Improved FGMRP Routing Protocol to Solve Energy Hole Problem in Wireless Sensor Networks

Manjeet Singh
M.Tech Scholor
Rayat Bahra University,Mohali

Amanpreet Singh Dhillon
Assistant Professor
Rayat Bahra University,Mohali

Abstract

The wireless sensor network is the decentralized and self configuring type of network in which sensor nodes can sense information and pass it to the base station. Due to decentralized network and far deployment energy consumption is the major issue of wireless sensor networks. In this research work, FGMRP protocol is implemented and improved to increase the lifetime of wireless sensor networks. In the FGMRP protocol, whole network is divided into clusters and cluster heads are selected in each cluster. The leader nodes are also selected in the network which collect data from the cluster heads and pass it to the base station. In the improvement of FGMRP protocol, Gateway nodes are deployed in network to increase the lifetime of WSN. In the proposed improvement gateway nodes are deployed near to the base station which takes data from the leader nodes. The leader nodes take data from the cluster head. The proposed FGMRP protocol and FGMRP protocol are implemented in NS2.

KEYWORDS:

FGMRP, Multi-level Hierarchy, Gateway

Introduction

Wireless sensor network is one of the most important and popular advancement of the technology. It is made up of interconnected sensor node which provides excellent services not only in sensing the data but also in the interaction between the user and the sensor nodes. Recently, it is widely popular because of the introduced advanced smart sensors which are specialized with the Micro-Electro-Mechanical Systems (MEMS) technology [1]. Wireless sensor network is uniformly distributed network and it is made up of large number of widely distributed, self-directed, tiny, low powered appliances known as senor nodes. it is comprised of large number of spatially dispersed, petite, battery-operated, embedded devices that are connected to collect, process and forward the data to the users and restrict the computing and processing availability. These sensor nodes are in the form of small computers which combines together and perform the entire task collectively [2]. They are energy efficient, multi-functional wireless components. There are certain metrics which are used to evaluate the performance of a WSN: network coverage, node coverage, efficiency in terms of system lifetime, effortless deployment, data accuracy, system response time, fault tolerance, scalability, network throughput, sample rate, security, the cost of the network and network architecture used. The individual sensor node in the WSN is calculated using flexibility, robustness, computation, communication, security, synchronization, node size and cost [3]. The components of WSN system are sensor node, rely node, actor node, cluster head, gateway and base station. Sensor node comprised of open environment which regularly sense the physical as well as environmental changes which forward the information to the most centralized type of a server which is known as gateway. The physical environment is different for different nodes along with the computational rate and interaction of sensor node. In reality, the sensor nodes are more controlled in its energy of computation and storage resources [4]. These are very intelligent, it is used to observe extensive diversity of ambient circumstances which involve flow, temperature, pressure, humidity, moisture, noise levels, mechanical stress, speed and many more. Various applications were proposed due to the presence of new concept of micro sensing and wireless networking. Wireless sensor network is made up of non-accessible environment which are powered using batteries with power harvesting techniques but the replacement of batteries is not an option. The network should not be relying on the battery because it not only affects the battery life span but also affects the energy consumption of the network. This limitation provokes many researchers to propose techniques to overcome these limitations at all [5] the layers of the protocols. The architecture of the networks like OSI and internet are basically functional models arranged in layer in which every layer provides services to the upper layer for e.g. the application layer provides assistance to the end users. The network usually calculates the quality of the parameters like delay, throughput, availability, reliability and network security. There is a problem related evaluation and optimization of the network during energy consumption calculation and a complete model will take charge of this energy consumption evaluation [6]. The researchers mainly focuses on the traditional network architecture and they try to reduce the certain parts of single layer which just gives a hope that the overall energy consumption will reduce without interacting with the other layers. The life of a sensor

network can be defined on the basis of amount of energy being consumed by the nodes. Since the only sources to provide energy are the batteries available in the sensor nodes, this factor is considered to be important [7]. Within the sensor networks, energy optimization is highly complex at times since the lifetime of network is also increased when the energy consumption is reduced here. By providing certain guidelines with respect to design and osperation to create the energy awareness, optimization can be done. Within the groups of communication sensor nodes and within the complete network, energy awareness is ensured.

Literature Review

Hajji et al. [8] proposed a novel adaptive and dynamic routing protocol in this paper particularly for multi-constraint scenarios. The state of network and preferences of user keep changing which cannot be monitored by applying the existing solutions. Arya et al. [9] presented a study that aims to increase the lifetime and minimize the amount of energy being consumed by the network. In comparison to the other existing protocols, better results have been achieved when NEAHC is applied with the help of firefly algorithm. Compressed sensing and optimization are hybridized to approve the lifespan of a network. The MATLAB2010 wireless data analysis toolbox is used to implement this proposed technique. Tayeb et al. [10] proposed an improvement in the Energy Efficient Credit-Based routing algorithm. Here, the priority of relay nodes is used to choose the most optimal cluster head. Experiments are conducted which show that in terms of load balancing, lifetime as well as energy consumption, the performance of proposed mechanism is better. However, there is a minimal increment in the packet loss and the data delivery rate also reduces to some extent here. Comparisons against standard LEACH protocol and the proposed protocol are made to evaluate the performance of proposed protocol. In comparison to LEACH, higher data-delivery is achieved during the initiation of the network. Fradj et al. [11] proposed a novel approach for providing control over the energy consumption of WSNs. The energy consumption and reliability of WSN are enhanced by proposing Opportunistic routing (OR). There is limited number of non-rechargeable battery power available within the sensor nodes deployed in these networks. So, the most difficult task here in these networks is to apply an optimal routing mechanism. Yildiz et al. [12] proposed a novel approach in which the solar and electromagnetic energies were exploited. The energy dissipation of sensor nodes is reduced by the development of a Mixed Integer Programming (MIP) technique through this newly proposed hybrid energy harvesting approach. The effects of proposed technique are calculated using the MIP framework along with the management of energy consumption by handling the transmission power. Panda et al. [13] proposed a novel mechanism through which the capacity of energy can be increased in WSNs. Here, the clustering model is applied for proposing an Artificial Bee Colony algorithm. The internal dynamics of cluster heads and sensor nodes are enhanced by applying the proposed technique. The amount of energy consumed by nodes is reduced; the energy consumption is balanced as well as the lifetime of network is increased by applying this algorithm.

Research Methodology

This research work is based on FGMRP routing protocol for wireless sensor networks. The FGMRP is the fixed group based routing protocol for wireless sensor networks. In this protocol, whole network is divided into fixed size groups based on intimacy, optimizes energy consumption among nodes in each group by performing adaptive cluster head round-robin rotations based on residual energy, concentration and centrality, and balances energy consumption among groups. In this research work, the gateway nodes will be deployed near the base station. The data from all groups will be delivered to gateway nodes which forward it to base station. The clustering is the efficient scheme which improve lifetime of wireless sensor network. The three-level hierarchical routing scheme is proposed in the work to reduce energy consumption of the network.

Following are the 3-phases involved in the aggregation process:

Level 1: Choosing the Cluster head

In this phase, the network is divided into certain clusters and process of cluster head selection is initiated by the base station. The message is passed all across the network which states that an efficient cluster head can be chosen. The distance of one node from the base station is calculated mathematically. The sensor nodes also present their residual energy which play important role in being chosen as cluster head. The radius of each cluster is calculated and the sensor nodes which lie within the radius of the cluster represent that cluster. The number of nodes represent the cluster should be 3 or more than 3. The nodes which are within the cluster should select their cluster head on the basis of residual energy.

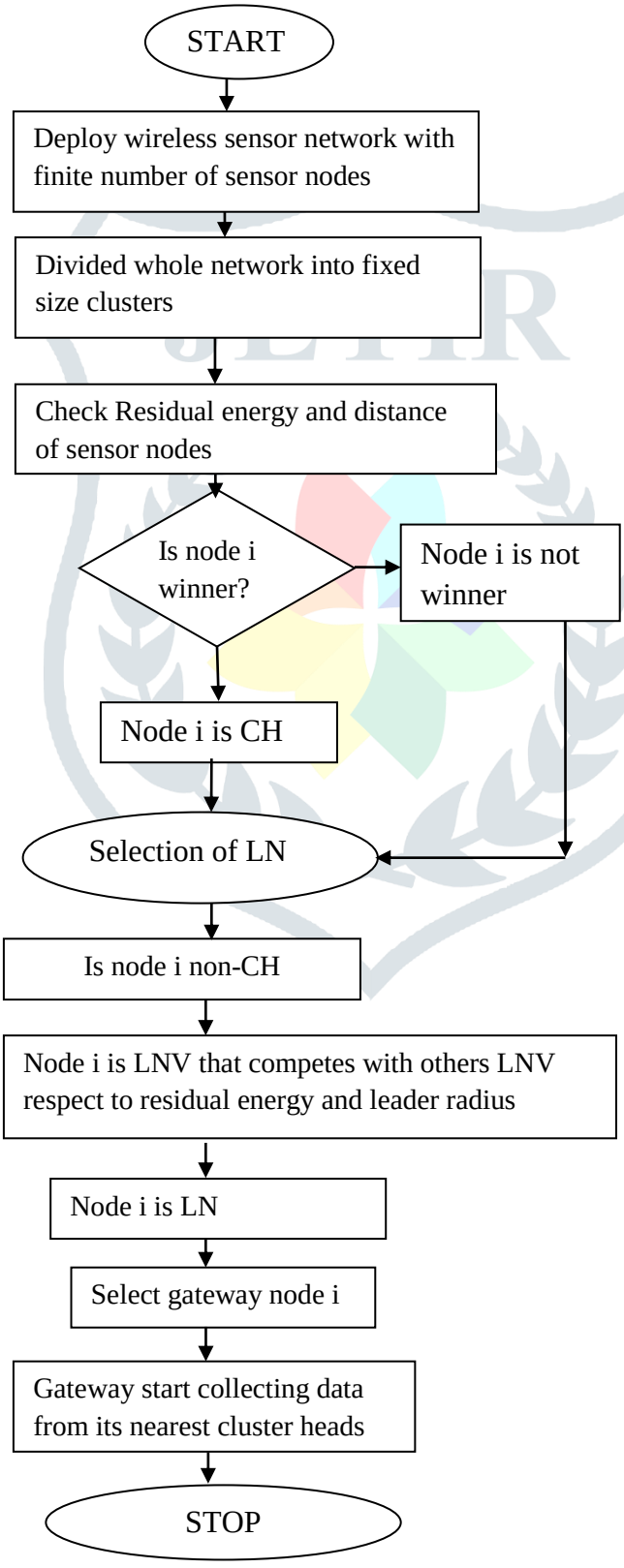
Level 2: Choosing the Leader Nodes

In the level 1, the cluster heads are selected in the network to aggregate the data to the base station. Some nodes have least distance to the base station but do not have maximum residual energy. Those nodes have the probability to be selected as leader nodes. The nodes which are not selected as cluster head are the volunteer nodes to be selected as leader nodes. The calculation is

performed in the network which defines maximum number of leader nodes in the network and the leader nodes will generate a random number between 0 and 1 and nodes which satisfy the defined condition are selection as leader nodes.

Level 3: Choosing the Gateway node

The gateway selection is the last phase of proposed protocol. Gateway nodes are the extra nodes which are deployed in the network to improve network lifetime. The number of gateway nodes depends upon the size of network. The cluster heads transmit the data to leader nodes. The leader nodes transmit data to gateway nodes. The gateway node forwards this data to the base station. The base station takes data from the nearest gateway node and leader node transmits the data to the nearest gateway node. The distance between the nodes is calculated with the Euclidean distance.



Experimental Results

The proposed research work is implemented in NS2 and the results are evaluated by making comparisons against proposed and existing techniques in terms of several parameters.

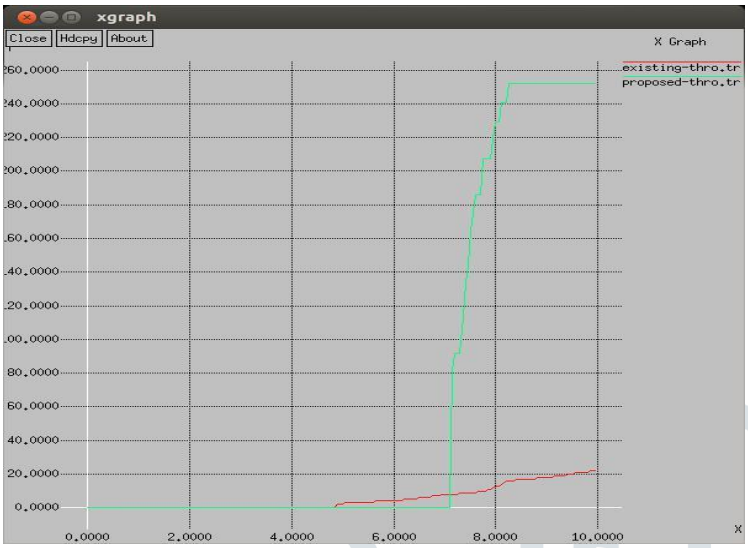


Figure 2: Comparison based on throughput

Figure 2 shows the throughput graph. Comparison between new and previous technique is shown in the figure. Proposed work throughput is shown here by the green line and previous work is shown with the red line. Throughput in the modified work is more as there is synchronization between nodes and no packet loss. Throughput is measured in terms of packet sent per second.

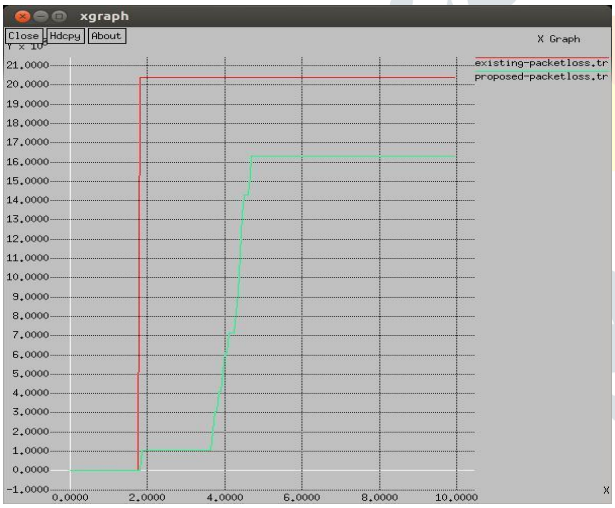


Figure 3: Comparison based on packet loss

Figure 3 is for the packet loss in the system. Green line is for the packet loss in the proposed work and red line shows the packet loss in the existing technique. Packet loss decreases because in the modified technique, clock synchronization technique is implied which reduces the collision and hence packet loss. Packet loss decreases from 19000 to 4000 packets. The packet loss is reduced because the clocks of the sensor nodes are synchronized for the efficient communication in the network.

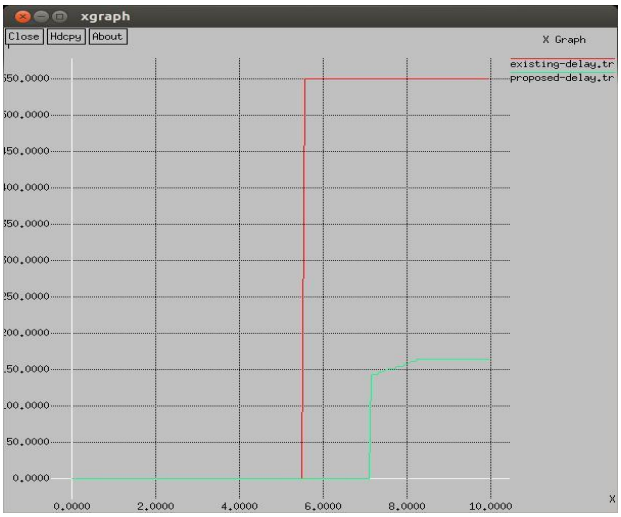


Figure 4: Delay graph

Figure 4 shows the results in the delay. Green line shows the delay in the proposed work and red line shows the delay in existing method. Delay in proposed work decreases from 525 to 125(approx.). The delay in the network is reduced because the clocks of the sensor nodes are synchronized. In the case where clocks are not synchronized the delay is very high which is reduced in the case of clock synchronization.

Figure 5: Energy consumption graph

Figure 5 shows the energy consumption in the system. Red line shows the energy consumption in the existing work and green line shows the energy consumption in the modified or proposed work. The energy consumption in the modified method is reduced, because synchronization is done with time lay technique.

Conclusion

The wireless sensor network is self configuring type of network which is deployed on far places to sense environmental conditions. Due to far deployment of the network energy consumption is the major issue which reduces network performance. The FGMRP is the protocol in which cluster heads and leader nodes are formed in the network. The cluster head send information to leader which forwards it to base station. In this research work, the FGMRP protocol is improved using the gateway nodes. The cluster head send information to leader node which forward information to leader node. The leader node then forward information to gateway node. The proposed protocol is implemented in NS2 and simulations show up to 20 percent improvement in the results.

References

[1] R. Patel, S. Priyani and V. Ukani, “Energy and Throughput Analysis of Hierarchical Routing Protocol (LEACH) for Wireless Sensor Network”, International Journal of Computer Applications, vol. 20, no. 4, 2011

[2] V. Mhatre and C. Rosenberg, "Design Guidelines for Wireless Sensor Networks: Communication, Clustering and Aggregation", Ad Hoc Networks, vol. 2, no. 1, (2004), pp. 45-63.

[3] P. Kaushik and J. Singhai, "Energy Efficient Routing Algorithm for Maximizing the Minimum Lifetime of Wireless Sensor Network: A Review", International Journal of Ad hoc, Sensor & Ubiquitous Computing (IJASUC), vol. 2, no. 2, (2011) June.

[4] O. Younis and S. Fahmy, "HEED: a hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks", IEEE Transactions on Mobile Computing, vol. 3, no. 4, (2004), pp. 366-379.

[5] V. Loscri, G. Morabito and S. Marano, "A Two Level Hierarchy for Low Energy Adaptive Clustering Hierarchy (TL_LEACH)", 62nd IEEE Vehicular Technology Conference (VTC-Fall), (2008), pp. 1809- 1813, 25-28.

[6] C. F. Li, M. Ye, G. H. Chen and J. Wu, "An Energy Efficient Unequal Clustering mechanism for Wireless Sensor Networks", Proc. of 2nd IEEE Mass, (2005).

[7] G. Chen, C. Li, M. Ye and J. Wu, "An unequal cluster-based routing protocol in wireless sensor networks", Wireless Networks, vol. 15, no. 2, (2009), pp. 193-207.

[8] Fouad El Hajji, Cherkaoui Leghris, Khadija Douzi, "Adaptive Routing Protocol for Lifetime Maximization in Multi-Constraint Wireless Sensor Networks," 2018, IEEE

[9] Vandna Arya, "Energy Enhancement of NEAHC Protocol Wireless Sensor Network using Firefly Algorithm," International Journal of Computer Science Engineering (IJCSE), 2018

[10] Shahab Tayeb*, Miresmaeil Mirnabibaboli and Shahram Latifi, "Cluster Head Energy Optimization in Wireless Sensor Networks," 2016, IEEE

[11] Hajer Ben Fradj, Rajoua Anane, and Ridha Bouallegue, "Energy consumption for opportunistic routing algorithms in WSN," 2018, IEEE

[12] Huseyin Ugur Yildiz, Vehbi Cagri Gungor , and Bulent Tavli, "A Hybrid Energy Harvesting Framework for Energy Efficiency in Wireless Sensor Networks Based Smart Grid Applications," 2018, IEEE

[13] Satyasen Panda, Sweta Srivastava, Santosh Mohapatra and Priyaranjan Kumar, "Performance analysis of wireless sensor networks using Artificial Bee Colony algorithm," 2018, IEEE