Differential evolution based energy efficient clustering protocol for wireless sensor networks

[1]Ramndeep Singh, [2]Parmbir Singh,
[1]Mtech Scholar, [2] Associate Professor,
[1] Department of Electronic and Communication Engineering,
[1]Khalsa College of Engineering and Technology, Amritsar, India

Abstract: Wireless sensor networks (WSNs) require energy management protocols to efficiently use the energy supply constraints of battery-powered sensors to prolong its network lifetime. This paper proposes a novel Heuristic Algorithm for Clustering Hierarchy (HACH).The clustering algorithm uses a novel heuristic crossover operator to combine two different solutions to achieve an improved solution that enhances the distribution of cluster head nodes and coordinates energy consumption in WSNs. We have evaluated the performance of the proposed technique with existing technique i.e. tree-based on the following metrics i.e. stability period, network lifetime, residual energy (average remaining energy), and throughput. The proposed algorithm is evaluated via simulation experiments and compared with some existing algorithms. Our protocol shows improved performance in terms of extended lifetime and maintains favorable performances even under different energy heterogeneity settings.

Index Terms **- Wireless sensor networks, Clustering, Differential evolution, Energy Efficiency.**

I. INTRODUCTION

In the modern era, there is a need for a world of fully connected devices. Networking is considered to be the fastest growing field in the area of research. Remote correspondences have brought the colossal unrest as it amplifies the abilities of different sorts of altered systems which incorporates area autonomous data stockpiling, transport, recovery, preparing and to help the clients to move openly starting with one area then onto the next [1]. Recent scientific and technical advancements in the field of networking have enabled us to produce a very small size, Cheap and battery-operated sensor nodes.

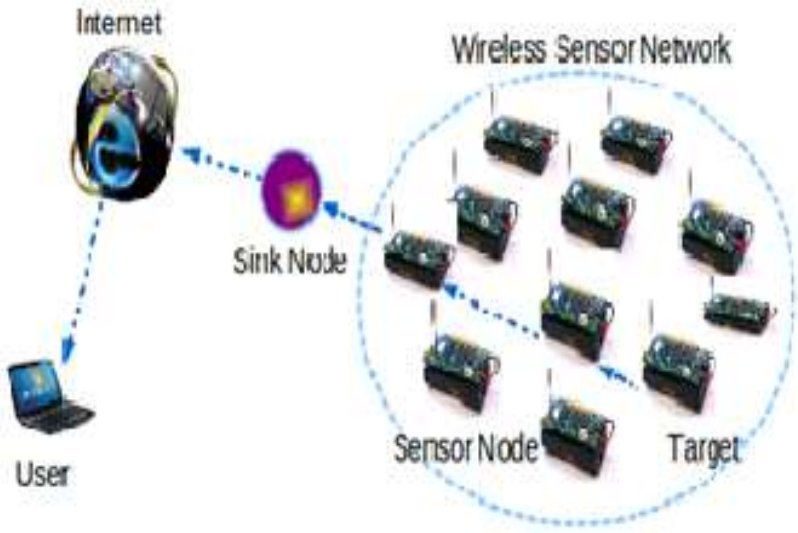

Figure 1: Wireless Sensor Network

These types of nodes can sense the earth and collect the information and forward through numerous jumps. Sensor hubs measure totally concealing situation with in the encompassing atmosphere which can be utilized to depict the qualities of the marvels happening at the area where the sensor hubs are appropriated efficiently.

An extensive number of sensor hubs are than set discretionarily over a topographical locale and organized through remote connections so as to arrange a remote sensor arrange. Every sensor hub is than ready to collaborate with each other and base stations are than used to incorporate and telecast the information further. Wireless networking is a significant structure which is used to aid the specifications of armed forces and industrial services.

Many types of restraints including storage capacity or energy supplies are considered to be important issues [2]. There are many provisions which can keep back the strength of WSNs to assist different applications including sensor devices and limited battery power. To eradicate the difficulty or to balance the WSN load, energy consumption should be reduced and life time of nodes should be maximized.

II. HISTORICAL BACKGROUND

It discussed different energy efficient routing protocols that are based on clustering mechanism. It divides the area into several zones according to the distance and uses the clustering method among these zones. The basic idea of these conventions was that cluster head within the group gets the information from remaining hubs and such information was given to base station **[10]**.Ithas talked about some real applications as planning minimal effort secured Intelligent Buildings, In-Home Health consideration and Agriculture. Along with this the classification and challenges of the Next Generation Wsn has also been discussed in this paper**[11]**.It resented road and rail network fitness monitoring application that uses sensor networks to gather the data about the structural wellbeing along with actions of the infrastructure when a train travels along it and transfers the readings to a base station. The base station then uses the following train(s) as a information mule to transfer the data. The assessment completed demonstrates that the versatile information exchange is really possible and that the outcomes acquired are agreeable, both regarding dependability and power utilization **[12]** It has analyzed a few procedures that adjust the vitality utilization of hubs and guarantee maximum lifetime by adjusting the load as similarly as could reasonably be expected. Furthermore comparison has been done between no. of load balancing strategies that are used in wireless sensor networks **[5].**In proposed a Tree based routing protocol algorithm that helps to construct steering hierarchy utilizing a procedure in which base Station designates a source hub and shows its determination to other alarming hubs. In this each center picks its guardian by considering just itself and its neighbors' information, thusly making Tree based routing protocol a dynamic tradition. Result shows that Tree based routing protocol has shown excellent results as compared to other protocols and helps in increasing the lifetime of whole sensor network**[4].** It compressed the assaults and orders in remote sensor systems. An effort has been made to investigate the security instrument broadly used to handle those assaults. The master plan of this paper had been to examine the security related problems, the difficulties and to propose a few arrangements with a specific end goal to secure the WSN against the security dangers**[7]**.In this paper, we discussed that in wireless body area networks, all the alarming nodes operate very close to each other either on or inside the body of a person. They can check bp, blockage, clotting, heart attacks etc. These nodes have very limited power and batteries can neither be changed nor charged. So, energy consumption model has been discussed which helps in increasing life of an alarming node**[3].**Some sort of 3-level heterogeneous network model to get WSNs to further improve the particular network lifelong is definitely carried out, that is seen a particular parameter. Based on value of the particular design parameter, it may possibly identify 1-level, 2-level, as well as 3-level heterogeneity. Heterogeneous system design can also help to choose cluster heads along with particular cluster members by utilizing calculated election possibility and limit function. The particular network life-time by simply using DEEC method due to this design is also implemented**[8]**.It demonstrated a novel bio-inspired routing protocol, named CB-RACO that combines the Ant Colony Optimization (ACO) meta-heuristic with the computationally cheap and distributed community detection technique Label Propagation (LP). CB-RACO creates communities in the WSNs and meets the balance of energy consumption by routing data inside-communities through swarm intelligence. As a consequence, CB-RACO demands low memory and overhead in construction and maintenance of routing paths. Additionally, CB-RACO achieves high data delivery reliability through a data retransmission strategy based on acknowledgments between communities**[6].**It implemented a new novel for Clustering Hierarchy (HACH),which usually sequentially carries out collection of non-active nodes as well as cluster head nodes at each round. Non-active node collection uses a new stochastic sleeping arrangement process to find out selecting a nodes that could be place into sleeping method without having negatively heaving an effect on network coverage. As well, a clustering algorithm criteria utilizes a story heuristic crossover user to mix a pair of several methods to accomplish a much better answer this improves the circulation connected with cluster head nodes and also coordinates energy utilization throughout WSNs **[9].**

III. CLUSTERING

When several sensors cooperatively observe hugereal environment, that they kind of wireless sensor network.Long term network life-time, scalability, load handling are very important requirement of several sensor network applications.

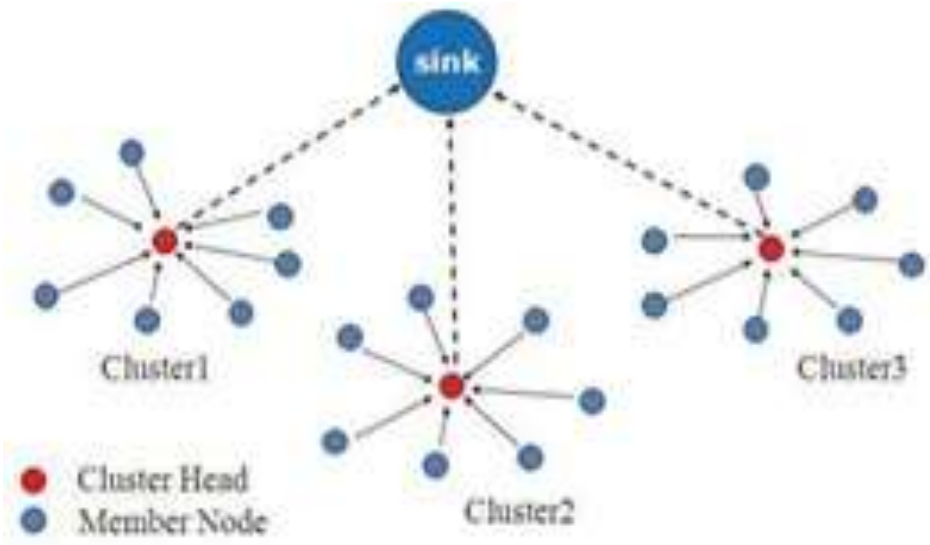

Figure 2: Cluster Head

Clustering sensor nodes is an efficient way of reaching these kinds of goals.

- Clustering technique is one of the well-liked systems through which nodes pick a Cluster Head (CH) with regard to communication.
- All nodes distributed their own information to you to CH, where, that collected info as well as post to your Base Station (BS). Only several nodes are widely-used to distribute at large long distance therefore, a lesser amount of energy will be consumed.
- The primary concept of clustering is usually to reduce the actual network traffic coming from node to base station.
- Cluster head is really a node that is reliable for manage cluster, collect information coming from nodes from the cluster and also communicate with sink.
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3.1 Clustering can be performed with 2 types of networks:

- Homogeneous networks.
- Heterogeneous networks.

The networks which all sensor networks have same amount of energy are called Homogeneous Network. In Heterogeneous clustering the network which some of the sensor network have extra power as compared to other nodes in the network are called Heterogeneous Network.

The characteristics of Heterogeneous WSNs algorithms are better than the Homogeneous WSNs in term of the first node dies and the number of packets sent to the base station. Heterogeneous WSNs cluster-based protocols have the better ability to manage the clusters and their member nodes and can better balance the energy consumption of the nodes in the whole network than Homogeneous WSNs energy.

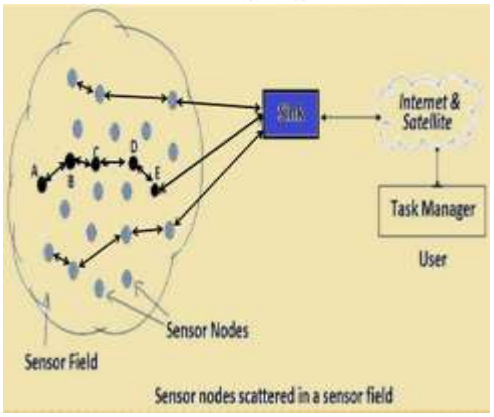

Figure 3: Homogeneous

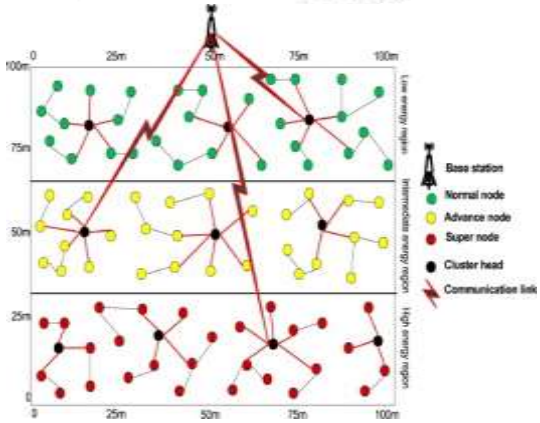

Figure 4: Heterogeneous

IV. ENERGY EFFICIENT ROUTING PROTOCOLS IN WSN

4.1 Hybrid Energy-Efficient Distributed Clustering (HEED)

- HEED is a multi-hop WSN clustering protocol that will be actually provides a good energy effective clustering routing by utilizing from time to time a exactly stress connected with energy.
- It's totally different from LEACH during the practices with CH commitment, HEED will not choose nodes because CHs randomly.
- The best way of cluster create is completed dependant on hybrid collection using a number of parameters.
- Among the variables relies in across the node's staying around energy, and also other parameter could possibly be the intra-cluster communicating expenditure.
- In HEED, chosen CHs include huge standard remaining energy when compared with MNs.

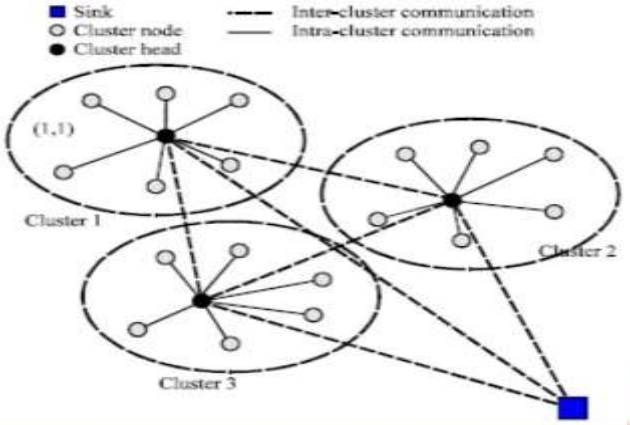

Figure 4: HEED

4.2 Low Energy Adaptive Clustering Hierarchy (LEACH)

- LEACH is a well-known energy efficient versatile clustering criteria in which types node clusters depending on the good acquired transmission strength.
- With LEACH the actual nodes sort area clusters and among this nodes performing as being an area sink or maybe cluster head.
- When precisely the same node would certain stay because cluster head all over the running on the network, it might pass away rapidly due to the extensive load with the engaging sensor inside the cluster.
- For this reason the particular revolving with the cluster head in every around is definitely essential to disperse the load uniformly.
- Additional energy dissipation may be decreased by means of aggregating the information out of various sensor nodes at the cluster head.

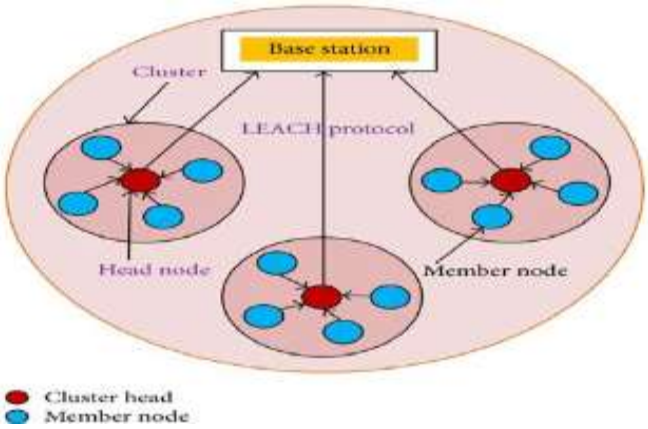

Figure 5: LEACH Protocol

4.3 Distributed Weight-based Energy-efficient Hierarchical Clustering protocol (DWEHC)

- DWEHC is a dispersed clustering formula for instance HEED.
- The true secret basis for DWEHC could be to improve HEED simply because develop well balanced cluster measurements as well as improve a new intra-cluster topology through the use of position understanding a new nodes.

- The two similarly DWEHC as well as HEED focus on several commonalities and also no presumptions in terms of multilevel sizes as well as focus, and employing less than consideration left over energy inside the strategy relating to CH selection.
- Almost all nodes uses DWEHC automatically combined with the algorithm indicates immediately after various iterations which can be used in your dispersed manner.

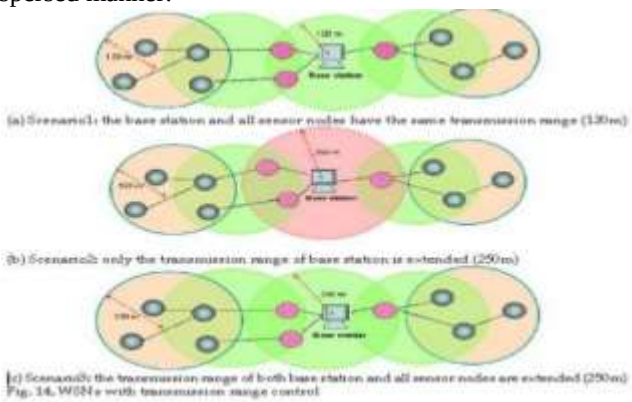

Figure 6: DWEHC

The effect of Differential evolution is ignored in existing literature especially for inert-cluster data aggregation for mobile sink based heuristic algorithms for clustering hierarchy protocols. The effect of network range and nodes scalability on the proposed protocol under mobile environment is also ignored. Genetic and ant colony based data aggregation technique for sensor networks have poor convergence speed. So, a novel tree based routing protocol has been proposed. In the projected scheme, a routing tree has been made in which base station relegates a root hub and telecast its determination to all sensor hubs. After that parent hub is chosen by every last hub. Finally, a dynamic convention is made by gathering the data identified with its neighbors. Outcome demonstrates that the projected approach performed superior than other methods.

V. METHODOLOGY

Steps involved in developing a projected protocol in MATLAB

Step1: Generate the new catalog in MATLAB with any name where we can put our protocol.

Step2: Append the different records like packet, routing and configuration in the new catalog.

Step3: Initialize the system

Step4: Organize network arbitrarily in previously defined sensor field

Step5: Apply Tree based routing protocol to assess the execution of sensor system utilizing stationary and portable sink.

Step6: Evaluate the network range and node scalability on the proposed Tree based routing protocol under mobile & stationary link based environment

Step7: Compare the proposed Tree based routing protocol algorithm with clustering and differential evolution based Tree based routing protocol routing protocol based on stable period, network lifetime, throughput &residual energy. Record the data & run the simulation code for wireless & wired networks.

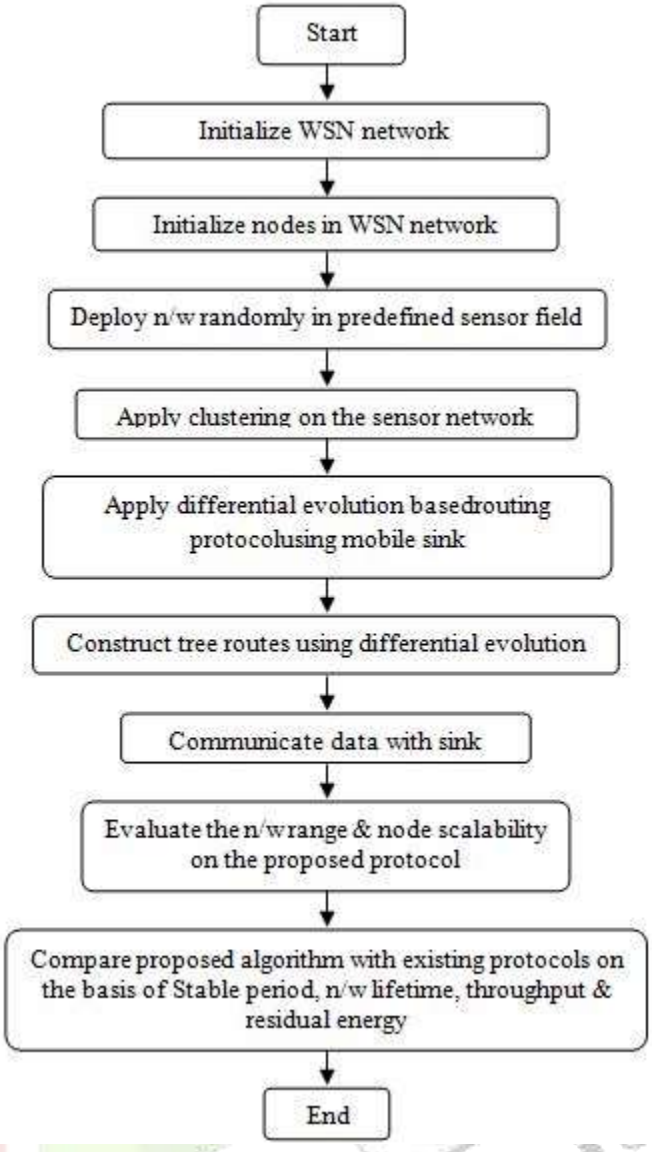

Figure 7. Flowchart of Purposed Hybrid approach

VI. PERFORMANCE ANALYSIS AND RESULT

This paper has designed and implemented the proposed technique in MATLAB tool u2013a. The evaluation of proposed technique is done on the basis of following metrics i.e. Stable period, Network lifetime, Throughput; Residual energy.A comparison is drawn between all the parameters with existing and proposed algorithm and figures shows all the results.

6.1 Stable period

Network stable period refers to the time from the network starting to work till the first node comes to death. That the network is stable means all the nodes are working properly. Therefore, the longer the network stay stable, the more reliable the network. The Sink mobility is also considered in order to reduce energy whole problem. Mobile sink improves the network lifetime and stability period by spreading the load of nodes that are closer to the sink.

Table I is demonstrating the quantized analysis of the Stable period. As Stable period must be higher which means proposed algorithm is demonstrating the superior results compared to the accessible methods as Stable period is higher in each case.

Figure 8 has demonstrated the quantized analysis of the Stable period of distinctive images. This diminishing symbolizes improvement in the target nature of the image.

TABLE 1 Stable period analysis

Nodes	Exiting Period	Proposed Period

100	147	170
120	157	181
140	162	181
160	147	163
180	157	169
200	151	190
220	151	161
240	147	158
260	169	212
280	193	234
300	199	233

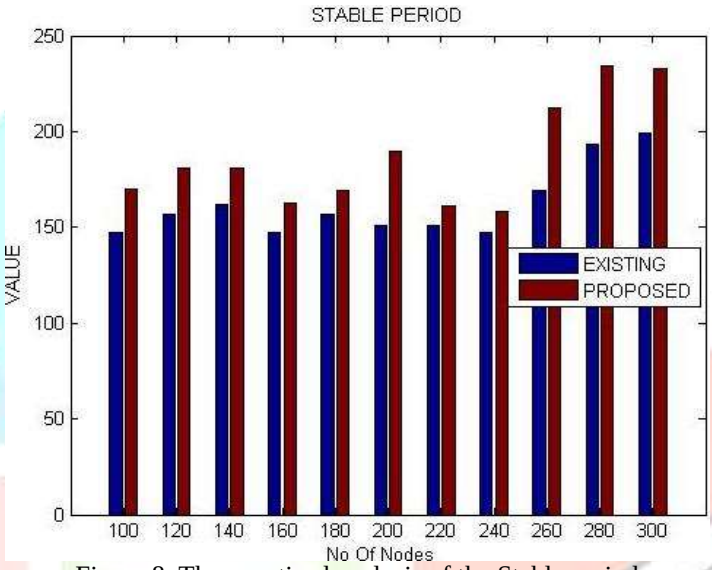

Figure 8. The quantized analysis of the Stable period

6.2 Network lifetime

Network lifetime refers to the time from the network starting to work till all nodes come to death. The life of network lasts for a period of time in the case of few nodes surviving.

Table II is demonstrating the quantized analysis of the Network lifetime. As Network lifetime must be higher which means proposed algorithm is demonstrating the superior results compared to the accessible methods as Network lifetime is higher in each case.

Figure 9 has demonstrated the quantized analysis of the Network lifetime of distinctive images. This diminishing symbolizes improvement in the target nature of the image.

Table II: Network lifetime. Analysis

Nodes	Exiting Period	Proposed Period
100	613	638
120	590	615
140	589	620
160	606	627
180	598	624
200	597	628
220	616	649
240	598	626
260	616	631
280	597	617
300	612	645

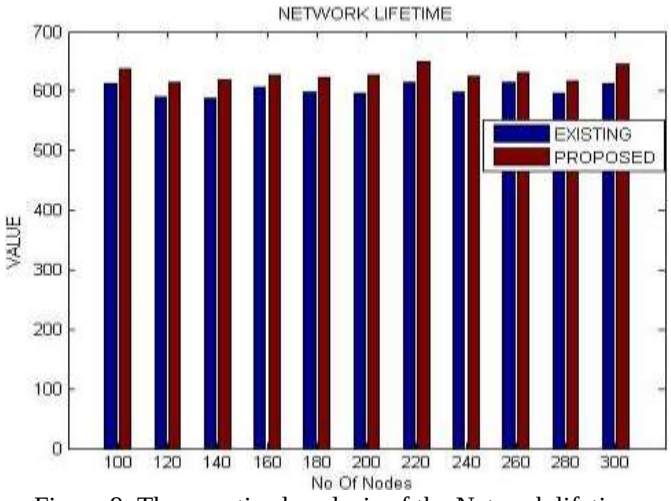

Figure 9. The quantized analysis of the Network lifetime

6.3 Throughput

The network throughput determines the number of packets transmitted at the base station. The results of throughput evolution depending on the number of nodes are taken in the round at which the FND and the LND for each protocol.

Table III is demonstrating the quantized analysis of the Throughput. As Throughput must be higher which means proposed algorithm is demonstrating the superior results compared to the accessible methods as Throughput is higher in each case.

Figure 10 has demonstrated the quantized analysis of the Throughput of distinctive images. This diminishing symbolizes improvement in the target nature of the image.

Table III: Throughput analysis

Nodes	Exiting Period	Proposed Period
100	28.2893	30.3472
120	27.4659	29.1512
140	26.8776	28.8970
160	26.9642	28.7705
180	26.5275	28.3244
200	26.2398	28.5314
220	26.9371	28.9677
240	26.3372	28.1270
260	26.8160	27.9821
280	26.1895	27.6219
300	26.6388	28.2614

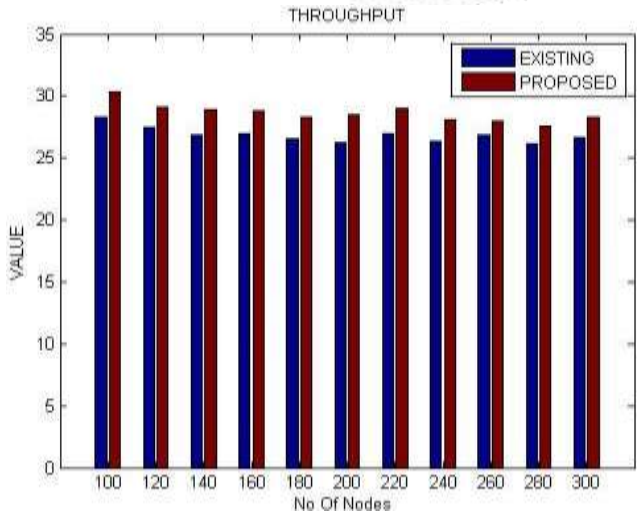

Figure 10. The quantized analysis of the Throughput

4. Residual energy

It is the total of consumed energy of sensor nodes in the network. The results of energy consumption evolution depending on the number of nodes are taken in the round at which the FND and the LND for protocol.

Table IV is demonstrating the quantized analysis of the Residual energy. As Residual energy must be higher which means proposed algorithm is demonstrating the superior results compared to the accessible methods as Residual energy is higher in each case.

Figure 11 has demonstrated the quantized analysis of the Residual energy of distinctive images. This diminishing symbolizes improvement in the target nature of the image.

Table IV: Residual energy analysis

Nodes	Exiting Period	Proposed Period
100	33.5320	37.8003
120	34.2745	37.9982
140	33.4415	37.2270
160	33.7303	38.1463
180	34.5907	38.4391
200	34.1082	38.5691
220	34.9632	39.0472
240	35.1544	38.8137
260	34.4540	38.0576
280	34.0342	38.5181
300	34.8961	38.3479

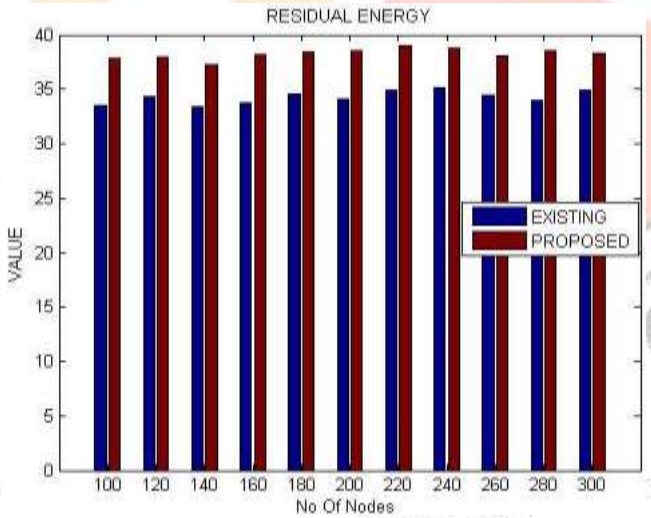

Figure 11. The quantized analysis of the Residual energy

VII. CONCLUSION

Wireless network composed of spatially spread autonomous system working with detectors to evaluate physical as well as the environmental conditions. The *WSN* system contains a path which offers wireless connection back to the community along with distributed nodes. The MATLAB simulation tool is used for simulation purpose. It evaluates the performance of the proposed technique with existing technique i.e. tree-based on the following metrics i.e. stability period, network lifetime, residual energy (average remaining energy), and throughput. Extensive analysis indicates that the proposed technique outperforms others. Therefore in near future we will purpose technique based on energy efficient protocols to overcome the restrictions regarding the previous energy-efficient methods utilizing the compressive sensing as well as evolutionary optimization dependent tree structure. Several analytics will likely be utilized to measure the enhancement in offered method above the actual established energy-efficient protocols.

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