CLUSTER BASED ENERGY EFFICIENT NODE DEPLOYMENT IN WSN

***Anuj Jain, #Surender Kumar, ## Bhawna Mathur**

*School of Electronics and Electrical Engineering, Lovely Professional University, Jalandhar, 144402, India (e-mail: a1978jain@gmail.com)
#Dept. of Electronics and Communication Engineering, ADGITM, Delhi, 110053, India(e-mail:drsurenderkdhiman@gmail.com)
Research Scholar Bhagwant University Ajmer Rajasthan (mathurbhawna27@gmail.com)

Abstract: A wireless sensors network (WSN) comprises of randomly deployed small devices providing reliable and effective communication over wireless network. They have the tendency to detect physical conditions caused due to environmental changes, in real time, such as pressure, light, temperature, humidity etc. The issues concerning in WSN are power conservation, routing, data rates and memory usage. Enormous research has been done in WSN till date as it has a huge potential to revolutionize human computer inter action in the coming future. Multiple solutions have been proposed to combat various challenges based on the type of services required. This paper focuses on the power issues in WSN and efforts have been made to provide optimal power solution for node deployment using cluster based algorithm in combination with the existing Fuzzy Self-Healing Algorithm. The simulations are done using NS-2.35, from the analysis of results it can be concluded that the proposed approach provides an optimized solution by enhancing the overall network life time leading to reduced power consumption. There by, improving the performance in terms of power consumption and efficient communication.

Keywords: wireless sensor network, cluster based algorithm, fuzzy self-healing algorithm.

I. INTRODUCTION

A rapid increase in the number of smart applications based on energy management, inexpensive and standard MCUs are creating demand for actuators/ sensor networks in the market which also includes home automation, telemedicine, and smart lighting.

Wireless sensors network is a simple and economic step towards the deployment of control devices and distributed monitors. They avoid expensive retro fits required in wired systems. But there are some challenges and limitations associated with the wireless protocols faced by the application developers that continue to persist such as limited bandwidth, in experience with RF design and confusing profusion of protocols.

A wireless sensors network as shown in Figure 1, consist of randomly deployed small devices providing various features such as; the tendency to detect changes in physical conditions due to environmental changes, in real time, such as pressure, light, temperature, humidity etc. WSN have the ability to operate these types of devices as switches, actuators or motors that are used to control those conditions and also provide a reliable and effective communication over wireless network.

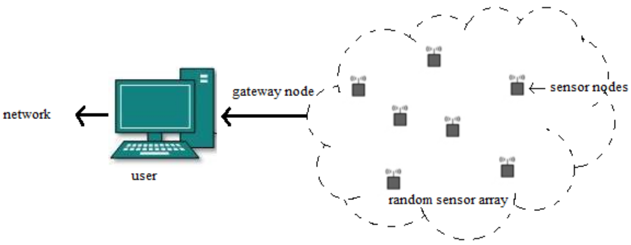

Figure 1. Wireless Sensor/ Actuator Network

Effective and reliable communication is one of the most prominent features of a Wireless sensors network. They are basically built for low traffic monitoring and controlling. It may not be important for a WSN to support high data rates and throughput as the case in some data networks like Wi-Fi. Typically, the data rates of WSN may vary between the ranges of 20kbps to 1Mbps. They have the ability to operate with very low power consumption that compliments their battery and the size.

The wireless sensors networks have the capability of self-organizing and self-healing. The former allows a random node to join the network automatically without requiring manual interferences. While in the self-healing network, nodes can re-configure themselves and can find alternate paths in case there is some failure of nodes. The implementation of these capabilities is specified by management protocols and the topology of the network. There by making a way to determine the scalability, cost, performance and flexibility of the network.

II. PROBLEM FORMULATION

The random node deployment by Davood Izadietal (2015)[1] employed fuzzy based self- healing coverage algorithm to determine the uncovered areas and select the best mobile node, which tends to cover the coverage hole. This coverage hole could be owing to the failure of a node caused due to any of the following reasons like physical damage or battery

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drainage, or the inability of the mobile node to communicate or due to environmental interferences. As the nodes are distributed randomly there by the distance between the nodes isn't uniform and as a result the node would only have the knowledge about their neighboring nodes instead of the entire topology.

Coverage redundancy and Euclidean distance between the nodes is used to carry out node selection. The objective of the proposed work is to maximize coverage, to make sure that the mobile nodes are located at equal Euclidian distance to each other, to reduce redundancy of data and finally to minimize the power consumption.

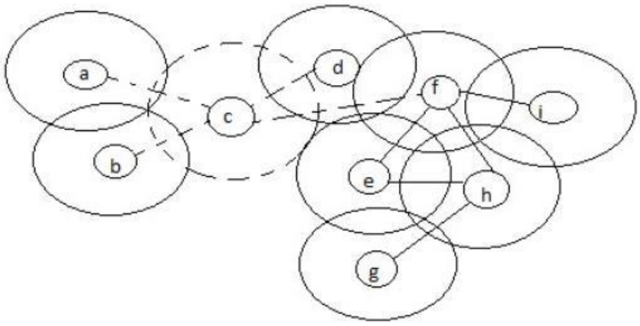

Figure 2 Node failures in WSN

Figure 2 illustrates node failure in WSN, wherein the nodes continuously send periodic pulse messages to their immediate neighbors to ensure that they are fully functional. This signal is used by the neighboring nodes to calculate the Euclidian distance between them. It also detects whether the node is noisy or not. In case the node is noisy it is considered as node failure and the nodes move to minimize the coverage hole. The data redundancy is checked by comparing the energies of the received signal. When a node moves to cover the coverage hole it sends "Self-relocation ON" to its neighbor. No node can move until this message is ON and has to wait for the "Self-relocation OFF" message. As a result, the power consumption is continuously used to send information signal to the neighbor continuously at fixed intervals.

III. PROPOSED SCHEME

The aim of the proposed work is to minimize the power consumption of the nodes in a WSN by adapting a clustered fuzzy self-healing algorithm (CFSHC) which enhances the efficiency of the existing FSHC by reducing the power consumption involved in sending pulse messages to various neighboring nodes. As clustering is adopted wherein the node needs to send pulse message indicating about it's existence and its functionalities to the selected cluster head. In addition to this nodes, need not continuously calculate their Euclidian distance for every neighbor as cluster head is responsible for the formation of the topology and calculation. This would further reduce the power consumption. The selection of the cluster head would be based upon the power availability of the mobile nodes. The cluster head will change at regular intervals so that node does not experience complete power drain. As more energy is consumed by the cluster head as compared to the cluster member nodes. Also, clustering reduces the redundancy as all the member nodes will communicate with their respective head. Hence redundancy can be removed at once. This will further reduce the power consumption as each node does not need to check for redundant data received by receiver. And lastly it will also eliminate the need of "Self-relocation ON/OFF" messages send by mobile nodes to their neighbors while relocating as cluster head will have the knowledge about the movement of the member nodes, thus reducing control head messages and hence energy consumption.

IV. RESULTS AND DISCUSSIONS

The proposed solution is simulated in NS2.35. The parameters used for simulation are as given below. Table 1 summarizes the simulation parameters being used and their typical values.

Table 1: Simulation parameters and their typical values

Parameters	Values
Number of Nodes	80
Routing protocol	DSR
Sensing Field	450m X 400m
Communication Range	up to-44m
Sensing Range	25m
Initial Energy	10 J
Noise Factor (Nth)	0.0001
Sleep Power	0.00005
Transmission Time	0.005
Transmission Power	0.002
Ideal Power	1.0
Channel	Wireless- Radio propagation model
Interface, MAC type	Wireless; 802_11

In addition to the above parameters the CMU primary queue is the interface queue type and the maximum number of packet in the interface queue can be taken as 500. AUDP agent and nodes are attached. The null agent is connected to a UDP agent. This null agent releases the received packets. Also CBR and FTP (traffic generator) are connected to UDP and TCP respectively. The nodes are randomly deployed, and the link is created between the nodes if the distance between them is less than 25, i.e. the sensing range. As the nodes are not uniformly deployed, thus few areas would remain uncovered and few nodes could not create a link thereby communication is not possible thus the aim is to relocate them to the desired area.

The obtained results of the base problem are mentioned in this section. The algorithm has been implemented exactly and similar results have been obtained. The parameters and the constraint taken are similar to the original work. The nodes have relocated to their best suitable positions to minimize the coverage hole. Implementation shows the coverage ratio for the given number of nodes. The remaining energy obtained is a good match as obtained in many previous works being done.

Figure 3 shows the graph of the remaining energy wherein, X-Axis represents the energy in Joules and the Y-Axis represents the time in mili seconds. It can be inferred from the figure that the coverage ratio improves as the number of nodes increases. The algorithm performs better with more number of nodes.

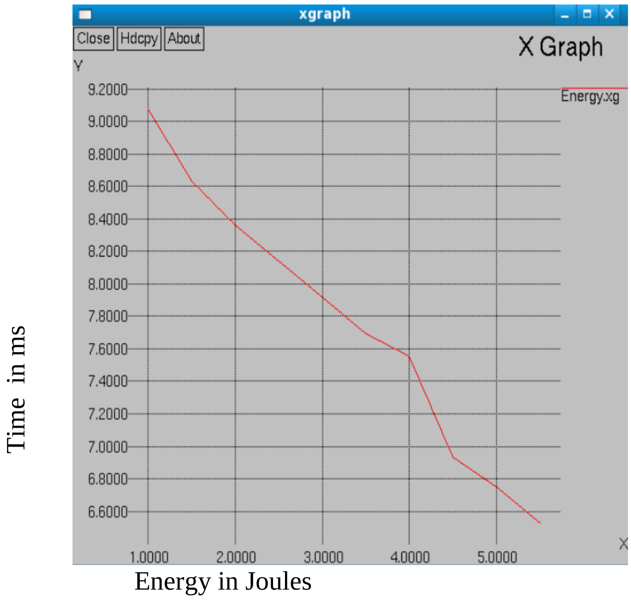

Figure 3. Remaining Energy in Joules w.r.t Time in milli seconds.

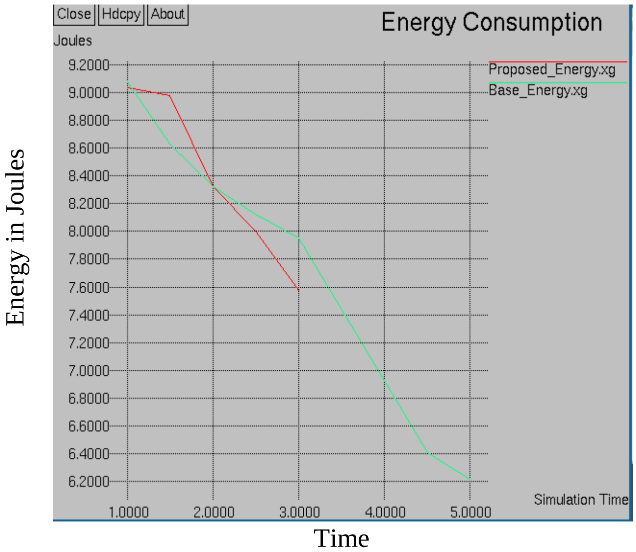

Figure 4 Comparison of remaining Energy for 80 nodes.

Figure 4 shows the Comparison of residual energy amongst the existing method and proposed method for 80 nodes. The results obtained shows that the network life time is increased significantly. Also the consumed energy is greatly reduced. Authors have considered the network life time till the last node dies. As the energy consumed is less therefore the network life time is greatly enhanced. The coverage results of the proposed method shows 99% coverage which was around 90-95%in case of FSHC.

Figure5 shows that the comparison of residual energy for 60 nodes. It can be inferred from the graph that the residual energy of the proposed work is more as compared to the energy in case of FSHC. In addition to this, it can be inferred that the iteration time in case of CFSHC is less as compared to FSHC.

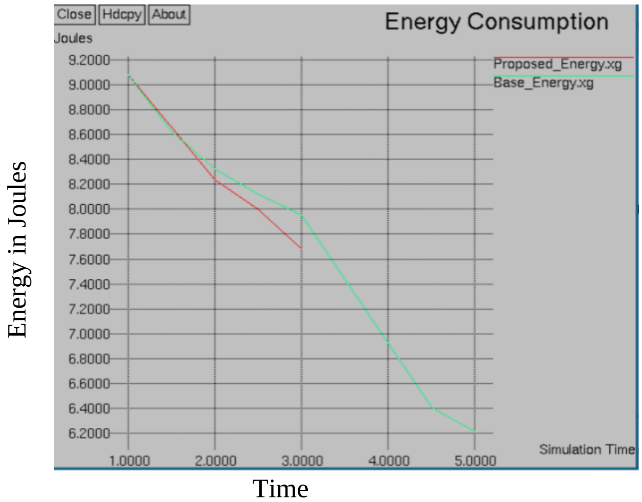

Figure 5. Comparison of remaining Energy for 60 nodes.

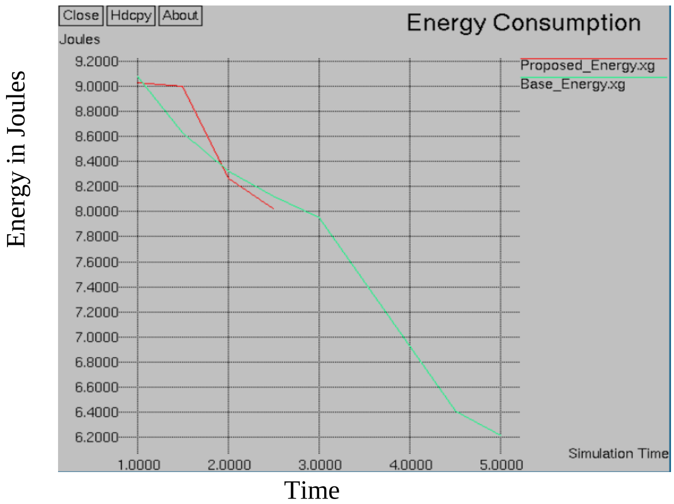

Figure 6. Remaining Energy for 60 nodes in Base Problem and Proposed Work.

V. PERFORMANCE EVALUATION

The energy consumed by every node in the CFSHC and FSHC has been analyzed and it can be observed that the energy consumed in case of CFSHC is less as compared to FSHC. Also the iteration time of the proposed algorithm is less as compared to FSHC as the number of nodes are increased. Thus the remaining energy of the CFSHC algorithm is more as compared to the FSHC. The results show that the number of node after applying the algorithm is almost zero, i.e. no uncovered nodes is there after initial iteration, which were present in case of FSHC. There is only a slight difference in the coverage ratio, since it was already 95% in FSHC. The uniformity is obtained as the node would move to equal Euclidean distance. Figure 7 shows the coverage ratio of FSHC and FSHC.

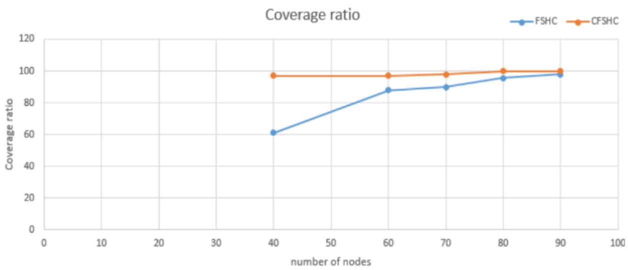

Figure 7. Coverage ratio.

Table 2. Comparison of coverage ratio

Number of Nodes	Coverage Ratio (%)	
	FSHC	CFSHC
40	60	88
60	85	89
70	88	90
80	93	100
90	95	100

Table.2 presents a comparative result analysis of the coverage ratio of the proposed work with the existing work. It can be concluded that as the number of nodes increases the coverage ratio of the proposed work outnumbers the existing algorithm by 6%-7% approximately.

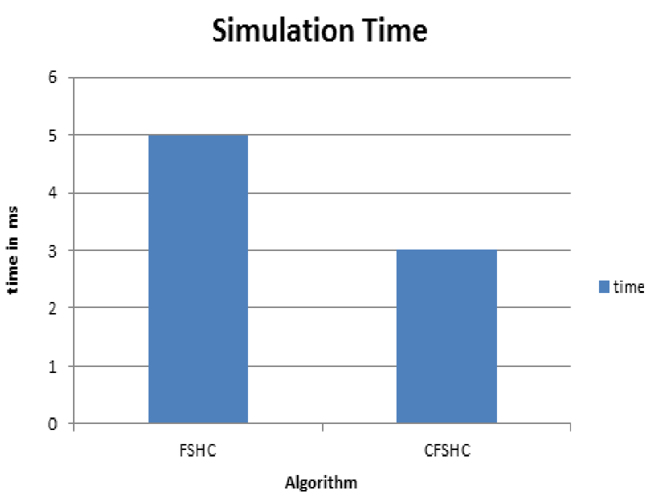

Figure 8 Simulation time

Figure 8 shows the time take taken by two algorithms for single iteration. From the results it can be inferred that the simulation time of the proposed algorithm is almost 40% lesser than the existing FSHC algorithm. This shows that the proposed algorithm is not only energy efficient but is also faster.

CONCLUSION

Cluster based fuzzy self-healing algorithm (CFSHC) has been proposed in this paper which overcomes the issues of coverage hole due to node failure and reduced network lifetime. The proposed model of CFSHC is the enhanced version of the existing FSHC method. That randomly deploys nodes to maximize the coverage ratio. With the proposed algorithm energy consumption gets reduced, which in turn enhances the network life time. The coverage ratio is 99.9% and the simulation time gets reduced by 40% in comparison with FSHC method. The simulation results uphold the efficiency and effectiveness of the proposed work.

Since the life time of the network is mostly limited by the battery, there is a need to improve the power conservation method. Battery technology is lagging far behind the mechanic/electronic technology; hence there is always a need to improve in future. This research could be further carried out to provide more optimal energy results. That would increase the lifetime and therefore directly influencing the cost factor.

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AUTHORS PROFILE

Anuj Jain is working as a Professor in Lovely Professional University ,Punjab India. He obtained his Bachelor's degree in the field of Instrumentation in 2002&Master's degree in 2005 with distinction in Electronics and Communication Engineering. After completing his Maters studies, he is working in teaching field .He has Completed his Ph.D. in the field of Electronics and Communication at Mewar University, Chittorgarh, Rajasthan in 2016.

Surender Kumar was born in Kurukshetra, India, in 1975. He received the B.Tech. degree in 2000, and the M.Tech. degree in electronics and communication engineering in 2010. He has completed the Ph.D. degree in electronics engineering at Mewar University, Chittorgarh, India. He has been working as Professor with the Electronic Department in ADGITM.

Mrs. Bhawna Mathur, Ph.D scholar, in E.C.E Department, Bhagwant University, Ajmer. M.Tech in Digital Communication from Bhagwant University, Ajmer. 8290912867, (mathurbhawna27@ gmail .com)