Wireless Sensor Networks Improvement using LEACH Algorithm

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Wireless Sensor Networks Improvement using LEACH Algorithm

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Abstract. Wireless sensor networks (WSN) are a gathering of several low-power and low-cost network sensors which are used to sense an environment, collect data, process the collected data, and transmit the handled data to a base station (BS) through the cluster heads (CH). The CH collects the sensed and processed information from the sensors and transmit them to the base station for the analysis. In WSN, the major problem encountered is energy whole problem which results from energy depletion in the nodes near the BS. This work proposed the use of LEACH (Low Energy Adaptive Clustering Hierarchy) algorithm to which ensures a balance between energy consumption and delay to resolve energy problem in WSNs.

Keywords: WSN; Energy; Cluster; LEACH; Network.

1. Introduction

Wireless sensor network (WSN) is a communication platform, whatever has the potential to influence several Information Communication features in the future. Before now, WSN has been receiving serious research attention due to its numerous applicability in several fields of human endeavor. WSNs depends on several small disposable independent devices called sensor nodes to form a network. The specific nodes in WSN can sense an environment, process the sensed data, or send it to a central unit for processing through a wireless link [1], [2],[3]. The daily demand for WSN keeps increasing, ranging from military use to national, ground, and space usage. WSN emerged as a result of the developments in the micro electromechanical scheme (MEMS) technology and in wireless communications [4]. WSNs have recently become an interesting field of research recently; a WSN is made up of several sensor nodes (wireless) which connects to form a sensor field and a sink. The major problems in the WSN are the large number of nodes used, their low power rating, and their restriction to short distance communication [5]. These nodes work together to bring about information sensing, tracking, and transmission [6], making the wireless sensors suitable for the monitoring of natural occurrences and environmental changes [7], estimating traffic movements, controlling security, and monitoring military request [8]. These applications require a high reliability of the sensor networks and to improve the reliability of sensor networks, recent studies have focused on heterogeneous WSNs [4], [7], [9], [10]. Researchers have widely grouped sensor nodes into clusters in direction to attain the aim of network scalability; each group has a cluster-head (CH) who is chosen by the members of a cluster or is pre-designated by the network developer. Similarly, any sensor that is richer in resources can also be the CH. There are several benefits of clustering and the greatest of it all is the implementation of an enhanced organization strategy which additionally extends the lifetime of the sensor batteries and further improves the network operation life. In

the network the CH can schedule actions in the group such that the nodes be able to switch to a low-power mode often (during the idle times) to minimize the rate of power ingesting. The sensors be able to also be arranged in a round-robin manner so that their transmission and reception time should be resolute to avoid sensor reties and prevent redundancy and access collision. The CH can also decrease the quantity of relayed packages through collecting all the data from the sensors within its cluster and make a direct communication with the BS [11], [12], [13].

2. LEACH Algorithm

LEACH was developed as a conservative clustering method for WSNs due to the failure of the conventional protocols to ensure an even dissipation of energy throughout a network. As such, LEACH was developed to offer a balanced energy utilization through a random CHs rotation [14]. The LEACH procedure is arranged in a manner that the rate of data propagation can be reduced through data combination/fusion. The selection of a CH in the LEACH algorithm is dynamically done at all intervals. This CH collection is solely founded on the inability of the other independent nodes to have more resources than the selected CH as it is founded on the proportion of the optimal CHs in a network; it also depends on how often an expected node has previously become a CH [15]. In the LEACH, the threshold function T(n) is denoted as {P/1−P(r mod 1/P) only if n € G, else, = 0, where the given node is represented as *n* and the pre-determined chances of selecting a node to be a CH is represented as *P*; the current number of rounds is represented as *r*, and G signifies nodes that have never been chosen as CHs in the last 1/P rounds. Each of the nodes will produce an arbitrary sum in the range of [0 1] through the CHs. A node will be selected as the CH if the sum is less from the threshold T(n). After being selected as the CH, the new CH will broadcast its position to the neighboring nodes who will then determine the optimal CH (based on the minimum required transmission energy) and relay their want to be in that group.to minimize collision, the message broadcasted by the CH is transmitted using Carrier Sense Multiple Access (CSMA). After broadcasting its position, the CH will create a transmission schedule which will be broadcasted to all the nodes in their respective clusters [16]. This transmission schedule contains TDMA slots for each of the neighboring nodes which permits low energy consumption as the nodes can switch off their radio during their idle moments. The major aim of cluster-based routing frameworks is to encourage low energy utilization by the network nodes to ensure a longer network service lifetime. Network organization is usually introduced to provide an additional energy efficiency in the entire network. A review of some of the energy-aware protocols in WSN was performed in this section. LEACH [17] was developed as a robust clustering frameworks for WSNs which depends on the expected signal forte by the clusters and uses the CH as routers to reach the base station. The task of information handling (including information fusion/combination) is locally performed by the clusters. In the LEACH algorithm, the clusters are formed using a dispersed procedure whose nodes are independent in making choices (no external interference from the central unit) [18]. A node is originally designated to be the CH based on its probability p value; for the non-CH nodes, they determine their group by selecting the CH that be able to be contacted using the minimal energy. To balance the load in each cluster, the role of being a CH is periodically rotated between the nodes in each cluster. This variation is done through making each node to randomly choice a arbitrary ‘T’ among 0 and 1 [19].

3. Network Analysis and Simulation

This unit provided the proposed processes for the development of the significantly enhanced hierarchical routing protocol, LEACH. The procedure was simulated using a MALTAB Simulator [20]. During the simulation process, numerous random network topologies were considered, and their average results were taken in order to decrease the effect of a random network distribution. Numerous MATLAB parameters were used to calculate the presentation of the suggested procedure in this study. The simulated network contained 100 nodes in a stationary area of 200 m x 200 m. before the simulation, wholly the nodes were assigned an energy value of 1 J and were all assumed to consumes an equal amount energy for data

reception and transmission. After each round of simulation, the dead nodes were marked with a red circle while the CH was marked with a green diamond-shaped color. The experiments suggested an improvement of the network service life by about 20 % - 25 % using the proposed method. In the conventional protocols, CH collection is done based on a probability function while CHs are chosen in each round. A constant simulation process was ensured until all the nodes have consumed their assigned energy values. The magnitude of the information message was also stationary at 500 bytes, where the length of the packet header was 25 bytes. Table 1 showed the simulation factors to utilize in this paper.

Table 1. The simulation factors used in this study

Parameter	Value
Year length and width	200 in both and y axis
Initial nodal energy	One Joule
Energy for bit reception and transmission	100×10^{-10}
Free space model energy	20×10^{-13}
Multi path model energy	0.0015×10^{-14}
Energy for data propagation	10×10^{-11}
The number of nodes	200
The number of rounds	100000
Length of packet	6400
Critical packet length	300
New network	200, 200, 100, 275
Bandwidth of the channel	1 Mbps

Figure 1 presented the sensor network scenario by mobile nodes while Figure 2 explained the number of packets transmitted to the BS per round. Figure 3 explained the numeral of deceased nodes per round while the sum of nodal energy in each round was explained in Figure 4. From the figures, it was clear that energy is being wasted in each node (note that each node was initially assigned an energy value of 1 J).

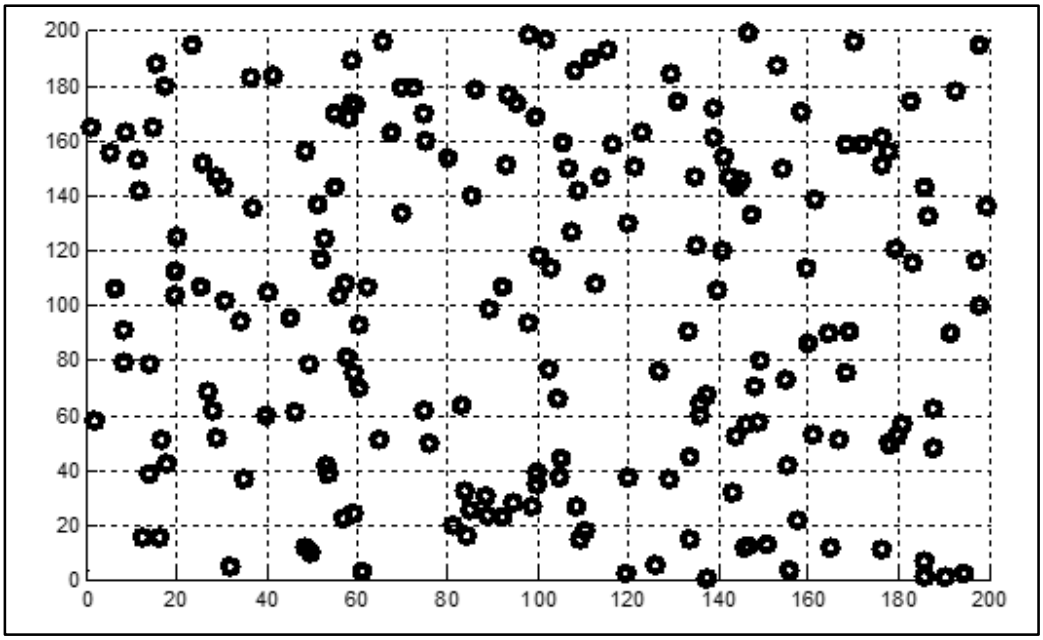

Figure 1. The sensor network in a mobile nodes scenario

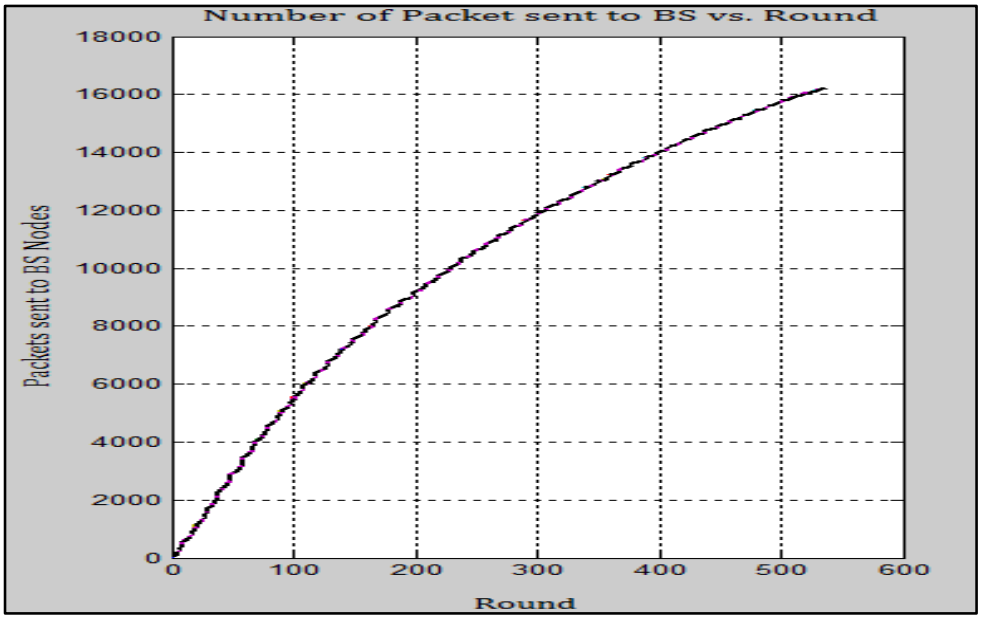

Figure 2. The number of data packet transmitted to the BS in each round.

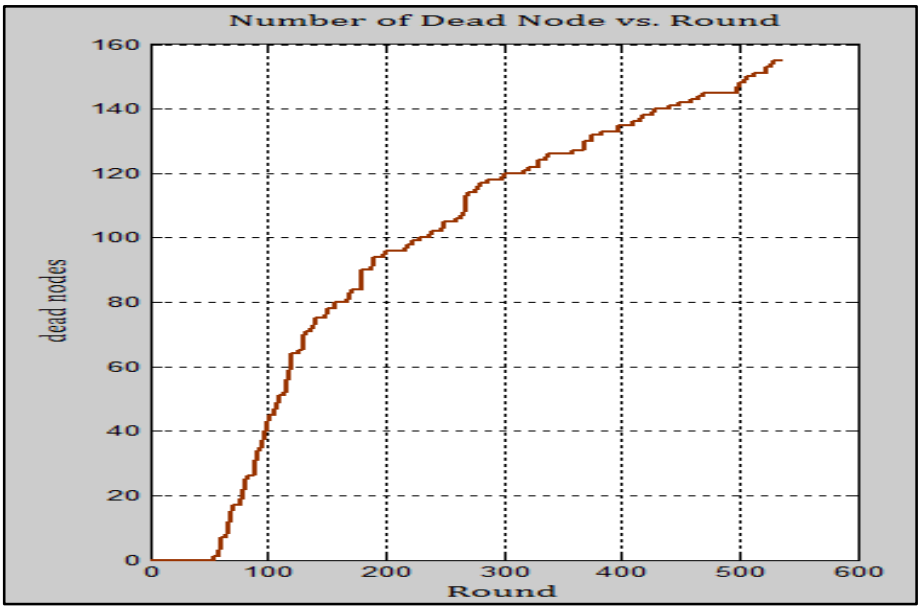

Figure 3. The number of dead nodes in each round.

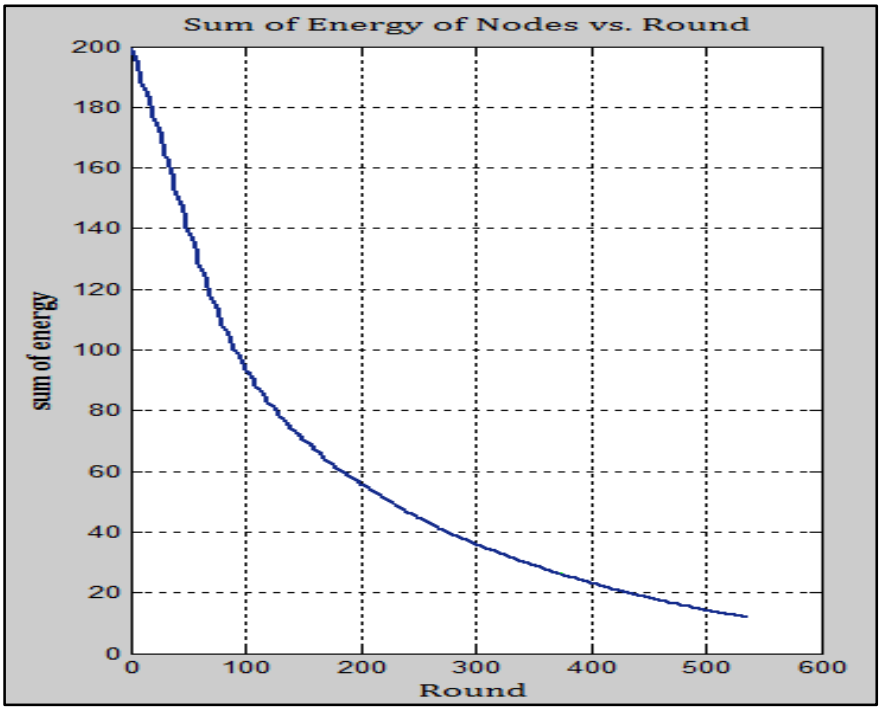

Figure 4. Sum of nodal energies per round

4. Conclusion

Several procedures have been proposed with different objectives for WSNs. A major aim of most of these procedures is to spread the service life of the network through reducing the rate of energy ingesting by the nodes. This paper proposed an algorithm which first assumed that all the nodes in the network are low-powered, and these nodes has the capability to select a CH. The network simulation was performed for 200 nodes in a 200 x 200 m^2 network which showed an improved network performance using the suggested LEACH algorithm in this paper to schedule the active time of the network nodes. The selection of the CH in the proposed LEACH protocol is done in each round based on their energy level. This technique of cluster head rotation in each round has not been considered by any study before now as most of the existing studies suggest changes in the ranges of the CHs while the clusters remain unattended.

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