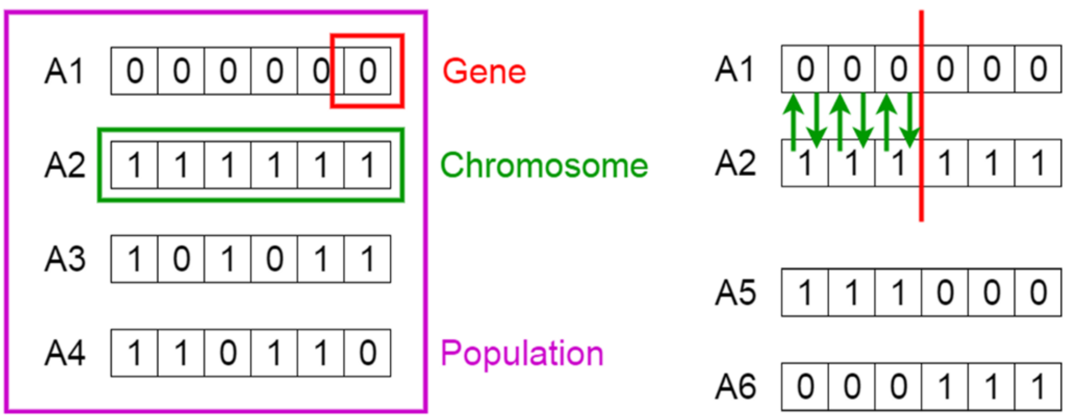

Figure 3. 8: An example of value coding

4) Tree coding

Tree coding is used in evolutionary programs for evolutionary planning. In tree coding, each chromosome is a tree of objects such as functions or commands in the programming language. This type of coding is great for evolutionary programs. The LISP programming language often uses this type of coding because its programs are displayed in this form and can be easily parsed. Therefore, combination and mutation operators are equally easy to perform [1].

3.5.4 Chromosome

A string or arrangement of pieces that is encoded as a potential (suitable or improper) response to the issue is known as a chromosome. Truth be told, the pieces of a chromosome assume the part of qualities in nature. Each piece is a discrete variable chosen from a bunch of Q part sets. On the off chance that double coding is utilized, each piece will acknowledge one of two qualities, 0 or 1, so Q = 2. A chromosome has n qualities or pieces, which are appeared in Figure (3.9). bi in this figure addresses the worth of the ith bit that is chosen from the set Q = m of the part.

b_1	b_2	b_3	.	.	b_{n-1}	b_n

Figure 3. 9: Representation of an n-bit chromosome on a numerical basis of m

$b_i \in (0,1,\ldots, m),\ i = 1,2,\ldots, n$

3.5.5 Genetic population

A bunch of chromosomes is known as a populace. One of the qualities of hereditary calculations is that they work on a populace of chromosomes as opposed to zeroing in on one point in the inquiry space or a chromosome. In this way, in each progression, the calculation has a populace of chromosomes that have a greater number of properties than the number of inhabitants in the past advance. Every populace, or age of chromosomes, has a size known as the populace. Populace size addresses the quantity of chromosomes in a populace or an age. On the off chance that the quantity of chromosomes is exceptionally little, the chance of framing the dislodging activity by the hereditary calculation will be little and just a little piece of the pursuit space will be investigated. Then again, if the quantity of chromosomes is too enormous, the speed of the calculation will be moderate. As per research, all around measured populaces have around 20 to 30 chromosomes. Obviously, in some cases a populace of 50 to 100 offers the best responses. Some research also suggests that population size should be defined based on the type of problem and its coding, and further increase would be useless and would never help to solve the problem more quickly.

3.5.6 Fit function

One of the steps of the genetic algorithm is to evaluate the results obtained in each step. In fact, the value of the answers obtained at each stage is determined. The appropriateness or inadequacy of the answer is measured by the criterion obtained from the objective function. The more appropriate an answer is, the more appropriate it is to use the range of knowledge of the problem. In order to increase the chances of survival of such an answer, its probability of survival is considered in proportion to its suitability. Therefore, the more appropriate discipline is more likely to participate in the production of offspring and create more sequences. The most valuable answers at each stage are like the strongest beings in a population. In proliferation, low-adaptation strings are eliminated from the population, and high-adaptation strings will have a greater impact on the production of the next population. Normally, where possible, the fit function is normalized to a distance of (1.0).

3.6 FUZZY LOGIC

Fuzzy logic is a relatively new technology that performs conventional methods for designing a system that requires relatively complex mathematics and probabilities using fuzzy values and laws that aim to make system design simpler, more accurate, and more efficient [4]. Fuzzy logic control systems are very suitable because of their transparency in decision making as well as the presentation of results and work reports. In classical logic, expressions are expressed in binary form (either zero or one, white or black, yes or no), but fuzzy logic expresses Boolean correct statements with a degree of accuracy.

The fuzzy inference system consists of an input and a processing system and an output. The initial step maps the inputs to the fuzzy membership functions to the correct degree. The second step is to summon the processing on each rule and the results accordingly. Finally, the final step presents the combined output results as output values.

The membership function of a fuzzy set is, in a special case, a curve that indicates how each point in space is mapped to the membership degree, or the membership degree is between zero and one. A much more common form for membership functions or fuzzy tags is triangle representation; Of course, other membership functions such as trapezoidal and bell membership functions are also used depending on the type of work. As mentioned earlier, the processing step, called the inference engine, is based on a set of fuzzy rules in the form of IF-THEN expressions, the IF part being the part preceded by it and the THEN part being called the sequence. Is. An example of a fuzzy if-then rule is this: If the repetition is low, the displacement priority is so high that the expressions "priority" and "repetition" are linguistic variables, and the expressions "low" and "very high" are linguistic expressions. Each language phrase corresponds to a membership function.

3.6.1 Fuzzy inference rules database and engine

Before continuing to discuss the database of fuzzy inference rules and motors, it is necessary to provide a clear definition of a fuzzy system. A fuzzy system is a set of a number of inputs, one or more outputs, and a base of rules by which the relationship between inputs and outputs is defined. To make a correct mapping of the input to output, it is necessary to obtain a combination of rules in the rules database and then determine the output of the fuzzy system based on it as well as the input state. Such a system is called a fuzzy inference engine. In general, two different perspectives for inference are defined in a fuzzy inference engine. In the first method, known as "rule-based inference", all the rules in the fuzzy rule database are combined in a fuzzy relation in $U \times V$ (based on two operations of community or sharing) and then a rule if- Fuzzy is then looked at alone. An example of such a combination is the Mamdani rule. The second method is called "inference based on separate rules". Each rule in the fuzzy rule database specifies a fuzzy output, and the final output will be a combination M of separate output of fuzzy sets. The act of combining can be done through community or sharing.

It should be noted that since in most applications, the input and output of the fuzzy system are real numbers, we must use intermediaries between the inference motor and the real environment to provide the real numbers in the real environment as fuzzy input to the fuzzy system. Or convert the fuzzy output of a fuzzy inference engine to real-world execution. Such intermediaries are generally called fuzzy generators (to convert real numbers to fuzzy inputs) and non-fuzzy generators (to convert fuzzy output to real numbers). Based on the design criteria of fuzzy and non-fuzzy generators, various types of such intermediaries have been presented that have special applications.

3.6.2 Fuzzy and non-fuzzy

In most cases, in practical applications of fuzzy systems, it is necessary to convert the real inputs to fuzzy values using special intermediaries before applying the inputs to the fuzzy system, and also to convert the fuzzy output result to the real output in the output. Show me. These intermediates are called fuzzy and non-fuzzy and different types of them have been defined, each of which has specific properties and applications [45].

3.6.3 Fuzzy Makers

Mathematically, a fuzzy is a mapping from a point X ^ * ∈U⊂R ^ n to a fuzzy set $(A)'$∈U, defined by a specific mathematical relation. But what criteria should be considered when defining the mathematical relation of a fuzzy maker?
In defining the mathematical relation of a fuzzy generator, we must take into account the fact that the input at the point X ^ * is definite and therefore must at this point have the function of belonging to the maximum value.
If the input of the fuzzy system is damaged by noise, the fuzzy system must be able to reduce and eliminate the noise.
The fuzzy mathematical relations of the generator should be able to simplify as much as possible the mathematical relations related to the inference engine.
There are different types of fuzzy makers such as single fuzzy maker, Gaussian fuzzy maker, triangular fuzzy maker, etc. In this dissertation, triangular fuzzy maker has been used.

4. EXPERIMENTAL RESULT

4.1 RESULT

We utilized a counter for the piece communicated to the base station and bunch heads during the arrangement stage. Additionally, we at first set all counter qualities to nothing. For hubs we utilized typical hubs and progressed hub. We take the energy of typical hubs as 0.5 Joule and the energy of cutting edge hubs as 1 Joule. This technique is trailed by the steady determination convention strategy. With this technique, we can both utilize more energy and save more on the organization.

We have selected three ranges for both inputs and outputs. The range for energy is chosen between 0 and 1. For distance, this range is chosen between 0 and 200. In the end it is chosen between 0 and 100 for probability. In addition, small medium and high can be selected for all ranges. For the triangle element ship function, the parameters are chosen at random, but these data values depend on the program result.

The likelihood of the group header relies upon energy and distance. For instance, when the sensor is low in energy and the distance between the sensor and the sink is little, the odds of the individual sensor being CH are low. This possibility gives us the likelihood estimation of CH. In the event that the likelihood esteem is high, the sensor will be group head, if this likelihood esteem is low, the sensor won't be the bunch head.

We used the clustering cost for the genetic algorithm as follows:

$$z = \sqrt{(Sink.x - X)^2 + (Sink.y - Y)^2} \qquad (4.1)$$

The genetic parameter we used in this thesis is shown in Table 4.1.

Table 4. 1: Genetic Algorithm Parameters

Parameter	Value
Maximum Number of Repeats	10
Population size	50
Cross Percent	0.6
Mutation Percentage	0.5
Number of Mutants	30
Gamma	0.3
Mutation Rate	0.08
Election Pressure	10

According to the results, the best cost from the first iteration to the 4th iteration is 0.18, this value is 0.065 in the last iteration.

After this step, cluster formation is made by fuzzy logic. Then we checked the cluster head counter with fuzzy logic. The wireless sensor network setting up is shown in figure 4.1.

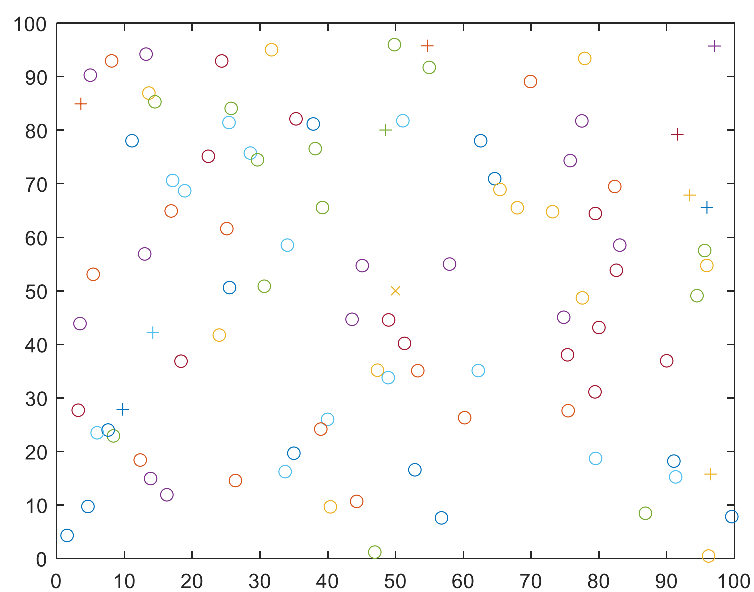

Figure 4. 1: Wireless sensor network creating

The situation of the final iteration that all sensors energy finished is illustrated in figure 4.2.

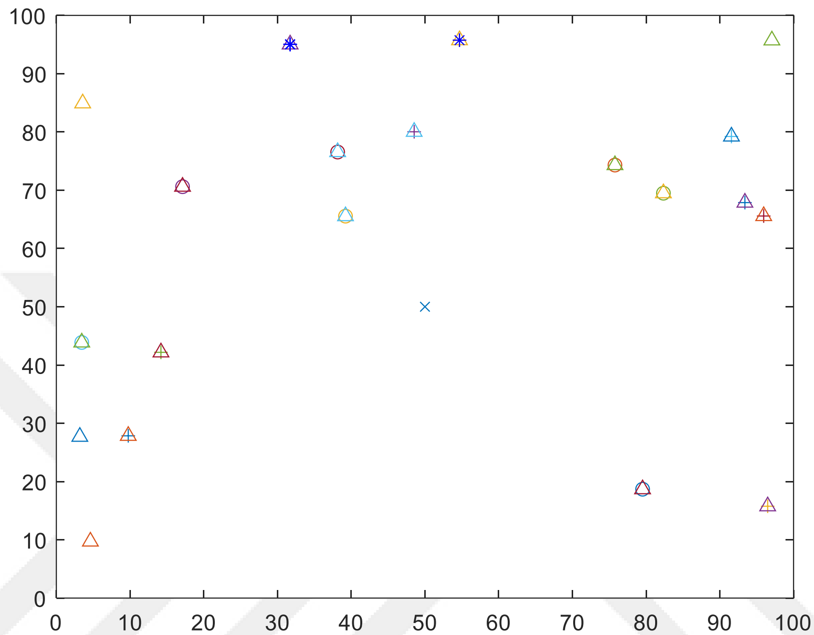

Figure 4. 2: final iteration that all sensors energy finished

The status of live nodes is shown in Figure 4.3 and Figure 4.4. It appears that the result of the method we propose is good. In the Proposed method, the first node begins to die at round 518 and all nodes die completely at round 810. In the proposed method, the first node begins to die at 821 and the last node dies at round 3000.

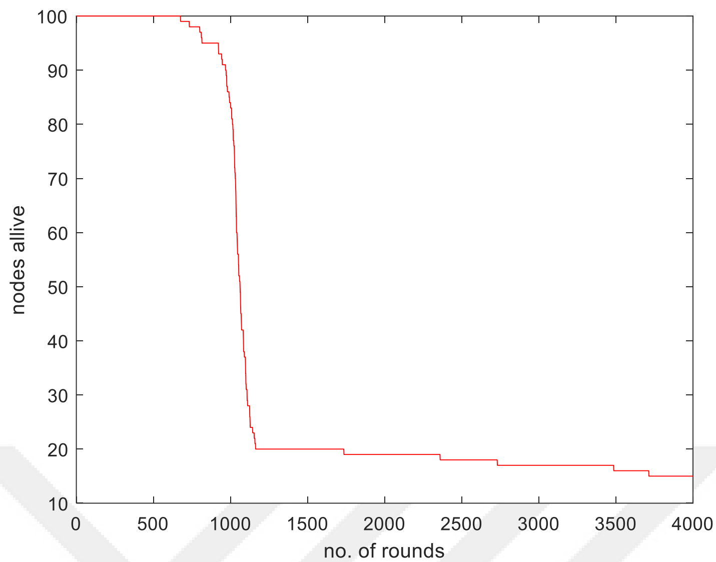

Figure 4. 3: node alive vs. number of iteration

The following figure is the number of decimals sent for proposed algorithm. In this figure, the horizontal axis represents the number of round and the vertical axis represents the number of data sent in the base station. As can be seen, the number of data submitted by the proposed method is high, which indicates an improvement in life expectancy compared to other algorithms.

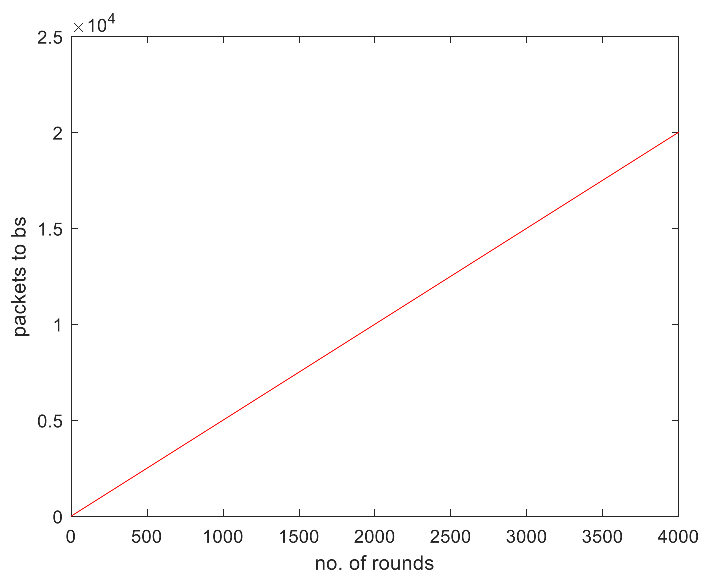

Figure 4. 4: packet to base station vs. number of nodes

Before reaching the network lifetime, the number of live sensors is equal to the total number of network sensors, which can be seen in Figure (4-3). The sensors then die one by one, and eventually the energy of all the sensors reaches zero as shown in Figure (4-4).

The criterion for evaluating the proposed method using two criteria is similar to other articles. The first criterion is the lifespan of the network; That is, the number of cycles that the sensors send data until the first sensor in the network dies (its energy reaches zero). The comparison of different methods in research has been based on this criterion, so that the longer the life of a method, the more appropriate that method is. In this figure, the horizontal axis is the number of iterations and the vertical axis is the minimum energy between the network sensors in each iteration. As can be seen, our proposed method has a longer lifespan than other methods.

Also, the second evaluation criterion is the end of network life. For this criterion, a diagram is drawn that shows the horizontal axis of the number of repetitions and the vertical axis of the number of live sensors. In this figure, the horizontal axis shows the number of repetitions and the vertical axis shows the average energy of live sensors. As can be seen, in the proposed method, the cap should be selected in such a way that it does not necessarily lead to the consumption of the minimum energy among the members of each cluster. In other words, choosing a sensor that consumes more power may increase the lifespan, but the average overall power consumption of the grid will increase. When the first sensor in the network dies, it sends less data than when all the sensors in the network are alive. In this figure, the horizontal axis represents the number of iterations and the vertical axis represents the data sent from each sensor.

5. CONCLUSION AND FUTURE WORKS

5.1 CONCLUSION

Optimization means that among the parameters of the function, we look for values that minimize or maximize the function. All suitable values for this matter are called possible solutions and the best value of these values is called the optimal solution. Optimization has many uses, including resource allocation, scheduling, and decision making. There are several ways to optimize. Of course, in the natural world there are problems that optimize several functions at the same time, these problems are called multi-objective. It is very difficult to find a solution to NP problems. Algorithms such as random search have partially solved this problem. With these types of searches, solutions are found that are close to the answer. The wireless sensor network consists of space-based autonomous, wireless sensor platforms (nodes).

These include one or more sensors , a transceiver that enables wireless communication, and a control unit . They are exclusively used to measure various physical quantities such as temperature, humidity, infrared light, vibration, pressure, chemical sensors and others. Their wireless communication and small size allow them to cover large areas such as forests, bridges and buildings. As mentioned in the thesis, wireless sensor networks are used in many areas of our lives (military, health, environment, etc.). Therefore, many algorithms have been designed and implemented to use the energy of these networks more efficiently. In this thesis, we proposed another technique to build remote sensor network life time by diminishing energy devoured for information transmission. We utilized the hereditary calculation and fluffy rationale strategy to moving the information in the base distance. For routing of the sensors and also for finding the best cluster head the genetic algorithm and fuzzy logic are used. The MATLAB 2020a version is used for implementation the method. total 10,000m2 is used for evaluating of the sensors performance. Also about 100 sensors are used. In this thesis, we designed a clustering algorithm using genetic algorithm and fuzzy logic methods together. In the algorithm, we used the assumption that the sensors in the network are heterogeneously distributed in a certain area. We preferred the fuzzy logic algorithm for routing the wireless sensor network. This orientation has produced the possibility to choose the most suitable cluster head for us, taking into account the energy of the sensors and the remoteness between the sensors. Sensors with low probability are eliminated, sensors with high probability are selected as per cluster.

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