Differential Evolution used for Clustering for Mobile Sink in Wireless Sensor Network

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***Abstract*—In wireless sensor networks, the sensor nodes find the route towards the sink to transmit data. Data transmission happens either particularly to the sink node or through the intermediate nodes. As the sensor node has limited energy, it is imperative to create productive routing strategy to drag out network life time. It is highly dynamic network and specific to the application, and additionally it has limited energy, storage, and processing capability. Every sensor network node can be made out of different sensors that are utilized to collect data is exchanged to the client through system and furthermore control some physical procedures. PSO is a populace based methodology for progression. It is a computational knowledge oriented, stochastic, populace based global optimization strategy. The mobile agents can move wherever and at whatever point and they are accountable for social event the recognized data and forward them to the settled network involving Access Point. There are different methodologies for studying the mobility for data collection in WSNs. In this paper, Differential Evolution used for clustering and CH formation. Mobile sink is used for the data collection and increase the network lifetime.**

Keywords—Wireless Sensor Network, Mobility, Mobile Sink, Protocols, PSO, Differential Evolution.

I. INTRODUCTION

With huge advantages and incomprehensible potential outcomes of associating different devices and networks together, this has pulled in numerous organizations to put eloquent efforts to address important issues and challenges. Starting from the 3 millennium wireless sensor networks created an interest from industries and research aspects. The start of WSNs can be found in military and generous mechanical applications, far expelled from the light current and purchaser WSN applications that are pervasive today. The principal wireless network that drag any genuine similarity to a modern WSN is the Sound Surveillance System (SOSUS), created by the United States Military in the 1950s to distinguish and track Soviet submarines. This framework used submerged acoustic sensors – hydrophones – scattered in the Atlantic and Pacific oceans. This detecting innovation is still in benefit today, but serving more serene elements of observing undersea natural life and volcanic action. A remote sensor net work comprise of uniquely disseminated self administering sensors to screen physical or ecological conditions, for example, temperature, humidity, sound, vibrations, weight and so forth and it likewise goes the data through system to a principle area. Wireless sensor network (WSN) is developed of a gathering of a few hundred or thousand of sensor nodes, where every node is associated with one sensor node. Radio handset with an inside gathering mechanical assembly or relationship of an external accepting wire, a microcontroller, an electronic circuit for interfacing with sensors and an essentialness source are some regular parts of a lone sensor arrange node. Every sensor organize node can be made out of different sensors that are utilized to gather information is exchanged to the client through system and furthermore control some physical procedures. WSN utilizes a star topology with a progressed multi bounce remote work topology arrange. WSN comprise of fundamental 3 parts i.e., sensor nodes, user and interconnected backbone.

The essential necessities of WSN are as per the following:

- Scalability-WSN must be fit for being effortlessly extended or overhauled on request.
- Reliability-WSN must be worth trusting and it ought to give what is expected to the client.
- Responsiveness-WSN ought to rapidly respond in the coveted or positive way.
- Mobility-WSN must have the capacity to move starting with one place then onto the next.
- Power efficiency WSN must be power efficient [1].

II. MOBILITY IN WSN

Mobility to a few or all nodes in a WSN, enhances the network lifetime. It additionally gives more channel limit and improves scope and focusing on. The essential design of a three level Mobile WSN. The sensor nodes are sent arbitrarily in the network. These nodes can talk with each other and the mobile agents. The mobile agents can move wherever and at whatever point and they are responsible for social occasion the detected data and forward them to the settled framework including Access Point. There are diverse techniques for think the compactness for data assembling in WSNs. Mobility example of different nodes in the network must be displayed [2], which could be consolidated for different routing protocols.
According to an investigation of mobility models for WSN, the mobility model can be generally requested into two Homogeneous/Group mobility and Heterogeneous/individual or component mobility models. The homogeneous portability show

is the one in which a gathering of mobile sensor nodes move as indicated by a similar model in the given sending zone. They can be furthermore arranged into two - Random model and Controlled model.

The Random mobility model can be furthermore arranged into Partially Random and Totally Random models. In Partially mobility show, the mobile nodes rely upon each other to determine the development bearing in the system. Completely Random flexibility model will allow the social event of mobile nodes moving an random way.

The Controlled mobility model will empower an arrangement of nodes to move in a predefined course. In heterogeneous mobility show [3], the mobile nodes will move freely without contingent upon some other node in the network. Different nodes in the system will move as indicated by their embraced portability show. Hence in a network, different mobility models are embraced. Heterogeneous mobility model can be additionally arranged into four classes - Random mobility show, Controlled mobility display, Predictable mobility demonstrate and Geographic portability show.

The Random mobility model will parcel the development of the mobile node into delay period and movement period. They will empower the nodes to move in the network in an random pattern. In Controlled mobility demonstrate, the mobile nodes would visit the sensor nodes in light of the predefined plan that is fabricated in view of the examining rate of the sensors and occasion event rate.

The following order of portability show, Predictable versatility demonstrate where the sensor nodes know the way in which the portable sinks will utilize. Until the point that the foreseen time of data trade, the sensor nodes will be in rest mode, in this way saving a great deal of energy. From that point onward, the sensor nodes go to dynamic mode and will begin sending data to the mobile sink. The geographic mobility model is the one in which the mobile nodes development can be confined by the geographic idea of nature in which a mobile node or sink is sent. Mobile base station (MBS)- based λ Mobile data authority (MDC)- based data Rendezvous based solutions λ In a model WSN, where each one of the nodes are static, some portion of vitality get depleted for the node close to the sink. This intemperate energy use is because of the constant transmission and reaction by the sensor node near the sink. The basic purpose of MBS based game plans is extending the lifetime of the framework by impartially appropriating the essentialness usage. On the off chance that there ought to be an event of MDC based courses of action, the data are collected from sensors by going to them only. In light of the versatility example of the MDCs, there can be Random mobility, Predictable mobility, and Controlled mobility.

III. ROUTING TO MOBILE SINKS

Routing Protocol used to describe how to recognized communication by the routers. It produces the appropriate route for sending data by efficiently using an intermediate node. Mobility of nodes in WSNs includes a huge test. Without a doubt, even in dominatingly static sensor networks, it is possible to have two or three mobile nodes. One situation specifically that has gotten consideration is that of mobile sinks. In run of the mill WSNs application situations, sensor nodes are revealing their estimations to the sink utilizing multi-bounce correspondence. Along these lines the lifetime of the networks firmly relies upon the vitality of the sensors nodes around the sink that hand-off all messages on the last jump. One arrangement proposed for this issue is to utilize versatile sinks. In a sensor coordinate with a mobile sink (e.g. controlled robots or people/vehicles with door gadgets), the data must be directed from the static sensor sources to the moving substance, which may not really have an predictable/deterministic trajectory.

In [5] the creators proposed the two-level data dissemination (TTDD) protocol, which underpins packet routing towards a portable sink. In TTDD all nodes in the network are static, aside from the sinks that are thought to be versatile with obscure/uncontrolled mobility . The data about each event are assumed to originate from a single source. Each active source creates a grid structure dissemination network over the static network, with grid points acting as dissemination nodes. A mobile sink, when it issues queries for information, sends out a locally controlled flood that discovers its nearest dissemination point. The query is then routed to the source through the overlay network. The sink includes in the query packet information about its nearest static neighbor, which acts as a primary agent.

An alternative immediate agent is also chosen when the sink is about to go out of reach of the primary agent for robust delivery. The source sends data to the sink through the "overlay" dissemination network to its closest grid dissemination node, which then forwards it to its primary agent. As the sink moves through the network, new primary agents are selected and the old ones time out; when a sink moves far from its closest dissemination node, another dissemination node is found and the procedure proceeds. In another study [6], the authors propose to use mobile sinks that move in order to decrease the energy consumption of the whole network and they describe a routing protocol to support this architecture.

In [6] they proposed a slope based routing protocol where sensor nodes keep up a rundown of neighboring next hops that are the correct way towards the closest sink. The protocol utilizes restricted flooding to refresh the areas of the mobile sinks and the fundamental rule behind is to enlist a cost between the appropriate sink and the given node for each node and update only these routing entities where the relative change in cost is above a threshold.

An Adaptive Local Update-based Routing Protocol (ALURP). Utilizing this protocol the mobile sink needs just to communicate its area data inside a neighborhood of the whole system as it moves. Their routing mechanism is portrayed underneath: At the starting the goal zone is set, having as focus the situation of the mobile sink (VC) and a predefined radius R. Static sensor nodes that situated inside the goal zone will course packets to the sink utilizing a topology based routing plan. Nodes that are outside the goal zone will route packets toward the VC utilizing a geographic routing plan. Each time the mobile sink moves out of the present objective district it needs to impart its region to the whole system. As the mobile sink moves inside its goal region it needs just to refresh its area inside its goal zone. Additionally they discovered that as the sink moves towards its VC it needs just to refresh its area in the doughnut zone characterized by the goal zone when the circular area with center VC and radius the distance of VC from mobile sink current position is subtracted.

In [8] cluster based architecture is proposed for the mobile sink problem consisting of four phases:

a) Clustering Phase: the CHs are elected and the sensor network is divided into clusters.

b) Register phase: the mobile sink come into correspondence run with a CH hub is enlisted into the cluster.

c) Data Dissemination Phase: once the mobile sink is enlisted into the group the CH spreads the cluster sense information to the mobile sink.

d) Maintenance Phase: possible new sensor nodes are added to the cluster and the CH is evaluated.

Plainly, the previously mentioned routing protocols are primarily think about effective methods for how data can be directed towards the mobile sink (gateway) from the static sensor nodes (many nodes route information towards a mobile gateway). These algorithms cannot be used for efficient information routing from a static sink (or sensor node) towards mobile sensor nodes in the context of mixed WSNs (a gateway must route information towards mobile nodes).

IV. LITERATURE SURVEY

Rajanpreet Bhatti et al. [2017] in this paper, the proposed algorithm is an enhanced form of VGDRA algorithm which is grid based routing algorithm but lacks the concept of estimating energy on the basis of distance. In the proposed algorithm, sensor network is divided into logical grids of k-cells and a Cell Header (CH) is elected among each cell that acts as leader to cluster. The algorithm proves to be efficient in terms of energy by minimizing route construction cost considering shortest distance to sink [9].

Kushal B Y et al. [2016] in this paper, proposed strategy in this paper is planned to optimize the energy dissemination by modifying the CH (CH) selection approach in LEACH (Low Energy Adaptive Clustering Hierarchy) calculation and keeps away from the energy-hole problem considering mobility to the sink node which helps to prolong the lifetime of entire network [10].

Pavithra.H et al. [2016] in this paper, in WSNs, the sink flexibility along an obliged mode can improve the imperativeness capability. Sink mobility is a basic technique to upgrade sensor framework execution including imperativeness usage, end-to-end delay and lifetime. To manage the above issues researches introduced a Rendezvous design technique, where some sensor nodes are selected as an RP’s and the nodes which are not RP’s will forward data to the nearest RP’s. The major issue in this design is to find the set of RP’s and determine the tour that visits these RP’s. To overcome this issue in this paper we proposed an algorithm called as an “Weighted Rendezvous Planning (WRP)” , where each node is provided with some weight based on the number of packets that it sends and the nearest hop distance. The simulation is performed using NS2 simulator and we compared the WRP with the existing approach with the energy consumption and network lifetime of sensor nodes [11].

Xiaoqing Gong et al. [2016] in this paper, our first propose a strategy named Dynamic Estimation of Data Value (DEDV) to assess the value of data put away in the nodes powerfully. Moreover, we characterize a heuristic strategy that drives the mobile sink to gather data from the nodes to boost the estimation of the gathered data in a power-restricted mobile sink situation. Both recreation and trials comes about demonstrate that our strategy can accomplish at most more than 85% of the hypothetical greatest data value dictated by the OPT show [12].

Qi Liu et al. [2016] in this paper, our present a grid-based load-balanced routing method (GLRM) that means to utilize a controlled sink to accomplish load-balance in a non-uniform appropriated network. Cell-header decision of every cell depends on three parameters, i.e. the quantity of data packets that nodes need to hand-off, the Euclidean separation to the mid-purpose of cells and lingering energy of every node, individually. The GLRM likewise considers different components that waste battery control, for example, packet collision. Simulation results exhibit that our routing technique has demonstrated better execution [13].

V. PSO ALGORITHM

PSO defined a new era in SI. PSO is a people based strategy for optimization. It is a computational intelligence, situated, stochastic, masses based global optimization strategy proposed by Kennedy and Eberhart in 1995.It is stirred by the social direct of feathered animal running and fish schooling. PSO has been connected to numerous designing issues because of its extraordinary seeking component, basic idea, computational proficiency and simple usage. It utilizes a " populace " of particles that fly through the issue hyperspace with given velocities. At every cycle, the speeds of the individual particles are stochastically balanced by the recorded best position for the molecule itself and the neighbourhood best position. Both the particle best and the neighbourhood best are derived according to a user defined fitness function.

The development of every molecule normally evolves to an ideal or near-optimal solution. PSO isn't generally influenced by the size and non-linearity of the issue, and can join to the ideal arrangement in numerous issues where most expository techniques neglect to unite. Each molecule (populace part) in the swarm contrast with an answer in a high-dimensional space with four vectors, its recurring pattern position, best position discovered up until now, the best position discovered so far by its neighborhood and its speed and alters its situation in the pursuit space in light of the best position came to independent from anyone else (pbest) and its neighbor (gbest) amid the search procedure. Ventures in PSO calculation can be advised as beneath [4]:

1. Initialize the swarm by doling out an random position.

2. Estimate the fitness work for every molecule.

3. For every individual molecule, contrast the molecule's fitness esteem and its pbest. On the off chance that the present value is superior to the pbest value, at that point set this as pbest and the present molecule's position, xi , as pi .

4. Identify the molecule that has the best wellness esteem. This wellness work distinguished as gbest,

5. Revise the speeds and places of the considerable number of particles utilizing (1) and (2).

6. Repeat stages 2– 5 until the point when an adequately decent wellness esteem is accomplished. Considering a pursuit space of d-measurement and n particles, whose I th molecule at a particular position. Xi (xi1, xi2,……. xid) is moving with a velocity Vi (vi1, vi2,……. vid). Each particle is associated with its particular best, Pi (pi1, pi2,……. pid) which is defined by its own best performance in the swarm [6]. Correspondingly, a general best execution of the molecule concerning the swarm characterized worldwide best is gbest. Every molecule tries to modify its position utilizing the accompanying data:

- Current positions,
- Current speeds,
- Distance between the present position and pbest
- Distance between the present position and gbest.
- The development of the molecule is administered by updating its speed and position traits [6].

$$V_i^{t+1} = wV_i^t \, i{+}c_1 r_1 (x_{pbest} - X_i^t) + c_2 r_2 (x_{gbest} - X_i^t),$$

$$X_i^{t+1} = X_i^t + V_i^{t+1}$$

Where w= inertia weight, c1= psychological acceleration coefficient, c2= social expanding speed coefficient, r1 and r2 are the random values in the between of 0 and 1, xpbest is the individual best of the molecule and xgbest is the worldwide best of the molecule. Xi t is the present position of ith molecule at emphasis t. Vi t is the speed of ith molecule at cycle t [6]. In standard PSO, a minimization issue is considered which has a tendency to characterized a parameter set x a vector of m choice factors :x = (x1 , x2 , . . . , xm) t for single goal i.e. Limit/Maximize f(x); subject to xi $(^{L}) \leq$ xi $\leq$ xi $(^{U})$, I = 1, 2, ..., m.

VI. PROPOSED WORK

DE is a rising developmental protocol which is an optimization protocol that has its premise in the hypothesis of Swarm Intelligence, and performs optimization of quests through the participation and additionally rivalry between people in the swarm. DE has a relatively strong global convergence capacity as well as resilience and does not require assistance from knowledge regarding the problem features and hence. It is sensible for complex optimization issues.

In this paper, we propose a novel differential evolution (DE) based clustering calculation for WSNs called DECA. The primary goal of the DECA is to drag out the network life time of the WSN by dealing with the energy consumption of the basic sensor nodes and the passages (i.e., CHs). By the network life time, we mean the time from the arrangement of the WSN till the passing of the principal CH. The demise of the main CH is postponed through balancing the energy consumption of the CHs which is executed by the rate of energy utilization and leftover vitality.

We perform broad recreation of the proposed calculation. The exploratory outcomes show the proficiency of the proposed calculation regarding system life, vitality utilization and meeting rate
Our essential commitments in this paper can be consolidated as takes after:

- A DE based clustering algorithm for WSNs to postpone network lifetime.
- A proficient vector encoding plan for finish clustering solution.
- Mathematical derivation of the fitness function for DE based solution.

Proposed Algorithm:

Step:1 Initialize the network
Step:2 Place sensor nodes in a circular area
Step:3 Divide the network into two regions
Step:4 Form clusters using Differential Evolution

Formation of Clusters and Cluster-Heads:
Step:1 Formation of initial population by randomly selecting nodes

$$X= (x1, x2, \ldots, xn)$$

Step:2 Performed Mutation for getting novel solution in every iteration
Step:3 Crossover performed to improves the population diversity
Step:4 Now Selection used for choosing highly corrected vectors which are generated by mutation as well as crossover operators are contrasted with one another and that which is more appropriate is carried over to the subsequent generation
Step:5 Repeat the process until the best solution or clusters are formed
Step:6 Calculate remaining energy (RE) of each node and distance from Base station (D)
Step:7 At each cluster
a.If (RE = max and D = min)
b. Select CH
Step:8 CH collects data from the cluster members

Sink Node Movement for Data Collection:
Step:1 CH broadcast Hello packet periodically
Step:2 Packet contains ID of cluster and average of remaining energy (ARE)
Step:3 If (ARE=max)
Cluster is selected by mobile sink
Step:4 Move sink towards the CH of that cluster
Step:5 Collect data from CH and remain there for some amount of time
Step:6 Repeat the process from step 1
Step:7 Move to next location until the whole data transmitted
Step:8 Stop the process

VII. RESULT ANALYSIS

We used MATLAB tool for the simulation for the node deployment. In the proposed work, we estimate the whole network by analyzing the influence on the energy.

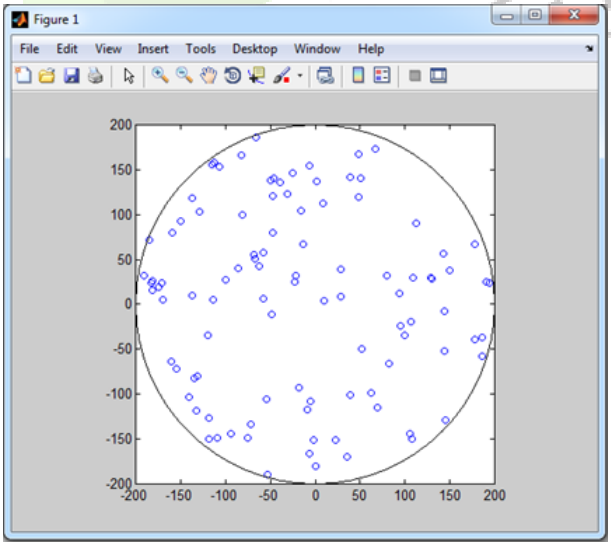


Fig.1 Initialization of Network

In the figure below, the network is partitioned into two regions and two clusters formed one is of red color and another is of green color.

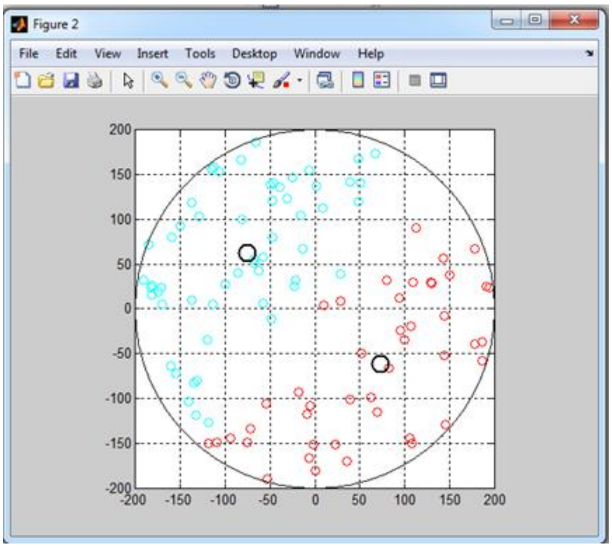


Fig.2 Divide into 2 regions

In the figure below, DE applied at one region to form the clusters and CHs.

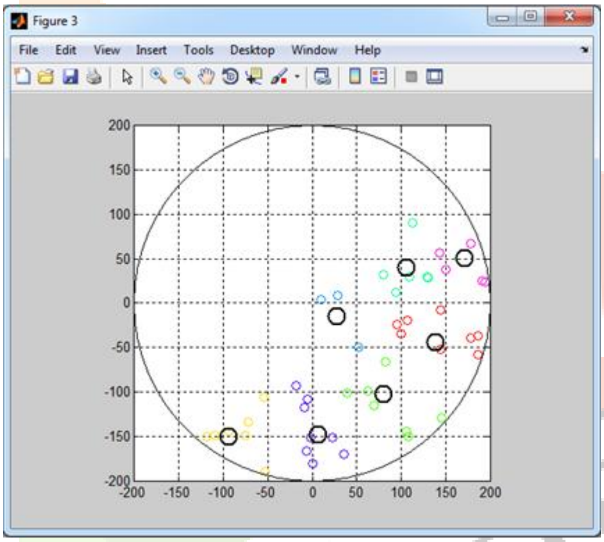


Fig.3 Perform Clustering at 1 region

In the figure below, it takes another region to form CHs using DE algorithm.

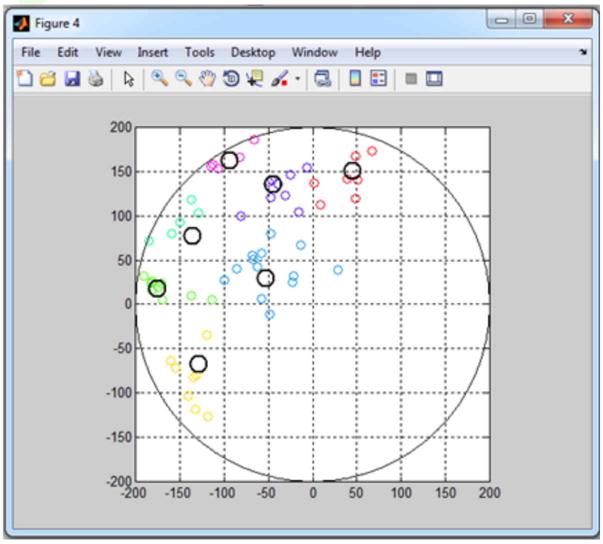


Fig.4 Perform Clustering at 2 region

In the figure below, the whole network has been formed with the clusters and their CHs. Mobile sink reached at CH to get the data from each nodes.

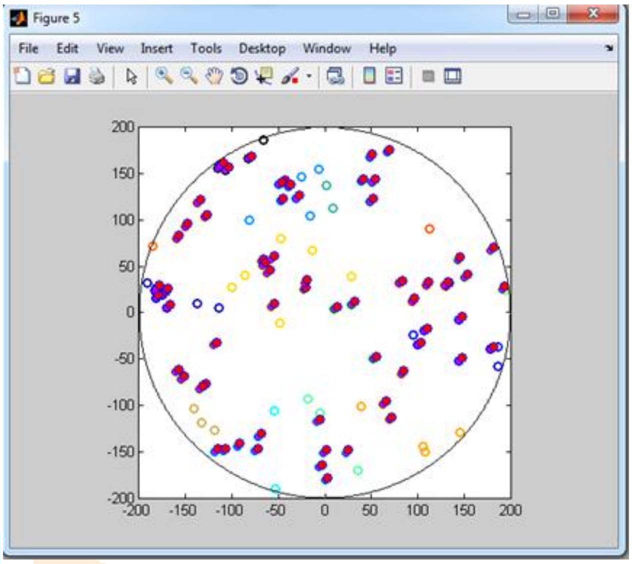
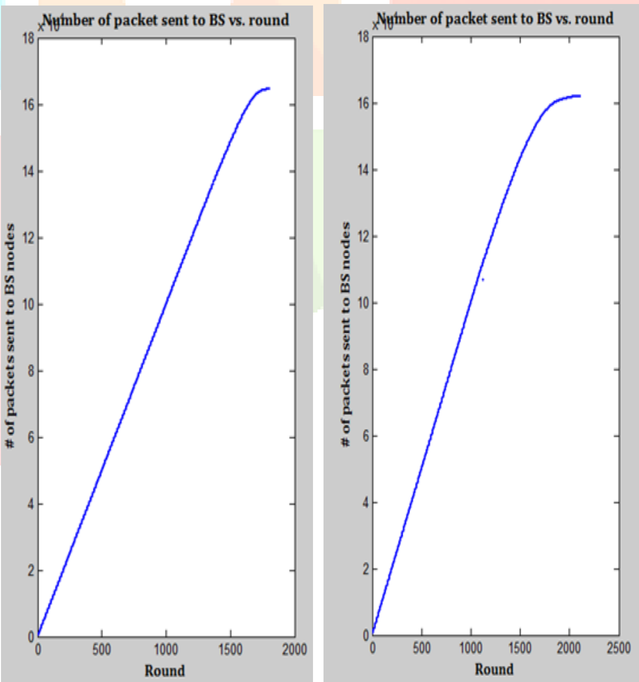


Fig.5 Sink Mobility Peformed

Packet Sent:

The overall quantity of packets sent to the BS is taken into consideration which indicates that the proposed scheme is a lot superior to the base scheme.

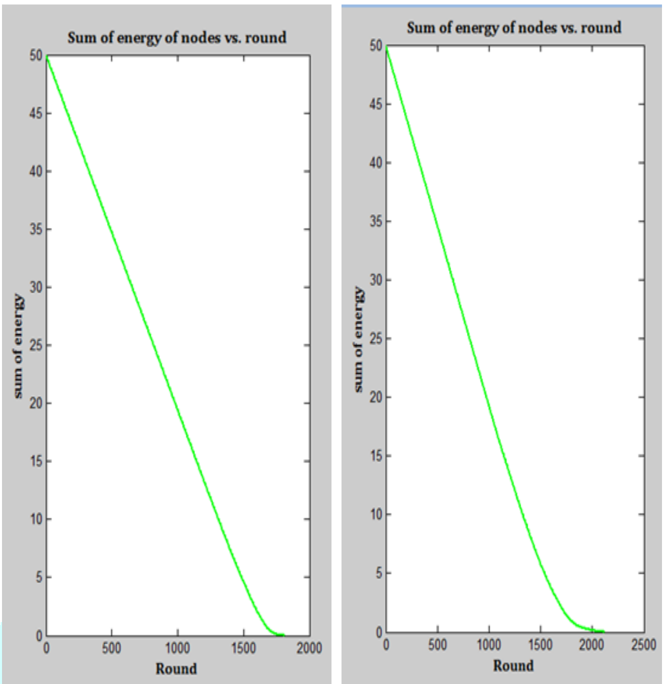


(a) Base (b) Propose

Fig.6 Number of packet sent to BS for base and proposed technique

Energy of nodes:

Energy of the nodes is taken inside the x- axis and changes inside the y- axis inside the graph underneath which endorses that the energy of nodes is supported in our proposed work over with the base system.

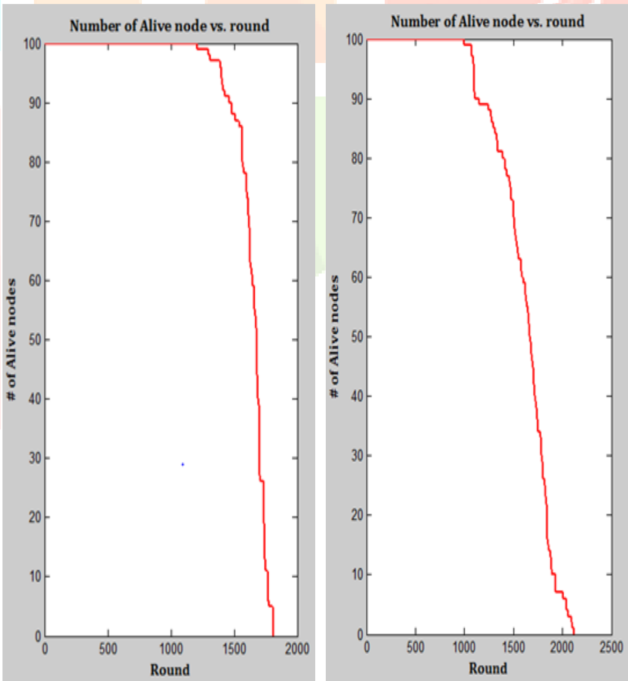


(a) Base (b) Propose

Fig. Sum of energy of nodes for base and proposed technique

Alive Nodes:

The number of alive nodes are the nodes which shows that the total number of alive nodes at different number of rounds. The number of round increase for the propose work which show that alive nodes are more than base work.



(a) Base (b) Propose

Figure 6.4. Number of Alive Nodes for base and proposed technique

CONCLUSION

A wireless sensor net work consist of specially distributed self governing sensors to monitor physical or environmental conditions, for example, temperature, humidity, sound, vibrations, weight and so on and it likewise goes the data through system to a primary area. In this, the network effectiveness improves as the sink moves through the network, new primary agents are selected and the old ones time out; when a sink moves far from its closest dissemination node, another scattering node is found and the procedure proceeds.

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