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Research Article

Advanced Q-Leach Technique to improve the Efficiency and Stability in Wireless Sensor Networks

Aashaq Hussain Lone†* and Birinderjit Singh†

† Department of ECE SVIET Banur, Punjab, PTU Punjab, India

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Abstract

This paper proposes an approach to enhance the efficiency and stability of wireless sensor networks by adding extra nodes at the quadrant boundary of a Q-LEACH system. This system will increase the lifetime of the nodes and also will increase the stability in nodes.

Keywords: *Q-Leach, WSN etc.*

Introduction

Earlier after the introduction of Stable Election Protocol(SEP), a muti-hop routing scheme (MH-SEP) in WSN was proposed which is based on different spatial density of nodes[2]. The network is to be divided into different sizes of areas according to the multi-hop routing scheme, the cluster heads use multi-hop mode of communication to send their data to the base station considering the heterogeneous of networks. This had a lot of advantage over SEP as it enhanced the system parameters but the greater size of surveillance area and smaller density of the network is the more obvious improvement made from the new scheme. The energy conservation of sensor nodes is the most crucial design goal while developing efficient routing protocol for wireless sensor networks. For this Multi-hop energy efficient protocol[3] was designed. The proposed protocol combines the idea of clustering and multi-hop communication. Heterogeneity is created in the network by using some nodes of high energy. Low energy nodes use a residual energy based scheme to become a cluster head. High energy nodes act as the relay nodes for low energy cluster head when they are not performing the duty of a cluster head to save their energy further. Protocol also suggests a sleep state for nodes in the cluster formation process for saving energy and increasing the life of sensor network. Simulation result shows that the proposed scheme is better than other two level heterogeneous sensor network protocol like SEP in energy efficiency and network life.

After that an improved gateway based multi-hop routing protocol for WSN was proposed[4]. In this research paper, a gateway based energy efficient Multi hop routing protocol for wireless sensor networks (WSNs) was introduced which utilizes minimum energy. In this, Base station is located out of the sensing field and number of gateway nodes is deployed at the edge of sensing field. These gateway nodes are rechargeable therefore, it reduces cost. It also reduces traffic problem and reduce distance for reliable transmission of data.

In conventional LEACH the clusters formed were arbitrary in size, so there was uneven distribution of nodes in the clusters. Cluster heads were randomly chosen and then some cluster members were located far away from the sink and the farther nodes suffered high energy drainage. The faster energy drainage resulted in degraded system performance. To overcome the early drainage and to increase system performance Q-LEACH[1] was introduced. It is advancement in the conventional LEACH and the basic problems like early system degradation and early energy drainage were overcome.

In Q-LEACH the clusters formed were more deterministic, the network was partitioned into four quadrants in which exact distribution of nodes was defined. In this sensor nodes are deployed in territory. The distribution of network into four equal quadrants results in better coverage. The optimum position of cluster heads is defined and the transmission load is reduced which further results in better system performance. The Q-LEACH improved the clustering process and increased the stability period. It also increased the network lifetime for the optimized performance of Wireless Sensor Networks (WSNs). Since, Q-LEACH overcomes all the problems faced by the conventional LEACH but there are some problems faced in this approach too. The distribution of

*Corresponding author: **Aashaq Hussain Lone; Birinderjit Singh** is working as Assistant Professor

networks resulted in better coverage but it was for the cluster heads located nearby to the sink as they had to travel lesser distance and the cluster heads located far away faced the same problem of early energy degradation as it had larger distance between the sink and the cluster heads. So, there needed to be introduced an approach in which the distance could be lessened between the far away located cluster heads from the sink so that the networks lifetime could be improved.

Proposed Work

The problems faced by the conventional LEACH were overcome in the Q-LEACH. The Q-LEACH improved:

1. Clustering process
2. Stability period
3. Network lifetime for optimized performance of WSNs.

In Q-LEACH the distribution of network into four equal quadrants resulted in better coverage than the conventional LEACH but still the far away located cluster heads lifetime was lesser than the lifetime of the cluster heads located nearby the sink. The decreased lifetime of the far cluster heads degrades systems performance so it was suggested to improve the systems performance by increasing the lifetime of the cluster heads located far away so that the lifetime of the whole network could be improved. Since, the optimum position of cluster heads is defined in the Q-LEACH to reduce the transmission load so it is advised to transfer the load of the cluster heads located far to the sink through an intermediate node located in between. This intermediate node will be on the boundaries of the four quadrants and they would also result in the decreased distance to the sink. We would introduce additional eight nodes, two on each quadrant boundary. These nodes would work as an intermediate to help communication of sink with the far away cluster heads. This can be depicted as :

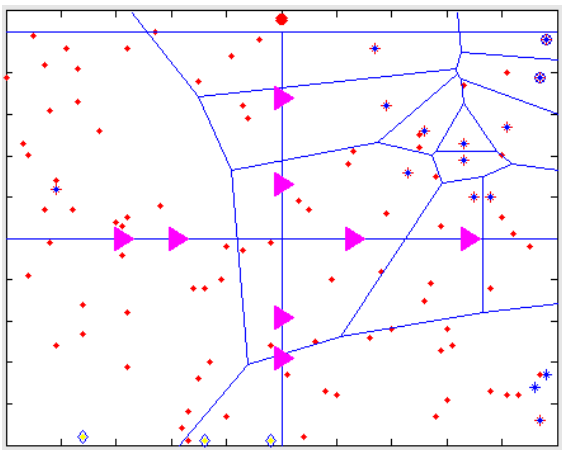

Fig. shows distribution of nodes into four quadrants, the sink and the location of additional nodes.

Firstly the area is divided into four quadrants having equal number of nodes. The distribution of nodes is done randomly. The sink is placed outside the area. The random selection of cluster heads would be done on the basis of the energy of the nodes. The cluster heads are selected separately for each of the sub-area. The cluster heads are the nodes which are then used for the communication between other nodes in the area and the sink. The distribution of the area into four equal quadrants and the selection of cluster head from the nodes in the particular area is called the setup phase. This phase can be illustrated as:

Algorithm I: Setup Phase

1. **begin**
2. **if** node €G → G = nodes which did not become cluster heads.
3. **if** (node belongs to = =area A) then
4. **if**(number of CHs <=(N/K)) then
5. **TEMP**= random number(0-1)
6. **if** (temp<= p/1-p(r,mod1/p)) then
7. node=CH_A
8. number of CHs = number of CHs+1
9. **end if**
10. **else if** (node belongs to = =area B) then
11. repeat step 4:8
12. **else if** (node belongs to = =area C) then
13. repeat step 4:8
14. **else if** (node belongs to = =area D) then
15. repeat step 4:8
16. **end if**
17. **end if**
18. **end if**

Algorithm I shows the setup phase for the distribution of nodes and the selection of cluster heads. The cluster head is selected after each node is allocated a random number between 0-1. This number is then compared with a threshold number. If this number is less than the threshold and the condition for the desired cluster head is not met then this node becomes the cluster head. Cluster heads are selected for each of the area and the nodes establish connection with this cluster head to communicate with the sink. The cluster head then specifies time slots for the nodes in the area.

The distance of the cluster heads will then be measured from the sink. The cluster heads having higher distance value from the sink will then check their distance from the intermediate nodes and then the distance between the intermediate nodes and sink will be checked. This will be our second phase in which the cluster head communicates with either the sink directly or with the intermediate nodes. This is done in order to use the energy efficiently because the more the distance, more power is required to transmit. This phase is called cluster head association phase. This can be illustrated as:

Algorithm II: CH association phase

1. N € group of normal nodes
2. GC € group of CHs
3. If N € (A, a_1) then
4. Where
5. A= a_1,a_2,a_3,a_4
6. Check all possible CHs
7. Check RSSI of CHs
8. **Associate** with ACHs
9. Specify distance between ACHs and intermediate nodes && between ACHs and sink
10. **then**
11. **transfer** data from the shortest path occurs
12. **end if**
13. If N € (A, a_2) then
14. Repeat step 5-9 for BCHs
15. **end if**
16. If N € (A, a_3) then
17. Repeat step 5-9 for CCHs
18. **end if**
19. If N € (A, a_4) then
20. Repeat step 5-9 for DCHs
21. **end if**

Algorithm II defines the association phase between the nodes and cluster heads, also between the CHs and intermediate nodes and between the intermediate nodes and the sink. The nodes in area a,b,c,d are specified as normal, intermediate and the advanced nodes on the basis of their energy. The CHS will only prefer the intermediate nodes that means for each cluster head we will probably have four intermediate nodes located at the boundaries of its quadrant. Then the distance of the intermediate nodes from the sink will be compared and the node having the least distance from the sink will be selected. The selected node will then be transferred the load from the cluster head, which it will then pass on to the sink. This will reduce the load on the farther cluster heads which slows the energy drainage and in turn results in better system performance. The problem of the degraded systems performance can be solved by using the intermediate nodes.

Simulation Results

The introduction of the intermediate nodes provides better results than the Q-LEACH process itself. In the previous technique, the first dead node occurred between round 2900-3000 but in the improved method the first dead node occurred between 4700-4800 round. This is a significant parameter as it showed that the system is more stable and enhanced. Moreover, it also increased the lifetime per round of the nodes thus increasing the residual energy of the system.

The results after simulation can be shown as:

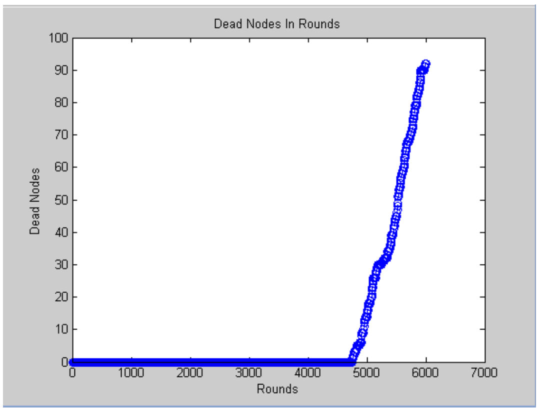

Fig. shows number of dead nodes in rounds

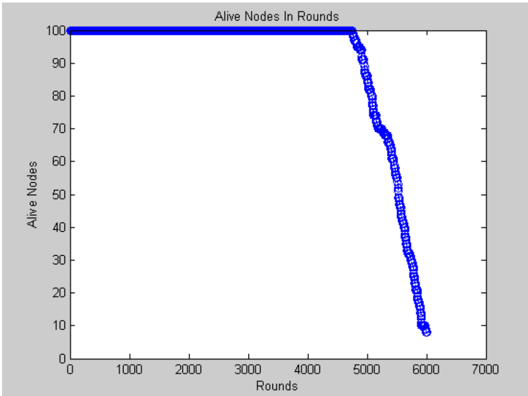

Fig. shows alive nodes in rounds

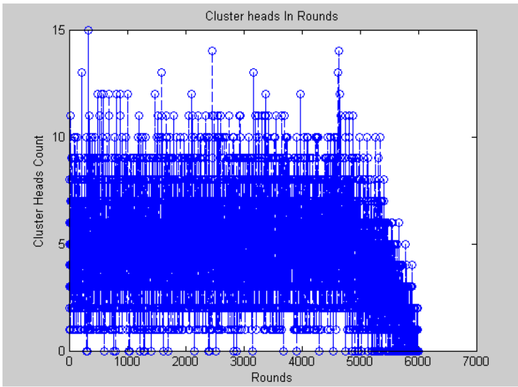

Fig. shows cluster heads in rounds

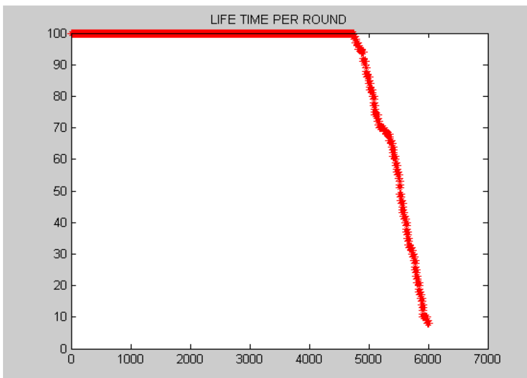

Fig. showing lifetime per round

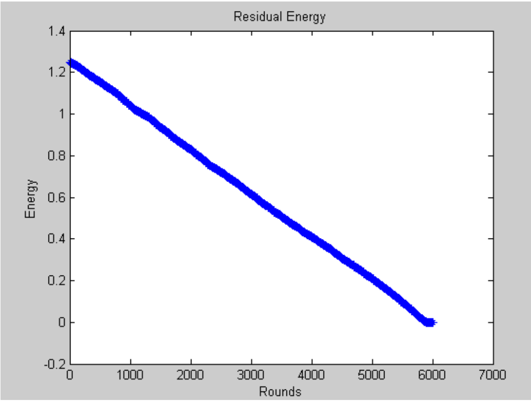

Fig. shows the residual energy of nodes.

Future Scope

As a future scope the proposed work can be extended on using the optimization algorithm which will work on selection of cluster heads methodology which might be better than the traditional works of selection of cluster heads in network.

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