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An Improved Cluster Head Selection Algorithm for Mobile Wireless Sensor Networks

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Abstract – Mobile Wireless Sensor Networks (MWSN) consists of nodes that are small sized and of mobile nature. Since nodes are mobile the energy drains out is continuous offering short duration networks and hence energy efficiency and network life time are still the major hurdles for efficient communication network. Literature indicates that Clustering is the most popular solution for energy efficient routing in MWSN. In this paper a cluster head selection algorithm is proposed. The cluster head is primarily selected on basis of the residual energy of the node during the communication. Node with highest remaining energy will be elected as new cluster head. The unique contribution of this research work is a process when the existing cluster head moves out of the cluster range and cluster remains unattended. The results obtained are reflecting a significant improvement in the life time of the network and it was further discovered that the ratio of unattended clusters has reduced potentially.

Index Terms – Mobile Wireless Sensor Network (MWSN), Cluster Head (CH), Cluster Range (CR), Network Lifetime

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1. INTRODUCTION

From the last few decades it has been observed that mobility in wireless sensor network plays an important role in the field of communication. Mobile Wireless Sensor Network (MWSN) consists of an oversized number of autonomous sensor nodes that are densely deployed either within the environment or terribly near it. These assemblies of sensing nodes are connected by wireless media so as to hold out the distributed sensing tasks. These sensor nodes in a wireless sensing network are ready to perform parallel sensing and acting in coordination with other reachable sensor nodes. Every sensing node has the potential of performing multiple functions like information collection, processing, information transmission and mutual communication.

MWSN offers numbers of advantages such as monitoring of unreachable areas, habitat monitoring, military applications but it suffers from lot of limitations such as low battery life, lack of control more prominently in a distributed environment, just to list a few. In present environment mobile wireless sensor networks plays a significant role in field of mobile communication.

Although the field of MWSN has become vibrant from the last few decades but still it has numerous issues in different areas like design, architectural and security. Energy efficiency, network life time and cost of routing are also some other issues that occur during communication in sensor networks [13]. Clustering is the most common solution in MWSN for energy efficient routing. Since the nodes in MWSN are mobile, it offers challenges like (1) what will happen if a node moves out of the cluster range (CR) of other nodes, considering LEACH as the underlying routing protocol, (2) what happens if member nodes moves out from cluster (3) If there is large number of nodes in a cluster, then there will no effect on cluster, but if cluster have limited number of nodes then it will affect the data or events sensed by the network. The major issue arises if the cluster head

moves out and member nodes have to reinitiate the cluster formation process. The rest of the paper is organized as follows. Section 2 presents the related work. Section 3 provides details of proposed mechanism for cluster head election as well as reelection process. Sections 4 discuss implementation of proposed work and outlines future research directions. Finally Section 5 concludes the results obtained.

2. RELATED WORK

Since the last few decades various researchers have proposed algorithms for routing in MWSN where communication within the network is done by implementing the concept of clustering but still there exist numerous challenges for cluster head election process. Energy Efficient Cluster Head Selection Protocol in Mobile Wireless Sensor Network (EECHS-MWSN) [1] mainly focus on selection of cluster head on the basis of various parameters like mobility, residual energy and density. It also uses gateway nodes as intermediate for transferring data to base station offering longer network life time but consumes more energy than the existing LEACH protocol. Gupta &Verma [2] proposed a method for cluster head selection for heterogeneous wireless sensor networks which offers the advantage of collecting different types of data from various sensors. This method deals with two levels of heterogeneous wireless sensor network that results in lower energy consumption and prolonged network lifetime. DB-LEACH (Distance Based- Low Energy Adaptive Cluster Head) and DBEB-LEACH (Distance Based and Energy Based) cluster head selection method [3] select the cluster head based on geographic distance between the sensor nodes. Additionally DBEB-LEACH compute the residual energy of sensor nodes. Effective Cluster Head Selection (ECHS) [4] based on EDM (Energy, Density, Mobility) scheme makes selection of cluster head with lowest mobility value, density of deployed nodes and residual energy of sensor nodes. Awwad & his team [5] proposed a scheme for rejoining of the sensor nodes to any cluster within the desired time span. Although this scheme prolonges the network life time but it has time constrain. Madani proposed Power Control Routing (PCR) protocol for mobile nodes and Enhanced Power Control Routing (EPCR) protocol [6] where transmission power of the node changes during data sending process on the basis of their weights and their distance from the base station. Lost Packet recovery mechanism is provided for enhancing the network life time, packet delivery ratio and high network throughput. An energy efficient cluster based election scheme for heterogeneous network [7] that considers their threshold values for selecting them as cluster head. This proposed scheme improves the stability and energy efficiency for heterogeneous networks that extended the network lifetime. A description about Hierarchical routing based protocols [8] which supports clusters based communication. This approach divides the whole network in the form of cluster layers and each layer sends the information through its cluster head. This cluster head collects the information and send this collected information to sink. Data travels from lower layer to higher with higher speed towards base station.

Lindsey & Raghavendra [9] proposed a protocol that is an extended version of LEACH protocol where each node sends the data to their neighboring node and using this way data is transmitted to the base station. This protocol consumes less energy as compared to LEACH protocol [10]. LEACH-ME is an extension of LEACH which addresses the issues such as dynamic topology, shadowing, channel fading and node failure arise due to mobility of sensor nodes. Cooperation among sensor nodes is maintained by keeping the information about its neighboring nodes. A round free Cluster Based Routing (CBR) [11] protocol that uses TDMA (Time Division Multiple Access) scheduling.

TEEN (Threshold sensitive Energy Efficient sensor Network) [12] is also a hierarchical protocol that is specially designs to sense the environmental changes like temperature. In this protocol nearby nodes combined to form clusters and data will move from upper level to lower level and this movement process will continue till it reaches to the sink. Due to longer distance between nodes this protocol consumes lot of energy and if number of layers increase then transmission rate of network decreases. APTEEN (Adaptive Threshold sensitive Energy Efficient sensor Network) [13] is an improved protocol over existing TEEN, it captures data on periodic basis for critical events. In this protocol clusters broadcast transmission schedule, threshold value and their attributes to all nodes in network. In this scheme nodes consume less energy however its major drawback is its complexity. Virtual Grid Based Routing scheme [14] consist of two phases, in clustering phase nodes are grouped together in fixed topology and cluster head in each cluster aggregates the data. In data aggregation phase heuristic functions are applied to provide optimal solution in terms of network life time and efficiency.

The critical look at the literature presented above highlights the fact that there exists lot of clustering based mechanisms but very few are suitable for MWSN. Moreover the best of our knowledge, none of these have suggested an algorithm addressing issues such as movement of cluster head out of the parent cluster and resulting reelection strategy. Hence an improved design of CH selection algorithm along with reelection approach is being proposed in next section.

3. PORPOSED WORK

As we know energy plays an important role for prolonging the network life time. Literature review highlighted that energy of sensor nodes is consumed in three ways: during transmission, during receiving and in idle state, further for mobile natured nodes energy will also be consumed during mobility. This work makes use of Radio Energy Dissipation Model [15] to calculate the energy consumption of sensor nodes. In order to transmit an n bit message, energy consumed is given by equation (1) and (2) respectively.

$$E_{Tx}(l,d) = E_{Tx-elec}(l) + E_{Tx-amp}(l,d) \quad (1)$$

$$= \begin{cases} lE_{elec} + l \in_{fs} d^2, & d < d_0 \\ lE_{elec} + l \in_{mp} d^4, & d \geq d_0 \end{cases}$$

$$E_{Rx}(l) = E_{Tx-elec}(l) = lE_{elec} \quad (2)$$

For this work we assume that initially all the nodes are of same energy and all the nodes consumes same amount of energy during transmission and receiving of data packet. Although [16, 17] has proposed the election of CH but issues related to mobility of CH and election of CH is still prevailing. Authors in [18,19,20] has compared the existing routing protocols including the hierarchical routing protocol and has also proposed a hybrid data fusion strategy for data aggregation.

The current work proposes an algorithm for selection of new cluster head when the old cluster head moves out of its cluster and the current cluster is left unattended. In the proposed algorithm, if node i sends request message to cluster head (CH) for data transfer, in response to that if CH sends an acknowledgement then node i transfers the data to cluster head and quits the process.

However problem arises when node i do not receive an acknowledgement which means CH had moved out from cluster, then node i sends the request for initiating the election process by sending message to higher energy node after examining the energy log. The node with highest energy starts the election process by sending the message to nodes with higher energy. If node i get no response then it declare itself as CH. The working of the proposed strategy is being illustrated with in figure 1.

The algorithm for the proposed strategy is being given in algorithm 1.

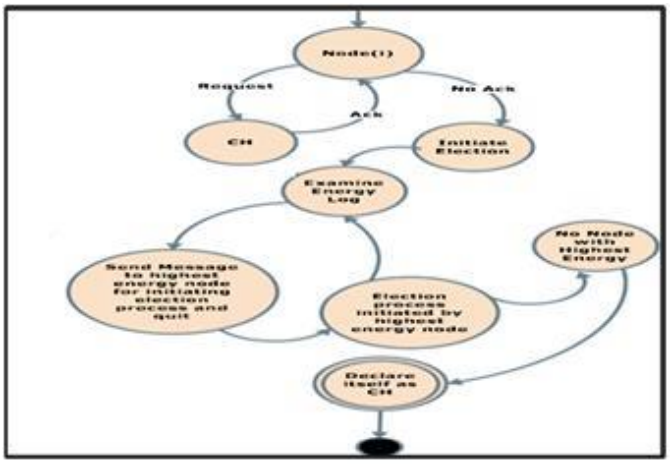

Figure 1: Cluster Head Election Process

Algorithm 1: Let us assume energy log is sorted.

Step 1: For node i =1 to n
$send\ request \rightarrow CH$
Step 2: $if\ received\ (ACK)$
{
$node\ i$ ACK $CH\ then$
CH ode i
Data
$exit(\,);$
}
Step 3: $Start\ (CH\ election\ process)$
$\max\_energy = E(1)$
$for\ i = 2\ to\ n$
{
$if\ E(i) > (\max\_energy)$ then
$\max\_energy := E(i);$
$temp := i;$
}
$N\_CH = node\ temp;$
$nodetemp$ $send\ msg(CH)$
Received ACK

4. RESULTS AND DISCUSSIONS

The performance of this proposed algorithm is evaluated on the basis of various parameters in Matlab. Our simulation network consist of 100 nodes in fixed area of 100 m X 100 m. Initially all nodes have same energy 50 J and all nodes

consumes same amount of energy for transmission and receiving of data packet. After each simulation round dead nodes are represented by red circle and cluster head is represented by green color diamond shape. We observed that life of time of the network is increased approximately by 25%-30 % using our approach as compared to existing protocols. In traditional protocols selection of cluster head is done on basis of probability function and cluster head is elected in each round.

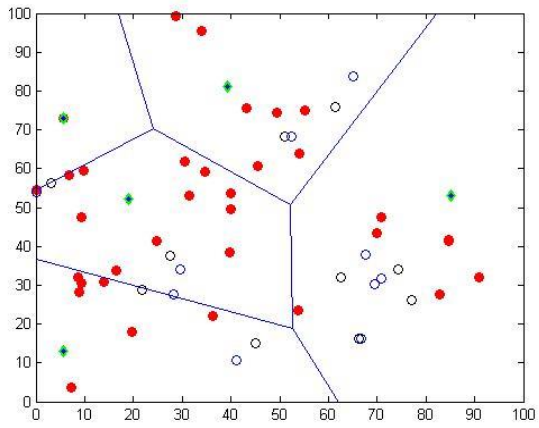

Figure 2: Sensor Network with mobile node

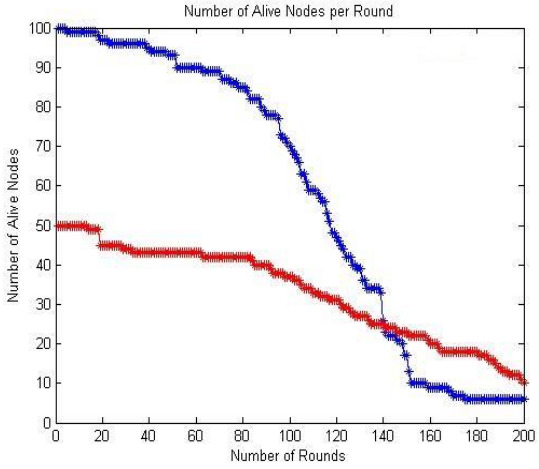

Figure 3: Number of Alive Nodes w.r.t. Number of Rounds

5. CONCLUSION

In this paper we proposed an algorithm for cluster head selection. Low energy level of sensor nodes causes limited network lifetime and nodes release their energy on regular basis. In existing LEACH protocol cluster head selection process is done in each round on the basis of their energy level but no researcher had focused on movement of cluster head i.e. cluster head moves out of the cluster range and cluster remains unattended. This proposed algorithm shall be considered as an improvement over the election process in LEACH protocol.

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