DESIGN AND EVALUATION OF CLUSTERING PROTOCOL TO ENHANCE THE LIFETIME OF WSN

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ABSTRACT

Increasing scalability, network lifetime and load balancing are important factors for Wireless sensor network (WSN). Due to the limitation of energy, the route protocol of wireless sensor network must minimize the energy consumption and extend network lifetime. Clustering is a useful technique to affect these factors. Each cluster is represented by a cluster head (CH), which is responsible for receiving data from all non-CH members, aggregating these data and sending to the base station (BS). In this paper we proposed a new method of clustering which prolongs network lifetime. The simulation result of proposed protocols has been compared for its network life time in MATLAB with LEACH and LEACH-SCH protocol.

Keywords: LEACH, LEACH-SCH, Network Life Time, Scalability Cluster Head, Wireless Sensor Network

I. INTRODUCTION

The Wireless Sensor Network (WSN) consists of a large number of small, relatively in expensive and low power sensors, which are equipped with a sensor module capable of sensing same quantity about the environment, a digital processor for processing the signal from the sensor and performing network protocol function and a battery to provide energy for operation. So Wireless Sensor Network represent a new paradigm for extracting data from the environment for application that include monitoring of a variety of environment for application that include home security, chemical/biological detection, medical monitoring and surveillance [1] [2]. Since the sensor nodes are equipped with small, often irreplaceable, batteries with limited power capacity, it is essential that the network be energy efficient in order to maximize the network lifetime [3]. In a hierarchical routing protocol first of all nodes are grouped together to form a cluster. Afterward the node with higher energy will become cluster head (CH). In this way each cluster comprises of a master node better known as cluster head (CH) followed by member nodes. Cluster Head perform the task of data aggregation and also responsible for sending and Processing the information to the base station (BS), whereas the remaining nodes of that cluster will perform sensing operation. In recent few years, many routing protocols have been proposed for Wireless Sensor Networks [4-7]. Clustering is one of method use to manage network energy consumption efficiently [10]. In this case each group of sensor has a cluster head node that data from its respective cluster and send it towards the base station (BS) as a representative sample of its cluster.

We have presented a new threshold algorithm to maximum the sensor network lifetime. The main idea in the proposed method is the selection of cluster head that can be reduce the low energy nodes to be cluster head, leading to the sensor nodes start to die in early time.Simulation result comparing the original LEACH, LEACH-SCH and proposed algorithm.

Several cluster- head protocols have been proposed in the literature, with the objective of maximizing the sensor network lifetime. Here LEACH is taken for finding the improvement scope due to its hierarchical structure and well developed algorithm for some definite wireless sensor network.

II. LEACH AND LEACH-SCH

Low Energy Adaptive Clustering Hierarchy (LEACH) is the first hierarchical cluster based routing protocol proposed by W.R. Heinzelman for Wireless Sensor Networks [2]. It is the most popular energy-efficient protocol that reduces power consumption in WSNs. The routing algorithm is designed to collect and deliver data to the data sink typically a base station. The main objectives of LEACH are given below.

(1) Extension of the network life time.

(2) Reduced energy consumption by each sensor node.

(3) Use of data aggregation to reduce the number of communication messages.

To achieve these objectives, LEACH adopts a hierarchical approach to organize the network into a set of clusters. Each cluster is managed by a selected cluster head (CH). The newly appointed cluster head performs various tasks. The first task consists of periodic collection of data from the members of the cluster .After gathering the data, the cluster head aggregates it. The second main task of CH is to transmit the aggregated data directly to the Base station (BS). The transmission of the aggregated data is achieved over a single hop. The network model used by LEACH is depicted in the figure given below.



Fig.1: LEACH Network Model [3]

The third main task of the cluster head is to create a TDMA-based schedule whereby each node of the cluster is assigned a time slot that it can use for transmission. The CH advertises the schedule to its cluster members through broadcasting. To reduce the likelihood of collisions among sensor nodes within and outside the cluster, LEACH nodes use a code-division multiple access-based scheme for communication.





The operations of LEACH can divide into rounds. Each round begins with a set-up phase when the clusters are organized, followed by a steady-state phase. These phases are illustrated in figure. The duration of the setup is assumed to relatively shorter than the steady state phase to minimize the protocol overhead.

During the setup phase, each sensor nod tries select itself a cluster head according to probability model. For selecting a cluster head, each sensor node generate a random number δ between 0 and 1 if δ is less than threshold T(n), the sensor node select itself as cluster head for current round. The threshold is presented as follows

$$T(n) = \begin{cases} \frac{k}{N - k \left[r \mod \left(\frac{N}{k} \right) \right]} & \text{if } n \in G \\ 0 & otherwise \end{cases}$$
(1)

Where N as the total number of sensor nodes in the network, k as the number of cluster head nodes for each round, r as the number of the of the current round, and G is the set of nodes that have not been selected as cluster heads in the last N/rounds. Upon cluster formation, each cluster head creates and distribute the TDMA schedule, which specifies the time slots allocated for each member of the cluster.

During the steady-phase, the cluster head keep its receiver on to receive all the data from the nodes in the cluster. Once the cluster head receives all the data, it can operate on the data, and then resultant data are sent from the cluster head to the base station. Upon receiving the cluster head advertisements, each remaining node selects a cluster to join. The nodes then inform their selected cluster head (CH) of their desire to become a member of the cluster. Upon cluster formation, each cluster head creates and distributes the TDMA schedule, which specifies the time slot allocated for each member of the cluster. Each cluster head also selects a CDMA code, which is then distributed to all members of its cluster. In this way the set up phase comes to an end and signals the beginning of the steady-state phase. During steady-state phase, nodes collect information and use their allocated slots to transmit to the cluster head the data collected. After gathering the data, the cluster head aggregates it (which not only minimizes redundancy but also reduces the total amount of data sent to the sink) and transmit this aggregated data directly to the Base station (BS). After a certain period of time spent on the steady-state phase, the network goes into the set up phase again and enters another round of selecting cluster heads [3]. Simulation results show that LEACH achieves significant energy savings.

LEACH-SCH is a multi-clustering type of routing protocol for some definite wireless sensor network. In the algorithm of LEACH-SCH 'sch_th' is the threshold value for generation of supporting cluster head. Approximate number of supporting cluster head is given by below equation:

Number of supporting cluster head = $n^*p^* sch_{th}$

(2)

For example if total number of nodes are 100 and the percentage of becoming CHs is se as 10% then 10 number of node will become CHs. Out of the 10 nodes supporting cluster heads will depends on 'sch_th'. So according to above equation if 'sch_th=0.5' then approximately 5 nodes are able to become supporting cluster heads.

III. PROPOSED ALGORITHM

To modified approach to increase the lifetime is the inclusion of the residual energy availability in each node. It can be achieved bymodifying the threshold. In this way, each node has different threshold in comparison with random number. So, higher energy level nodes have greater probability to be elected as a cluster heads than low

energy level nodes. Now, we define E_0 as the initial energy of each nod in network, λ as measure the value of energy consumption of each node, which is shown below:

$$\lambda = \frac{E - node}{E_o} \tag{3}$$

Where E_{-node} as the energy of current node. According to equation (1) and (3), the new threshold formulation can be defined as follows:

$$T(n)_{\text{nov}_{lacted}} = \begin{cases} Ge^* \lambda^* \frac{k}{N - k \left(r \operatorname{mad}(N_{k}) \right)} + G_{k} & \text{if } n \in G \\ 0 & \text{otherwise} \end{cases}$$

$$(4)$$

With G_0 and G_2 as the weight exponents of network. If $G_0 = 1$, $G_2 = 0$, the modified threshold is shown below:

$$T(n)_{new_leach1} = \lambda * \frac{k}{N - k \left(r \mod \left(\frac{N}{k} \right) \right)}$$
(5)

The equation (5) illustrate that high energy level sensor nodes have more probability to be selected as cluster heads than low energy level ones.

IV. SIMULATION RESULT

The simulation parameters used for developing LEACH, LEACH-SCH and proposed algorithm is shown in Table 1. Some common parameters used for simulation of all protocol are shown in Table 2.

Table 1: Simulation Parameters of LEACH, LEACH-SH and Proposed

Parameters	Scenario
Area	$200*200 (meter^2)$
No. of nodes	100
Base station location	(250,250) meter-from origin

Table 2: Some common Simulation Parame
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Parameters	Values
	A.X.
Initial energy of each node	2 J
Demonstrate of aluster hand	80/
Percentage of cluster head	8%
Packet length of each node per	4000 bits
rucket lengur of each houe per	1000 010
round	
Packet generated per round by each	1
node	
Ctrpacket length	200 bits
Cupacitor longui	200 010
Transmission & Receiving energy	50nJ/bit
	2
Free space Transmitter amplifier	10PJ/bit/m ²
energy	
Multipath fading Transmitter	0.0013PJ/bit/m ⁴
interpreter intering interiorities	
amplifier energy	

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Fig 3: Comparison Graph of LEACH, LEACH-SCH and Proposed

V. CONCLUSIONS

Most of wireless sensor network are battery operated so due to the limited resource energy efficiency is one of the most important criteria. To improve the life time of wireless sensor network designer have to choose routing protocol such that it consumes less amount of energy in radio communication. Simulation result shows that the proposed algorithm improves lifetime of network by 40% to 85% by proper adjustment of network parameters. In the developed algorithm assumption has taken that every node will send single data in every round. So the proposed algorithm can be used in the application where the network has reported after every specific time like temperature monitoring, periodic terrestrial data collection, etc.

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