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Energy Efficiency Based Fuzzy Logic Activation/Deactivation of Cluster Nodes for Object Tracking in WSN

FARAH HANNA ZAWAIDEH
Iribid National University
Email:Dr.FarahZawaideh@inu.edu.jo
Tel: +962796619175

Abstract

Wireless Sensor Networks (WSNs) have enormous applications in the present-day world. These applications are everywhere from military application to households. However, there are certain limitations which serve as hurdles in wide adoption of the WSNs. Mostly such networks are installed in a remote area where sensor nodes are operating using batteries. The conventional network protocols cannot be used due to security, high power consumption, and transmission ranges of such networks. The purpose of this paper is to discuss and evaluate the most efficient network protocol which increase the energy efficiency and network lifetime of the WSNs. Object tracking for the surveillance system is one of the challenges especially when an object is moving at variable speeds. The problem is addressed in this paper using Predictive Model for Object Detection. The fuzzy logic is inspiration from the natural procedures and it is used in this paper to enhance the efficiency of the network. Using fuzzy logic Low-energy Adaptive Clustering Hierarchy (LEACH-FL) protocol is optimized and revised to increase the efficiency of the network. To analyze the results of the designed, protocol a renowned software MATLAB/SIMULINK was used and the results were interoperated in a meaningful manner using the codes.

Keywords: *WSNs, Object Tracking, Fuzzy Logic, LEACH Protocols, Prediction Based Model.*

Introduction

Wireless Sensor Networks (WSNs) have seen significant development in last ten years due to the low cost of sensors and rapid adaptability to changing physical conditions. The WSNs consist of small sensor nodes which can communicate with each other and controlling system over the short distances Baihai et al.(2015). There are many clustering and routing protocols developed in the field to assign routing protocols to the sensor nodes rather than using ad hoc protocols. The energy consumption of sensor nodes and the overall system is a primary concern in such networks Azharuddin& Jana. (2016). To counter this situation a number of transmissions must be reduced to extend the battery life and operating efficiency of a WSN.

There are numerous applications of the WSNs in today's world such as surveillance on the battlegrounds, biological detection, and climate monitoring. One of the most affordable techniques to extend the lifetime of the sensor nodes is to divide the sensor networks into smaller cluster ones Cerpa et al.(2013). The head node of each of these cluster networks should be able to consider the data obtained by individual members, communicate with them, delete the irrelevant data, compress and transmit it to the base station.

In the recent years, the fuzzy logic is used in almost every aspect of engineering. The fuzzy systems are inspired by the natural systems. WSNs can also avail this inspiration and can make themselves more reliable. One of the major challenges faced by the WSN's is the energy consumption of sensor nodes. The

conventional codes are unable to provide efficient means of communications between sensor nodes due to energy and security constraints. Especially, in the object tracking applications where multiple cameras are operating it is required to install an energy efficient mechanism. In the current paper, the challenges in the object tracking applications are discussed and solution to the challenges is provided using fuzzy logic and LEACH protocol.

Literature Review

There exists an extensive research exertion for the improvement of steering conventions in WSNs. The development of these protocols depends on the specific application needs and the engineering of the system Cerpa et al.(2013). Be that as it may, there are a few components that ought to be thought about when creating steering conventions for WSNs. Vitality productivity is the most imperative among these variables since it specifically influences the lifetime of the system. There have been a couple of endeavors in writing seeking after energy effectiveness in WSNs.

Shirmali et.al present a Low Energy Adaptive Clustering Hierarchy (LEACH), with different level convention in which most nodes transmit to cluster heads is introduced. The operation of LEACH comprises of two stages:

The Setup Phase: In the configuration step, the clusters are sorted out, and the cluster heads are chosen. In each cycle, a stochastic calculation is utilized by every node to figure out if it will end up being a cluster head. If a node turns into a cluster head once, it can't turn into a cluster set out again toward P rounds, where P is the sought rate of cluster heads Pahuja, S., &Shrimali, T. (2016).

The Steady State Phase: In the consistent state stage, the information is sent to the base station. The span of the relentless state stage is longer than the length of the setup stage keeping in mind the end goal to limit overhead Pahuja, S., &Shrimali, T. (2016).

The drain is a convention that has a tendency to diminish energy utilization in a WSN. In any case, LEACH utilizes single-bounce steering in which every sensor node transmits data straightforwardly to the cluster head or the sink. Subsequently, it is not suggested for systems that are sent in expensive districts Pahuja, S., &Shrimali, T. (2016).

Control Efficient Gathering in Sensor Information Systems (PEGASIS) is a proficient energy convention, which gives enhancements over LEACH. In PEGASIS, every node discusses just with a close-by neighbor keeping in mind the end goal to trade information. It alternates to transmit the data to the base station, in this way diminishing the measure of energy spent per round. The nodes are composed so as to frame a chain, which can either be shaped by the sensor nodes themselves utilizing a ravenous calculation beginning from a particular node, or the BS can figure this anchor and communicate it to all the sensor nodes Bezerra et al.(2016).

In LEACH, a node turns into a cluster head utilizing a stochastic system. This is inclined to delivering different energy level saves in nodes and, accordingly, to expanding the aggregate power disseminated in the system. In PEGASIS, the cluster head determination mulls over neither the extra energy of the nodes nor the area of the base station. PEGASUS has better execution contrasted with LEACH, yet the nodes are gathered into chains that cause excess information transmissions Kaur & Grover (2015).

Edge Sensitive Energy Efficient (TEEN) is a various leveled convention intended for sudden changes in the detected condition. The reaction of the system in time-basic applications is critical, obliging the system to work in a responsive mode. The sensor organizes design in TEEN depends on many level gathering. The nodes near upper-level clusters are utilized to exchange information from different nodes that are further

away, a procedure that goes on the following level cluster until the sink is come to. The favorable principle position of TEEN is that it functions admirably in conditions where sudden changes in the detected traits happen Kaur & Grover (2015).

Then again, in huge territory systems and when the quantity of layers in the pecking order is little, TEEN has a tendency to expend extensive measures of energy, in light of high separation transmissions. Also, when the quantity of layers builds, the transmissions get to be distinctly shorter, and there exists an extensive overhead in the setup stage, and also the operation of the system.

The Shortest Hop Routing Tree convention (SHORT) proficiently gathers valuable information from a remote sensor system to the base station and gives energy effectiveness. This convention chooses the node with the biggest estimation of lingering energy as the pioneer. The Extending Lifetime of Cluster Head (ELCH) steering assembly has self-arrangement and hierarchal directing properties. It chooses cluster heads in view of the votes that it gathers from the system nodes Karaboga et al.(2016). The Energy Efficient Cluster Formation Protocol (EECFP) selects the nodes with the higher energy as cluster heads and turns them in each round to give an adjust of energy utilization and to limit the energy spend for cluster arrangement.

A concentrated directing convention, called Base-Station Controlled Dynamic Clustering Protocol (BCDCP), which disperses the energy dissemination equally among all the sensor nodes to enhance the system lifetime, and its average energy investment funds are introduced. The base station gets the residual energy of every node, and after that, it processes the average power level of the considerable number of nodes. At that point, it chooses as hopeful cluster heads various nodes, which have a higher remaining energy than this esteem. This convention gives an adjusted energy utilization Kumari et al.(2013). In any case, the determination of the node with the most astounding energy as a cluster head at around may bring about alternate nodes to spend more energy to send information to this node. The determination of a node that permits alternate nodes in the cluster to spend less energy is a superior arrangement.

Leach protocol was devised for the reduction of energy consumption in the WSNs settings. Leach converts the larger amount of data gathered by individual sensor nodes into smaller packets Karaboga et al.(2016).

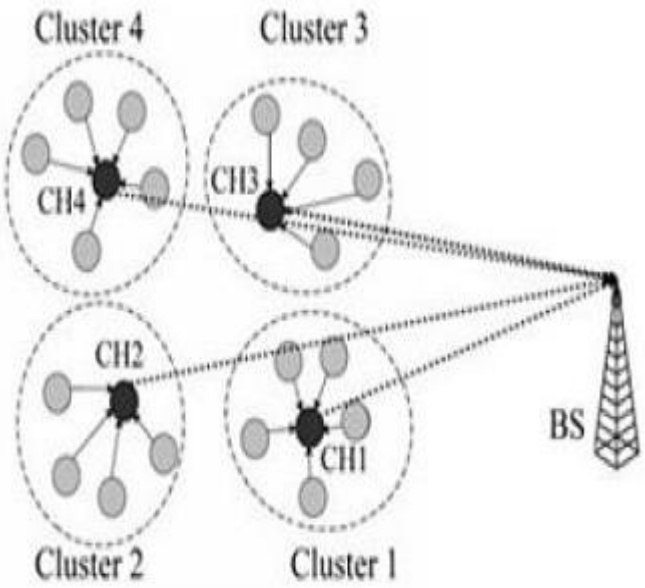


Figure 1: Overview LEACH protocol Kaur& Grover (2015).

The salient features of the protocol can be summarized as follows Kaur& Grover (2015):

1. Randomized alternation of cluster heads and the adjacent interested cluster heads.
2. Local compression is implied to reduce the global communication.
3. Low energy for MACs.
4. Data processing procedures optimized according to applications.

The table below gives a summary of different LEACH protocols developed so far with their specific features:

Table 1: LEACH Protocols Summary Liu et al.(2016)

Clustering Routing protocol	Classification	mobility	Scalability	Self organisation	Randomized Rotation	Distributed	Centralised	Hop count	Energy efficiency	homogeneous	Use of location information	Data aggregation
LEACH	Hierarchical	Fixed BS	Limited	Yes	Yes	Yes	No	Single hop	High	Yes	No	Yes
LEACH-S	Hierarchical	Fixed BS	Good	Yes	Yes	Yes	Yes	Single hop	Very high	Yes	No	Yes
Multi-hop LEACH	Hierarchical	Fixed BS	Very good	Yes	Yes	Yes	No	Multi hop	Very high	Yes	Yes	Yes
LEACH-M	Hierarchical	Mobile BS and nodes	Very good	Yes	Yes	Yes	No	Single hop	Very high	Yes	Yes	Yes
LEACH-A	Hierarchical	Fixed BS	good	Yes	Yes	Yes	No	Single hop	Very high	No	No	Yes
LEACH-C	Hierarchical	Fixed BS	good	Yes	Yes	No	Yes	Single hop	Very high	Yes	Yes	Yes
LEACH-B	Hierarchical	Fixed BS	good	Yes	Yes	Yes	No	Single hop	Very high	Yes	Yes	Yes
LEACH-F	Hierarchical	Fixed BS	limited	No	Yes	No	Yes	Single hop	Very high	Yes	Yes	Yes
LEACH-L	Hierarchical	Fixed BS	Very good	Yes	Yes	Yes	No	Multi hop	Very high	Yes	Yes	Yes
LEACH-E	Hierarchical	Fixed BS	Very good	Yes	Yes	Yes	No	Single hop	Very high	No	Yes	Yes

All the previously mentioned conventions attempt to limit the energy utilization utilizing diverse calculations. These estimates offer a suitable arrangement since they select the node with the higher leftover energy in the cluster as the cluster set out toward the following round. In any case, this does not guarantee the most extreme prolongation of the general system lifetime. Subsequently, if the node with the most elevated lingering energy is a node situated along the edge of the cluster, this can lead different nodes to spend impressive measures of energy to achieve that node, which can't be energy productive for the whole system Pahuja &Shrimali (2016). This is the reason we propose a convention that chooses as cluster heads nodes that limit the aggregate energy utilization in a cluster.

Clustering

It is the recently developed and widely adopted techniques to meet the challenges of object tracking in the WSNs. Mainly there are four primary stages of clustering:

1. Geographical location of the clusters.

2. Selection of some of the sensors which are sparsely developed to operate as cluster heads in the networks. Their selection is based on the processing capabilities, the range of communication, energy requirements, and locations of the object. Cluster heads need to be distributed efficiently over the sensor

fields Malcovati, P. (2002). In the case of failure of a single cluster head might result in the re-clustering of the entire WSN (Ismail et.al, 2016).

3. Data aggregation stage in which the data is gathered and transmitted all over the network. The data should be transmitted to the lesser number of packets to ensure energy efficient behavior of the installed network.

4. The data transmission stage in which the transmission of the data takes place from cluster heads to the sink node (Malcovati, 2002).

Types of Clustering

In wireless sensor networks field, Clustering can be classified into two types:

Static Clustering

In the static clustering approach, the clusters are formed at the deployment of the network. The characteristics of the cluster, size, sensor members, and cluster head are always static in nature. The sensor nodes are related to same cluster head and cluster throughout the lifetime of the cluster [6]. When an object enters the coverage area of the cluster, the cluster head gets activated and thus enables the members of the cluster. When the object moves away from the coverage area of one cluster to another the cluster head informs the required cluster to keep track of the object (Malcovati, 2002).

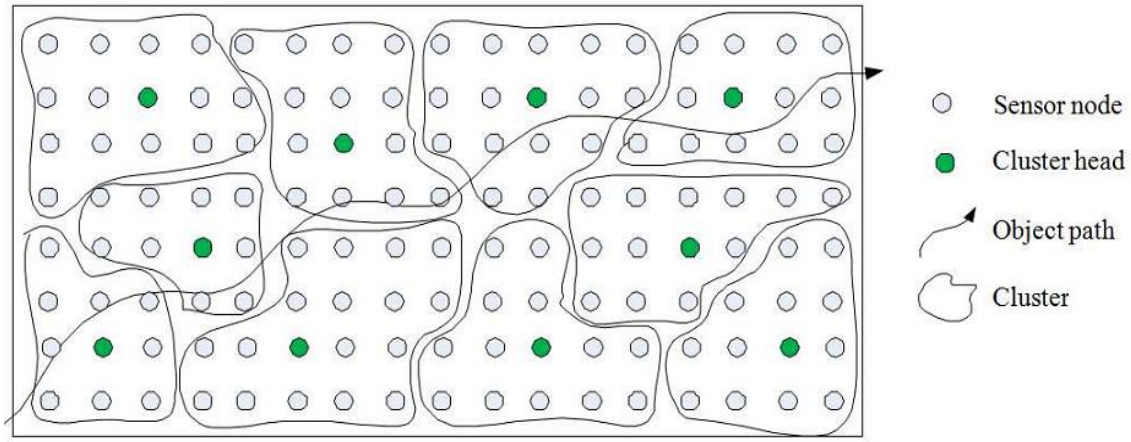


Figure 2: Static Clustering Case [6]

Dynamic Clustering

While static clustering is done at the time of network design the dynamic or adaptive clustering is triggered by special situations, for instance, moving object having acoustic sounds. When a sensor closed to the moving object or a sensor with high energy, detects the object, it volunteers to operate as a cluster head for the entire time. Typically, multiple sensors can detect an object, and in such cases, multiple volunteers can exist Ismail et.al. (2016).There should be a mechanism to ensure the selection of only one sensor node required to operate as a cluster head. Nodes which are near to the cluster heads are invited to perform and form a cluster. The cluster is efficiently dismantled after the object is no longer sensed Zhang D. &Lionel M. Ni. (2009).

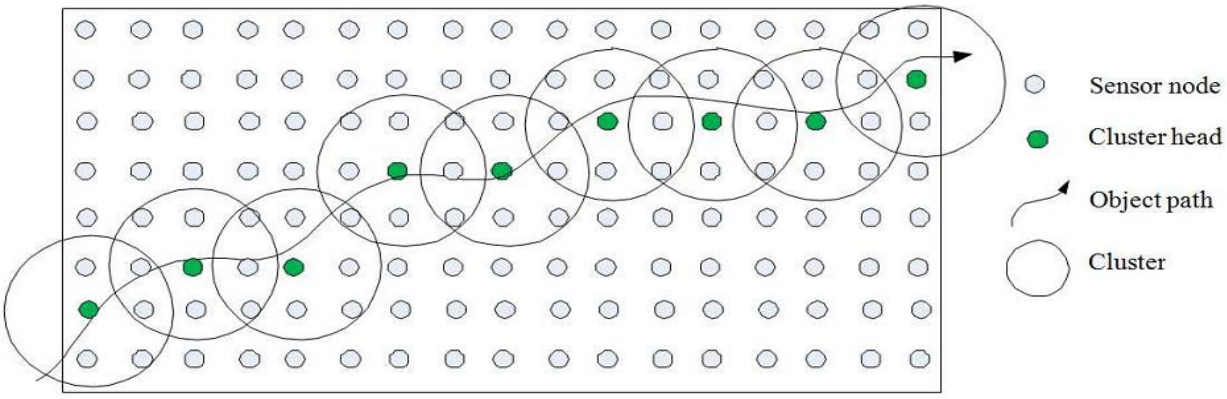


Figure 3: Dynamic Clustering Ismail et.al. (2016).

Challenges in Object Tracking on WSNs

In this section, we will briefly discuss some challenges in the object tracking on WSN's and importance to address these difficulties and use of LEACH protocol. The main challenges in object tracking using WSNs can be classified as follows Ismail et.al. (2016):

Scalability

The challenge of scalability is twofold. The two elements which are required to be addressed in each WSN design are the number of nodes operating in the network and secondly the number of objects needed for tracking. The number of nodes running in a WSN varies from thousands to millions. Tackling a such number of nodes is not easy as they might be unable to access, failure might occur in nodes, and finally there is a chance that new nodes might be added to the network. In such ever-changing situation, it is required to develop a proper coordination and management operations Ismail et.al, 2016). The designers of tracking algorithms consider the factors like number of active vs. inactive nodes, energy consumption, and communication among sensor nodes.

The second challenge is the number of objects that need to be tracked. The tracking algorithms should be able to identify and track each object separately. The number of packets assigned to tracking objects also change in some instances. They should be optimized and adopt energy efficient scheduling mechanisms.

The algorithms need to achieve minimize energy consumption, and common techniques are:

1. Deciding and scheduling when a node needs to active or inactive.
2. Minimizing of cost and computation.

Data Acquisition and Grading

Data gathering and classification is a very common task in the WSNs. The data gathered from the individual sensors is combined and compressed. After the compression of the data, it is transmitted to the base station. The extent of data generated and compressed is dependent on the intra-network spatial relationship and nature of the application. The aggregation of the data is also dependent on the suppression functions. The problem of this data generation and transmission cause a challenge for the network stability when the nodes start to generate duplicate data.

Sensor Technology and Localization Techniques

There are numerous types of sensors and localization techniques having different accuracies. So far there are no sensors developed which can suit for every application of the WSNs. The choice of the sensors is dependent on the required distance range, precision, available bandwidth, signal propagation and coding techniques, and finally the cost available for the application. The time difference for arrival and received signal strength indicator are some of the applications used for indoors while GPS is widely used for outdoor applications.

Tracking Accuracy

The tracking accuracy is one of the most critical challenges in the designing the applications for WSN. There should be the low probability of missing an object. The network should have low response latency, and low sensitivity to external noise.

Reporting Frequency

Tracking algorithms face the challenge of keeping up to date with the object it is tracking and informing the base station about its position. The operating frequency and energy efficiency while operations are among the highest challenges. The sink node should be adjusted according to operating frequency. In non-sink centric approaches, each node is capable of changing its frequency in case of retransmission and object recovery mechanism.

Localization Precision

The accuracy and precision of the WSNs to track moving object is dependent on the number of sensor nodes used in the application. For an object in 2D space at least 3 nodes are required, and for the object in 3D, at least 4 nodes are required. The object tracking application can face a stiff challenge between high precision and need to conserve energy at the same time. The algorithm should be able to reduce the number of active nodes and at the same time provide high-precision.

Sampling Frequency

The sampling rate is one of the challenges in the object-tracking applications. The existence of an object per unit of time is known as the sampling frequency. The parameter of sampling frequency directly affects the localization of the network. Low sampling rate hides the minor changes in the movement of objects or may totally fail to detect an object was moving at high-speed. The increase in the sample rate improves the tracking efficiency.

Security

One of the most debated problems in the WSNs is the safety of the information. This challenge is of extreme importance in the mission-critical applications. The sensors are sometimes in some positions in which they can be quickly attacked by some hacker to steal or alter the necessary changes. Tracking algorithms should take into account the source, data authenticity, integrity, and confidentiality. The violation of any of these features can cause damage to the purpose of the network in a manner which cannot be described.

Proposed System

The purpose of the protocol to be designed here is to minimize the energy consumption of the WSN. We name the protocol as H-Leach (Hierarchal LEACH). The idea behind the design of the protocol is to

minimize the distance for transmission. In simple words, more distance means more energy consumption and lesser distance means lesser consumption of energy. The designed protocol performs same like the average LEACH protocol. For clustering purposes, a Master Cluster Head is developed which is responsible to transmit messages towards the base station. The flow chart of LEACH protocol can be represented by the following diagram:

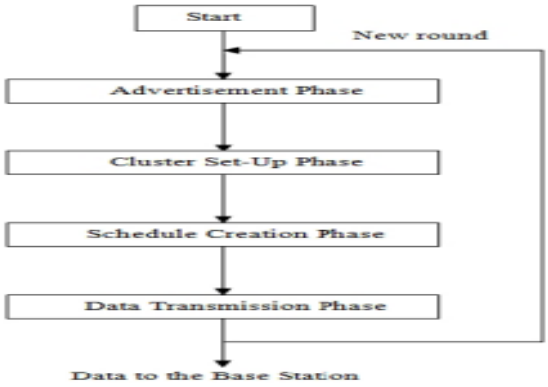


Figure 4: Flow Chart for operations of LEACH protocol

Methodology

In the proposed algorithm, the distribution of nodes is uneven and thus one cluster might have several nodes compared to others having lesser number of nodes. The cluster head of the network having more nodes can die faster affecting the efficiency of the WSN. To overcome this problem some modifications can be made to LEACH-C. According to the devised system the nodes are allocated to the nearest cluster if the number of nodes allocated to the cluster head is already lesser than a number N. If the number is greater than "N" than the node is allocated to the nearest cluster head. N is calculated by dividing the total number of nodes with available cluster heads.

The modified protocol algorithm has two phases: the setup phase and the steady state phase. In the setup phase, the base station is informed about the location and energy status of all the nodes present in the network. The nodes having energy greater than the average energy of the network are selected as cluster heads. The base station after determining the cluster head allocate the nodes to the nearest cluster heads. Once the allocation process is complete the base station sends information to all of the nodes of their respective cluster head identity. The energy drain the cluster head is kept equal to increase the lifetime and efficiency of the installed WSN.

In the steady state phase the nodes send data to their respective cluster heads. The cluster head gathers and grades the data and then forward it to the base station. After some time, the process starts again. The parameters selected for the modeling and design of the new algorithm are summarized in the following table:

Table 2: Parameters for design

Parameters	Values
Coordinates of x_m and y_m	(400, 400)
Sink node location	(200, 200)
Total number of nodes	100
Initial energy	0.5 J
T_x and R_x energy for each node	50×10^{-9}
Data aggregation energy	5.0×10^{-9}
Total number of rounds	2500

Clustering

The means so as to setup clusters and after that to choose cluster heads are the accompanying:

1. The BS makes a Time Division Multiple Access (TDMA) timetable and solicitations the nodes to publicize themselves, a procedure like that of different conventions.

2. Each node communicates a message to publicize its energy level and area to its neighbors. In light of this traded data, every node sets up a neighbor data table that records the energy level and the places of its neighbors and sends this table alongside its comparing data to its neighbors. This progression is rehashed until the data of the considerable number of nodes in the system is sent to the BS, permitting the BS to have a worldwide information of the system. At this progression, every one of the nodes are cluster head applicants, and every node has an exceptional ID that is likewise incorporated into the traded table.

3. As soon as the node commercial is finished, the BS runs the Gaussian disposal calculation and processes the quantity of rounds at which each node can be a cluster head, attempting to boost the system lifetime. In the initial step of the cluster head determination, the BS picks the nodes nearest to itself to be the above average state cluster heads. In addition, a portion of the nodes from which the BS has not gotten any immediate promotion message are thought to be low level cluster heads. The general number of nodes, which are doled out to be cluster heads, is 5% of the aggregate number of the nodes in the system, as this can be useful in accomplishing great execution in a homogeneous system with different parameter settings. Different rates can likewise be utilized.

4. The BS communicates the special IDs of the recently chose cluster heads, and their cluster individuals and the nodes utilize this data to frame and enter a cluster. Thusly, every node has the learning of the quantity of times that it can be a cluster head and the quantity of times that it can't. The BS runs the Gaussian end calculation and processes the fitting number of rounds that the nodes can be cluster heads and sends this data to the nodes.

5. The lower level cluster heads don't transmit specifically to the BS. They utilize the upper level cluster heads as halfway repeaters of their information to the BS.

6. Each cluster head makes a TDMA timetable and communicates this calendar to the nodes in its cluster, keeping in mind the end goal to educate every node of the timeslot that it can transmit. Also, the radio part of every node is permitted to be killed at unsurpassed periods, aside from amid its transmission time. In this way, the energy dispersal of each individual sensor is impressively lessened.

7. Then, the information transmission begins. The nodes, in light of the apportioned transmission time, send the information concerning the detected occasions to their cluster head. The transmission force of each node is changed in accordance with the base important to achieve its next bounce neighbor. Along these lines, both the impedance with different transmissions and the energy scattering are diminished.

8. Every lower level cluster head totals the information and after that transmits the compacted information to the upper lever cluster heads until the information achieves the base station. A series of information transmission has been finished, and the convention proceeds from step 4 for the following round.

9. In case that there is an adjustment in the system topology, due to either an adjustment in a node position or in the aggregate dissemination of a node lingering energy, the BS utilizes again the Gaussian end calculation to decide the fitting cluster head decision

10. The execution of the convention is ended when every one of the nodes in the system come up short on energy.

Steps for the New Algorithm

Step 1: Initialization takes place according to the parameters set in the above table.
Step 2: The nodes are distributed in a random manner and in a symmetric manner on entire area storing the location of the nodes.
Step 3: Cluster heads are formed by initializing the cluster head at zero.
Step 4: First Round: Cluster head selection takes place similar to the LEACH protocol.
Step 5: Second Round: In this step the cluster head calculates the energy of the entire network. The average energy of the network is calculated and as stated earlier if the energy of a specific node is greater than the average energy than it is selected as cluster head.
Step 6: Setup phase starts. In this phase:
The protocol calculates the number of nodes for each cluster. The generic formula followed by the algorithm here is given by the following equation:

$$\boldsymbol{Number\ of\ nodes} = \frac{\boldsymbol{nodes - cluster + 1}}{\boldsymbol{cluster - 1}}$$

The total number of non-CH nodes is distributed among the CH nodes.
Step 7: Communication phase is initialized among the nodes.

The salient features of the designed algorithm are as follows:

1. The cluster heads unlike other protocols are not selected randomly. The selection is done on the basis of the energy in the network. Thus, the designed algorithm is more energy efficient than the conventional LEACH protocols.

2. Every cluster in the WSN has the equal amount of the energy drain and thus cluster heads have equal energy considerations to tackle with. This factor also increase the lifetime of the network. The algorithm has its roots in LEACH and LEACH-C protocols.

Trilateration Algorithm

Trilateration generally refers to the process of calculating node's position on the basis of measurements of distance between itself and known anchor points in the network. It is known that the sensor should be placed at the circumference of the circle with anchor point as its center. The radius of the circle is thus sensor-anchor. The distances are estimated using RSS measurements. In a 2D space, the distance form at least three non-collinear anchors are required to obtain a unique location. In 3D space, the distance from at least four coplanar anchor points is required.

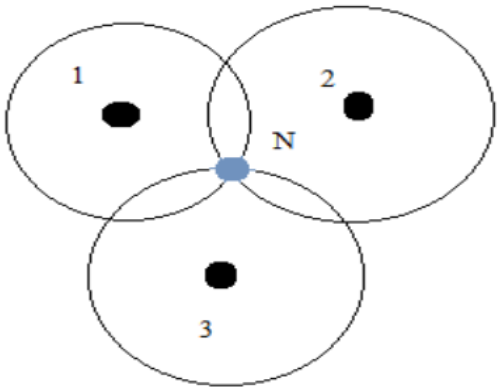


Figure 5: Trilateration

Trilateration Problem

The problem might occur in the 2D localization of the network when an unknown node is not located at the intersection of the 3 non-collinear anchor points. A node N is a node whose position is not known and it is not an anchor node. The location of the node N is calculated with respect to the anchor points. The goal of this exercise is to find location coordinates for the unknown node. RSSI is used to calculate the distance among the nodes keeping the anchor nodes at the center of the circles. To remove the errors in the calculations fuzzy optimization is used. The problem can be represented by the following diagram:

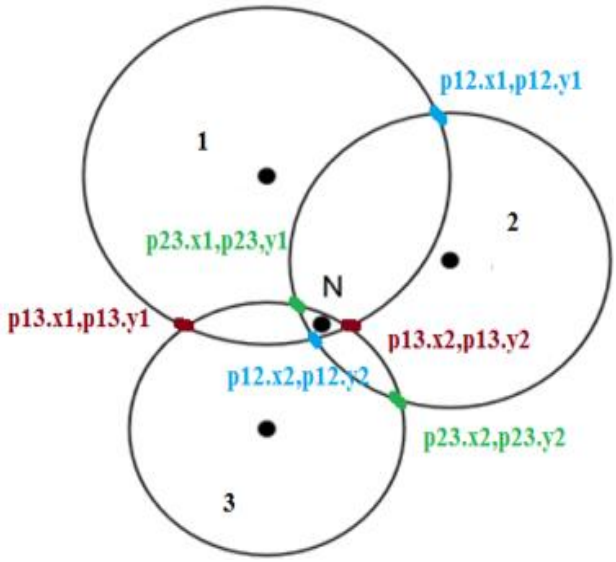


Figure 6: Trilateration Problem

Fuzzy Logic and Object Tracking

Generally, the fuzzy logic is regarded the human logical thoughts. Fuzzy logic includes several unique features which makes it a good alternative choice for several control problems. In fuzzy logic information, can be analyzed by using fuzzy sets and terms like “high” and “low” can be applied to the sets. Fuzzy sets can be explained by the range of real values including domain and membership function. A fuzzy system consists of three parts known as fuzzifier, engine, and defuzzifier. The rule base in such algorithms is simple which are IF-THEN rules relating the input parameters to the outputs. The part of FUZZY role before the THEN is a prediction of the values. The MIN-MAX rules are simple arithmetic sums.

Trilateration in Proposed Algorithm

The modified algorithm proposed here consists of the following steps:

Phase 1: Trilateration.

Phase 2: Debugging in the phase 1 using fuzzy logic. In the first step the distance between anchor nodes and distance from the sensors is calculated using RSSI values. After the measurement of the distance the circles are drawn taking the distance between anchor and non-anchor nodes as radius with anchor node at the center of the circle.

Phase 3: After the phase 2 intersection points of the circles are evaluated.

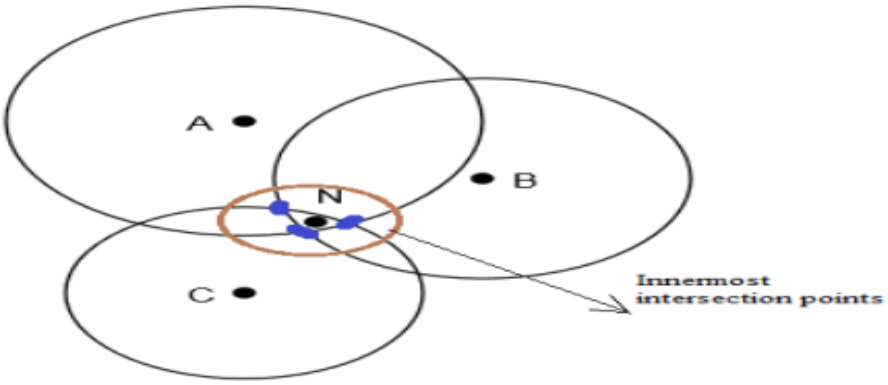


Figure 7: Evaluating Intersection Points

Phase 4: The weight of each node is calculated using fuzzy logic applied to RSSI scheme. These RSSI values are received by adjacent anchor and non-anchor nodes. After assigning the appropriate weight age to nodes a formula is applied to measure the "x" and "y" coordinates of the nodes.

Phase 5: Error is calculated considering the obtained position and actual position of the sensor node.

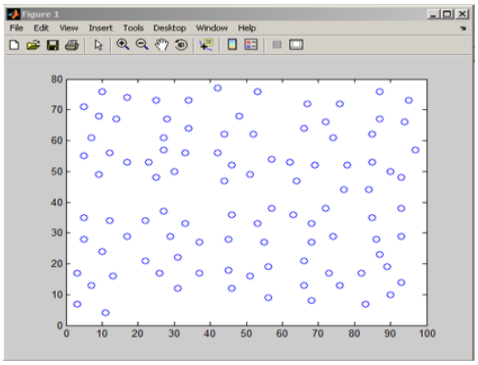
Object Tracking in Proposed Algorithm

Prediction based following strategy utilizing successive example is one of the question following system that foresee the future developments of the articles that track with the base number of sensor nodes. PTSP depends on two phases: Sequential example era, Object following and checking. In the consecutive example era organize, the prediction model is manufactured in light of an enormous log of information gathered from the sensor arrange and collected at the sink in a database, delivering the acquired behavioral examples of protest development in the checked region. Contingent on this information the sink will have the capacity to produce the consecutive examples that will be conveyed to the sensor nodes in the system. So, the sensor nodes that can anticipate the future developments of moving articles in their discovery range. In the second stage, the real following of moving articles begins. This stage has two sections: Activation Mechanism and Missing Object Recovery Mechanism. The utilization of the Activation Mechanism is to foresee which node ought to be initiated constantly to monitor the moving article. The missing article recuperation instrument is utilized to locate the missing item if there should arise an occurrence of the initiated node is not ready to find a question in its discovery zone.

Simulation Results

Estimation of the sensor nodes is done using trilateration method. The fuzzy logic is used to remove errors. The weights or energy situation of the node is the main variable in the simulation. RSSIs values are taken as input in order to map the values of the output. The membership function has the following fuzzy logic values:

Very very low (VVL),
Very Low (VL),
Low (L),
Medium Low (ML),
Medium (M),
Medium High (MH),
Very High (VH),
Very Very High (VVH),



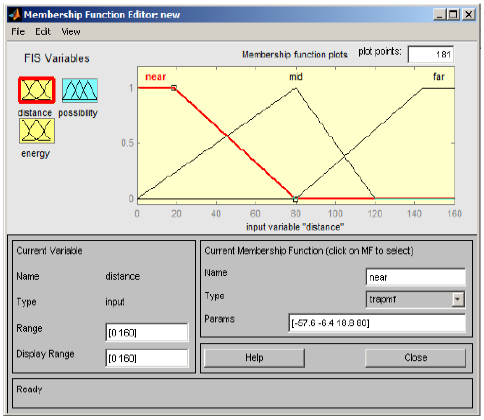


Figure 8: Input Variables.

Table 3: Rules of Fuzzy Logic.

RULES	IF CONDITIONS	WEIGHTAGE
1st RULE	V V LOW	V V L
2nd RULE	V LOW	V LOW
3rd RULE	LOW	LOW
4th RULE	MEDIUM LOW	M LOW
5th RULE	MEDIUM	M
6th RULE	MEDIUM HIGH	MH
7th RULE	HIGH	H
8th RULE	VERY HIGH	V HIGH
9th RULE	VERTY VERY HIGH	VV HIGH

RSSI Calculation

The algorithms are coded in the simulation program MATLAB the sensor nodes are separated with each other in a squire region separated with each other by 10m. The RSS is estimated using the following equation:

$$RSSI = -(10n \log 10\,(d) + alpha)$$

In the above equation "d" is the distance of each sensor node with respective anchor node:

$$d = \sqrt{(xanchor)2} - \sqrt{(x}sensor)2$$

"X" and "y" are the coordinates of the anchor nodes.

The circles must intersect each other at six different points, the centroid formula becomes:

$$(Xest, Yest) = (x12\ W1 + x12\ W2 + x23W3) \div (W1 + W2 + W3), (y13\ W1 + y12W2 + Y23W3 \div (W1 + W2 + W3)$$

W1, W2 and W3 are the weightage of each node calculated by the following equation:

$$W1 = \frac{weight\ 1 + weight\ 3}{2}$$

The error is located using the equation:

$$Location\ error = \sqrt{(xest - xsensor)2} + \sqrt{(yest - yesensor)2}$$

Average location of error can be given by:

$$average\ erro = \sum Location \frac{error}{n}$$

Applying the formulas, we found these two diagrams:

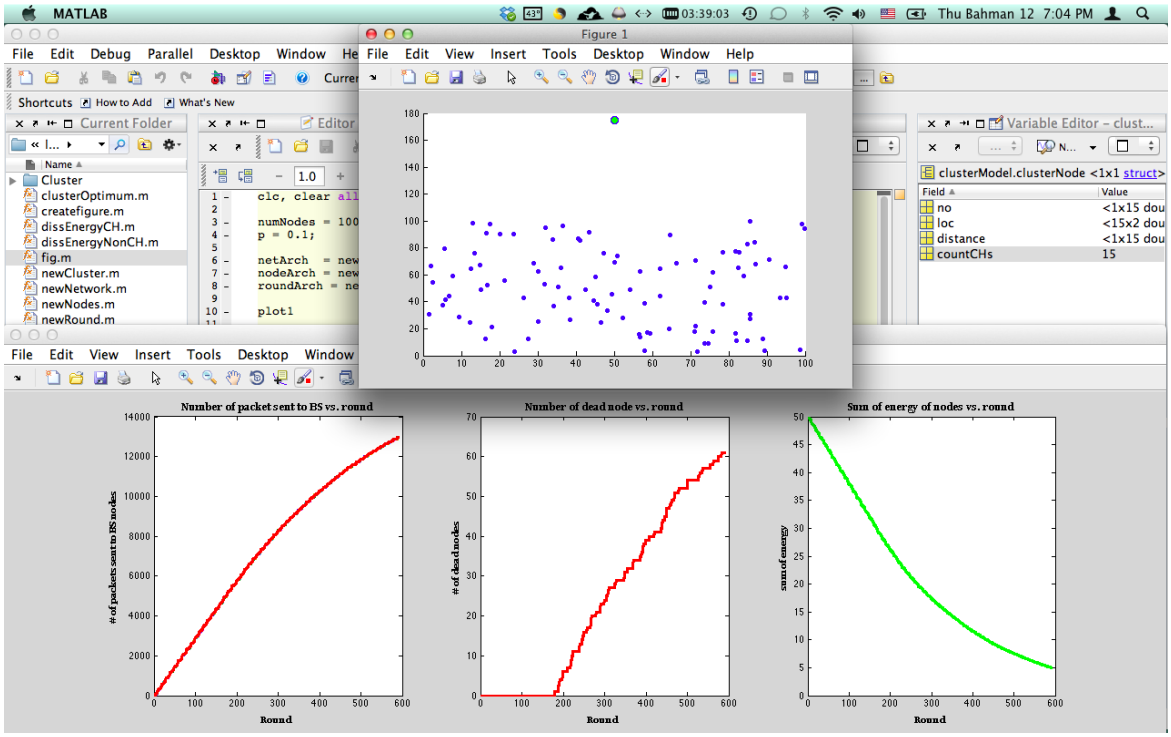


Figure 9: Error Plot for Diagram.

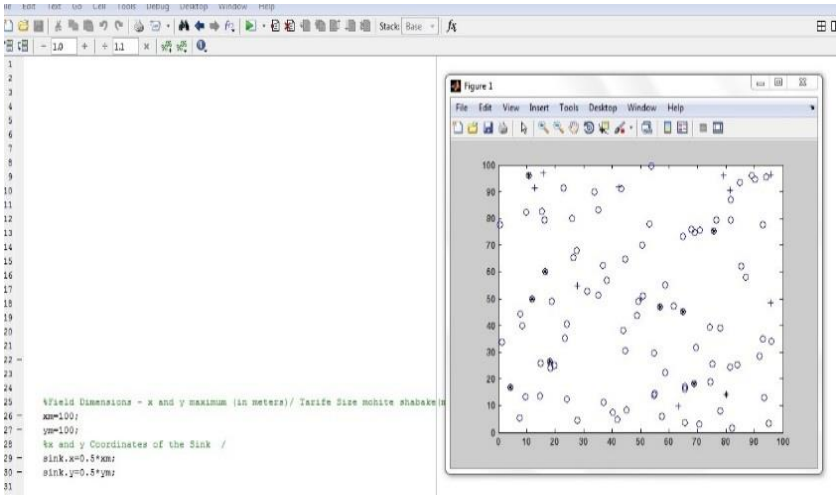


Figure 10: Plotting of Error Using Weighted Nodes.

Energy Consumed

In the proposed calculation, the energy devoured is decreased since just enacted nodes in the system is included in following and rest of nodes stay in standby mode. Figure 11 demonstrate the diagram contrasting the energy utilization prior and then afterward the proposed calculation. It expends more energy than whatever other assignment. It covers the interchanges as far as outflow and gathering. The energy devoured for the computation operation is low as contrasted and the correspondence energy.

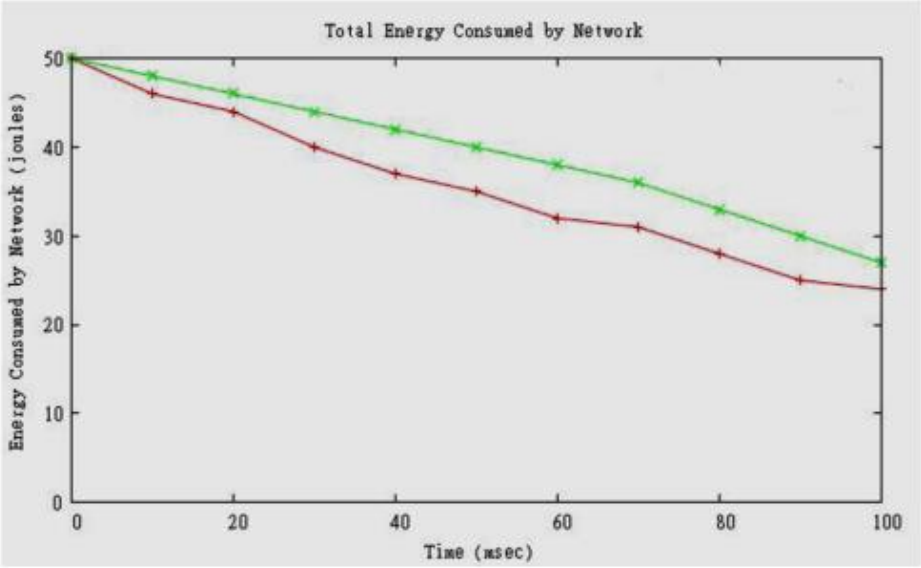


Figure 11: Energy Consumed with and Without Proposed Algorithm

Object Speed and Error Rates

At the point when an object is detected by a sensor, a three measurements cluster is utilized to store the area of target. Xk store the objective state at k venture and additionally the detected node parent and grandparent node likewise store the objective area. Target state is flip in the vicinity of 0 and 1. At the point when state

is settled i.e. either target is in or out from the direction. This is to limiting false cautions. Up to transmission run 150m, all conventions have right around 90% target identification likelihood. As transmission range builds the objective location likelihood forcefully diminishes.

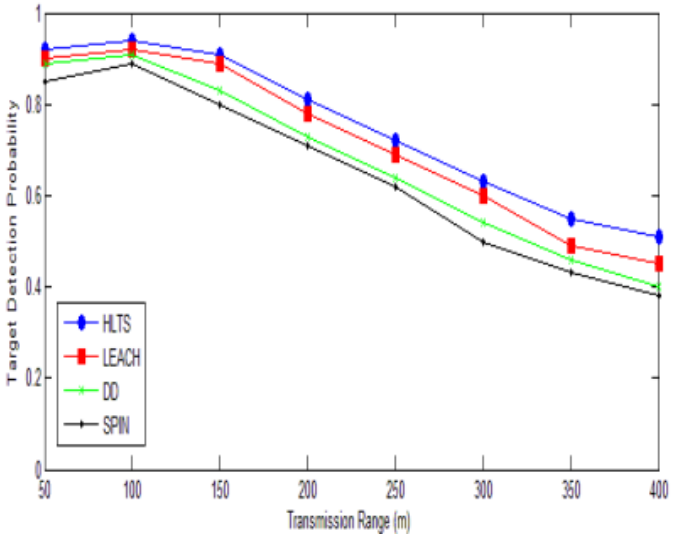


Figure 12: Transmission Rate and Object Tracking

The quantity of sensor nodes versus likelihood of target discovery with 100m transmission range and target speed is consistent of 10m/sec. As the quantity of nodes expanding all conventions have higher likelihood of target discovery. At first, as system thickness expanded the availability and in addition versatility additionally expanded. As the quantity of nodes increments to high the execution of target location move back because of expanding system thickness. Turn and DD conventions endure gravely because of different duplicates of information is conveyed. Filter and HLTS both have constrained movement implosion however both effect from topographical covering because of expanding in system thickness. HLTS execution corrupts by 10% though SPIN and DD endure by 30%.

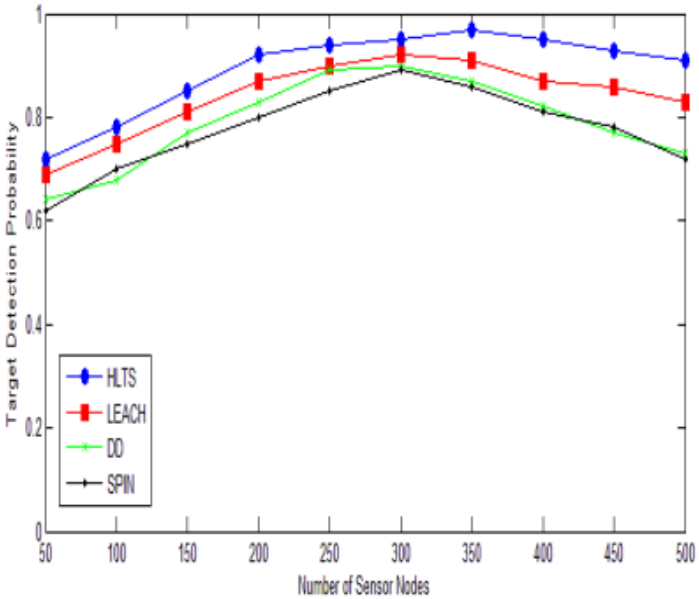


Figure 13: Number of Sensor Nodes and Probability of Object

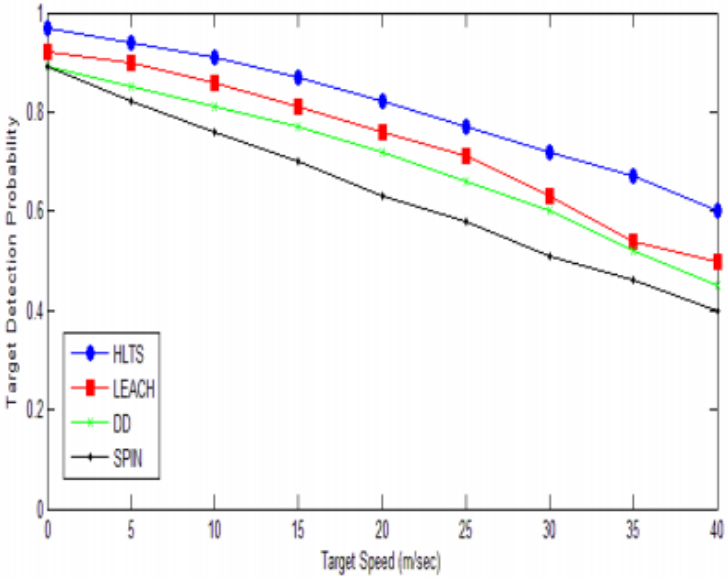


Figure 14: Target Speed Vs Object Detection Comparison

Normal error rates are measured against the transmission as appeared in Figure. At first target state is flip in the vicinity of 0 and 1 as the transmission run increments to 100. At the point when state is settled i.e. either target is in or out from the direction. This is to limiting false cautions. Up to transmission run 150m, all conventions have very nearly 10% average mistake rate. As transmission range expands the mistake rate likewise strongly increments.

Figure 15 demonstrates the quantity of sensor hubs versus average mistake rate with 100m transmission range and target speed is consistent of 10m/sec. At the point when the quantity of hubs expanding mistake rate diminishing. At first, as system thickness expanded the availability and also adaptability additionally expanded. As the quantity of hubs increments to 300 the mistake discovery is just 5%. Be that as it may, as further expanding in number of hubs builds arrange thickness and in addition error rate.

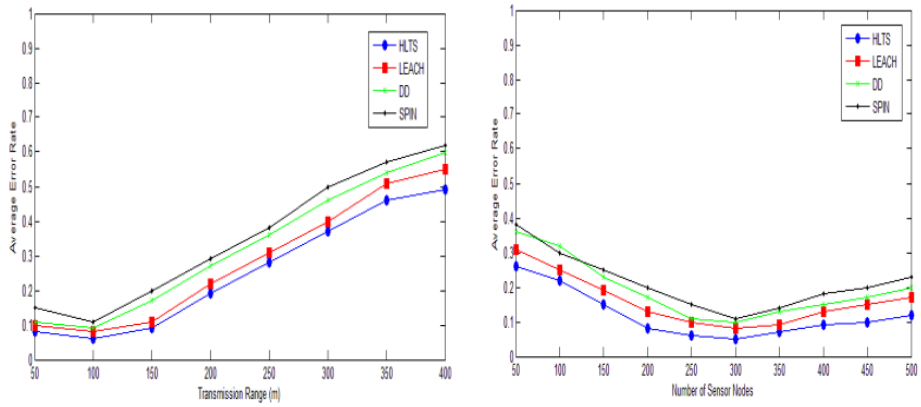


Figure 15: Error Rates

Discussions

The simulations were performed a renowned software MATLAB. The parameters and their respective values are explained in the algorithm. The number of packets transmitted to the BS was dependent on the number of rounds. The performance of the designed algorithm matches the performance of the conventional LEACH-FL protocol in case of small number of rounds. For the medium number of rounds

the values deviate. The relationship between the dead nodes and rounds deviate from the conventional LEACH-FL algorithm. The number of cluster heads with respect to rounds can be given by the following diagram:

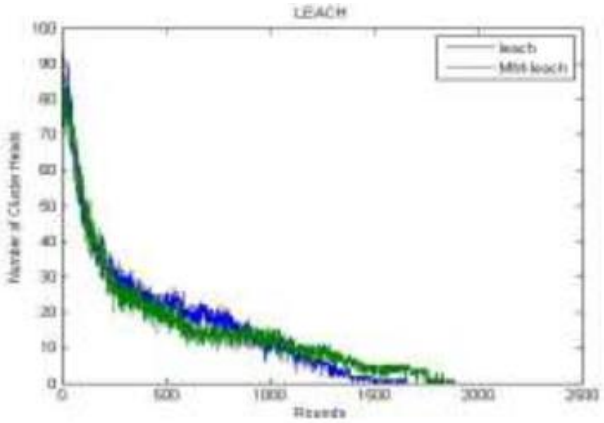


Figure 16: Number of Cluster Heads and Rounds

Conclusions and Future Work

Wireless sensor networks are regularly sent in an impromptu form, that is, their area is not known from the earlier. Confinement is important to give a physical setting to sensor readings. Without knowing the position of a sensor node, its data will just recount a part of the story. For instance, sensors conveyed in some backwoods to raise alerts at whatever point out of control fires happen, pick up fundamentally in esteem in the event that they can report the spatial relationship amongst them and the checked occasion generally data is futile. Then again, a few applications require the position of the node itself. This is the reason limitation is one of the urgent issues in WSN explore. Restriction alludes to the way toward evaluating and figuring the places of sensor nodes. The significance of these actualities guides analysts to search for an answer for restriction issue. One simple way is manual design yet this is unrealistic in substantial scale networks or when sensors are sent in difficult to reach regions, for example, volcanoes or when sensors are portable. Another route is to include outer equipment worldwide situating framework (GPS)- to every sensor. As a rule, it is difficult to utilize particular restriction gadgets, similar to a GPS, in light of the fact that these gadgets have tremendous energy utilization and essentially diminish self-rule. Likewise, the extra cost is a mishap for these gadgets to be utilized on a vast scale. In different applications, it is important to have nodes inside structures, where GPS innovation does not work decisively. In this manner, a few restriction calculations have been acquainted with take care of limitation issue. Sensor arrange restriction calculations appraise the areas of sensors with at first obscure area data by utilizing information of the outright places of a couple of sensors and between sensor estimations, for example, separation and bearing estimations Ismail et.al. (2016). The sensor nodes with universally known area i.e. furnished with an outer equipment (GPS) or by introducing sensor nodes at focuses with referred to directions are known as stay nodes. In applications requiring a worldwide organize framework, these grapples will decide the area of the sensor arrange in the worldwide facilitate framework. Due to limitations on the size and cost of sensors, energy utilization, execution environment (e.g., GPS is not available in a few situations) and the arrangement of sensors (e.g., sensor nodes might be haphazardly scattered in the area), most sensors don't have the foggiest idea about their areas. These sensors with obscure area data are called non-stay nodes and their directions will be assessed by the sensor arrange restriction calculation. Limitation calculations can be isolated into two classes: go based confinement strategies and without range restriction techniques. Go construct limitation depends with respect to the presumption that the total separation between a sender and a recipient can be assessed by gotten flag quality or when of-flight of correspondence flag from the sender to the beneficiary. The exactness of such estimation, nonetheless, is

liable to the transmission medium and encompassing environment and ordinarily depends on complex equipment. Conversely, go free restriction never tries to evaluate the outright indicate point separate in view of got flag quality. All things considered, the outline of equipment can be incredibly improved, making sans rang restriction exceptionally engaging for WSNs. Reference nodes with pre-information of the areas of themselves are likewise averagely utilized as a part of the without range restriction techniques.

The novel algorithm proposed in this research paper is 80 to 85% more accurate than the conventional algorithm used for the purpose. The error is also less than other forms of LEACH-FL protocols. The algorithm is more energy efficient, accurate and there are less number of anchor nodes. The model is prepared on the static nodes however, it can be transformed to the 3-D modelling in the future. Each variation in the LEACH-FL protocol is measure and authenticated to assess the energy efficiency of the WSN. The number of cluster heads are optimized to increase the lifetime and the efficiency of the installed WSN. In future, MAC protocols can be incorporated with the given LEACH-FL protocols to improve the efficiency further.

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