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A Novel Enhancement for Increasing Lifetime of WSN Via Leach Protocol

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ABSTRACT:

Sensor nodes are used in WSN with the onboard processor that manages and monitors the environment in a particular area. They are connected to the Base Station which acts as a processing unit in the WSN System WSN has many advantages such as low cost, small size, multifunctional, self-organized and able to be routed by WSN protocols. However, it has some drawbacks such as low battery, short lifetime, area of sensor deployed and sensor energy consumption. This paper proposes a new approach to improve WSN in terms of network lifetime and data transmission time by reducing the packet delay time. The simulated result of the proposed algorithm KSLEACH is compared with the basic LEACH protocol with fixing parameters.

Keywords: - WSN, LEACH Protocol, Secondary Cluster Head, Network Lifetime, Energy Efficient.

I. Introduction

Wireless Sensor Network (WSN) consists of a large number of very small sensors deployed in a specific area depending on the desired application [1]. Each sensor contains sensing, data processing, and communication components. These sensors form WSN nodes that transfer the sensing data to the Base Station (BS) or sink. In the BS, the data is processed and computed to give understandable results. The communication between BS and wireless nodes is arranged by different protocols. One of the energy-efficient protocols is the LEACH routing protocol. In this protocol, the network is divided into different clusters and each cluster has elected Cluster Head (CH) which connected with cluster member nodes and the BS, collecting data from the nodes and then sending the aggregated data to the BS [2][3]. As a cluster head has more functions than the other nodes, so it consumes its energy faster than the other nodes which leads it to die earlier [4][5]. In this paper, we propose a new algorithm called Secondary Cluster Head (SCH) which becomes a cluster head simultaneously with the death of the previous CH. So, all WSN cluster keep transmitting data even if some nodes dead which increase the network lifetime and performance. LEACH protocol uses TDMA or CDMA routing protocols [6][7][8]. First, LEACH processes start with the setup phase then the steady-state phase. The cluster formation and then Head has been chosen are in the setup phase. We propose in this research to select the CH besides of Distance-Based Cluster Head (DBCH) algorithm that improvements combination with KSLEACH - SCH approach would maximize the network lifetime, save energy, reduce delay time and increase the data transmission rate.

This paper is organized as follows: literature review, literature review and related work, LEACH protocol, proposed algorithm, base line simulation, experimental settings, results, and discussions, supporting and illustrative figures, and concluding in Section VII.

II. Related Work

Wireless sensor technology is growing rapidly, and researches are coming out with diversities of approaches to enhance and improve it. However, the drawback of sensor technologies is the low battery and short lifetime. Sharma proposed a novel LEACH protocol in the heterogeneous network and compared the simulation results with LEACH Homogeneous system. Naveen explored fifteen different types of clustering protocols and compared them with various parameters. Cluster head selection algorithm is the main factor of getting better performance in clustering wireless sensor network, and Prasad suggested an improved energy efficient leach protocol (IEE-LEACH) for MANET. Prasad simulated LEACH using TDMA routing protocol and surveyed previous approaches to improve WSN performance such as Euclidian Distance from a node to BS, remaining energy and number of nodes in the same cluster. Nandi [10] implemented a new protocol for choosing an optimal place for the BS, which overcomes the issues of delivering data and compared the simulation result with the basic LEACH protocol and TDMA technique. They found that transmitting data from a node to BS will cost more energy in the node, reducing the node lifetime and reducing the network lifetime. Additionally, packet delivery time would be reduced when the BS is positioned in the center near the nodes. The authors compared three WSN protocols, LEACH, EEELEACH, and DTx, and proposed an algorithm called Distance Based Cluster Head (DBCH) to improve data transmission time and throughput.

III. Leach Protocol

LEACH is a low-energy adaptive clustering hierarchical protocol proposed by MIT's Chandrakasan for wireless sensor networks. It is a self-adaptive cluster formation protocol where nodes are randomly deployed and one node is selected to be a cluster head. All nodes in the cluster have the same probability of being a cluster head based on the equation (2). The cluster head election occurs in the setup phase of each round, when each node generates a random number between 0 and 1.

$$T(n) = \frac{p}{1-p\left(r \bmod \frac{i}{p}\right)} + (1-p)\frac{D_{max}-D_{i\ to\ BS}}{D_{max}-D_{min}}\left(\frac{E_R}{E_0}\right) \quad (1)$$

$$T(n) = \begin{cases} p/(1-p\times(r \bmod(1/p))) & n \in G \\ 0 & otherwise \end{cases} \quad (2)$$

where p is the probability of a node to be a cluster head, r is the number of rounds, G is the set nodes that have not been selected in the last 1/p rounds. As the cluster head is known for each node in the cluster and the cluster head form the TDMA slots for each node in its cluster (to prevent interference). Then the steady-state stage of the LEACH protocol process starts. Next, all nodes send the data packet to the cluster head then the cluster head integrates the data packets and sends the fused data to the BS. We have noticed that the cluster head missions are more than the ordinary nodes, so the cluster head consumes more energy than the others which one of the drawbacks of the LEACH algorithm. LEACH disregards the BS and cluster head geographical positions, energy consumption, and instability in the case of cluster head death.

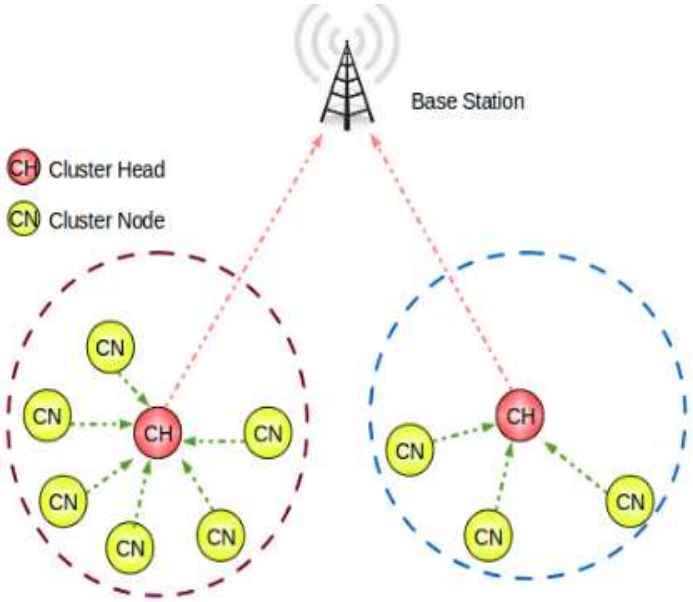

Figure 1: LEACH infrastructure

IV. Proposed Algorithm

On breaking down the properties of LEACH protocol, cluster head selection plays the main role in enhancing and improving the network lifetime, data transmission and energy-efficient. We propose a new algorithm to improve the lifetime of the network by selecting Cluster Head (CH) and Secondary Cluster Head (SCH) in the sensor setup phase of each round. According to previous researches, the nearest the distance between CH and BS, the better lifetime and energy-efficient the network is. Basis equation (1) we choose to select the closest node to the BS as CH and the closest node to the CH as SCH, with considering on energy and distance parameters of the node. Depending on this suggestion, if the CH dead the cluster will not cut off the communication with the sink and the secondary cluster head replace the dead cluster head and pronounces itself as a cluster head. Rather than that, the cluster continuously connecting the sink as long as the active node alive in the cluster. From the perspective of making the network with high latency. we apply the algorithm of node density in the cluster. Some nodes are not able to join the cluster because they have not the range ratio of any cluster, So they connect to BS directly without electing CH by the protocol which called Direct transmission (DTx), where we assume Figure 3 illustrates this algorithm.

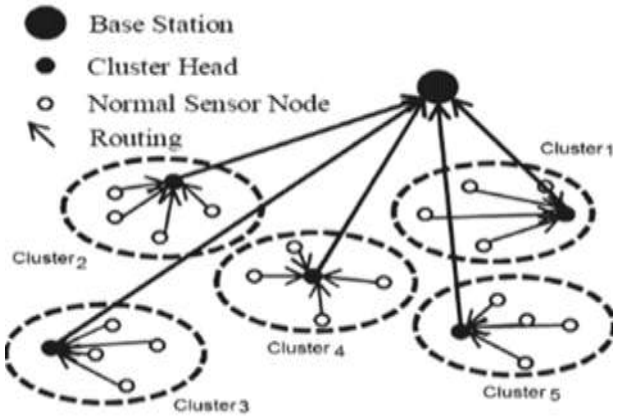

Figure 2: Architecture platform of the proposed algorithm

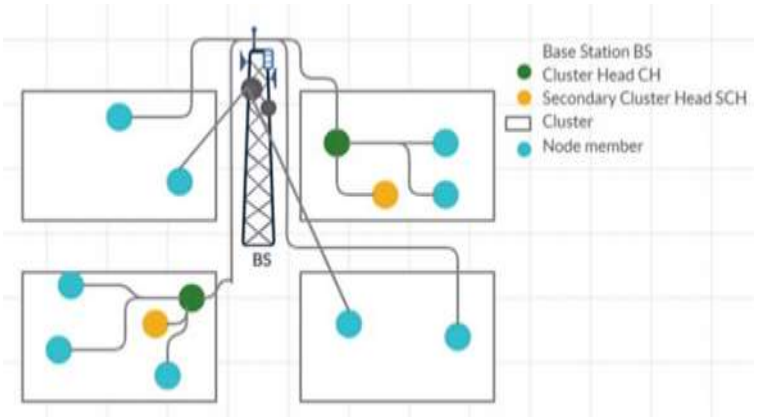

Figure 3 : Nodes density in a cluster; LEACH protocol connection and DTx protocol connection with BS

V. Base Line Simulation

The LEACH Protocol is a common algorithm used to improve the performance of Wireless Sensor Networks, such as energy efficiency, transmission time, transmission rate, optimal position of the sink, cluster head, node density and network lifetime. These are the main performance enhancement factors that we figure out in this paper. Figure 4 shows the initial LEACH protocol with homogenous network topology using MATLAB (Version: 9.2.0,518641) with an area of 100 × 100m. BS is in the center of the network (50,50), with 100 nodes are deployed randomly and certain nodes are randomly selected as cluster heads. We fixed a maximum number of clusters to be 10, a maximum number of rounds is 5000 and the initial energy equal 0.5Joules. Then, we set the data packet size equal to 4000 bits and the number of packets from each node to be 10 each round. We prefer to save the same parameters for all algorithms to gain fair comparison.

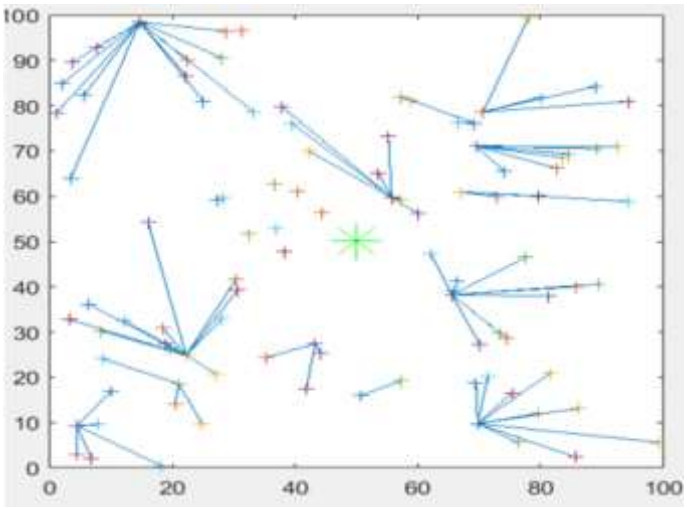

Figure 4: Snapshot of network while communicating and transferring packets

The figure shows alive nodes counting in contrast to a number of rounds of LEACH protocol. The network lifetime influenced by the energy consumption of each node. When the consumed energy increases, network lifetime decreases

VI. Proposed Algorithm Simulation Results

The proposed KS-LEACH protocol is designed to extend the network lifetime by using the same parameter used for the basic LEACH protocol. Parameters are chosen based on previous researches who analyze the WSN parameter to choose the optimal values for simulation and experiments. The proposed simulation parameters are shown in Table 1 we use MATLAB (Version: 9.2.0,518641) simulation tool with a simulation time of 2002.291161 seconds.

Table 1: Simulation Parameters

Parameter	Value
Sensor deployment area	100 × 100 m
Base Station Location	(50,50)m
Number of nodes	100
Data packet size	4000 bit
Control packet size	100 bit
Initial energy of sensor	0.5J
Probability of node to become CH	0.1

Network lifetime measurement factor is used to monitor the network life cycle, in this paper we focus on the last dead node in the whole network concurrently with data packet transmission through the network. The alive nodes of the proposed LEACH algorithm in contrast with the number of rounds are illustrated in Figure, As shown in the figure, by using our proposed algorithm, the last dead node was in round 4425 (after ten times of simulation). While in basic LEACH the last dead node was in round 1934. It turns out that the proposed KS-LEACH approach increased network lifetime by 128.80% compared with basic LEACH

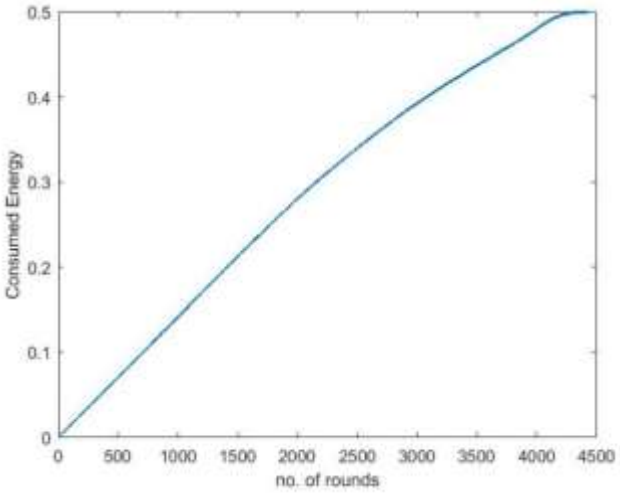

Figure 5: Energy consumption of proposed LEACH protocol

VII. Conclusion

This paper proposes a new algorithm called Secondary Cluster Head (SCH) which increases the network lifetime and performance of wireless sensor networks (WSN). It is shown that the last dead node in the proposed algorithm was in round 4425, which increased the network lifetime by 128.80% and increased the number of transmitted data packets in the network with the same network settings compared with the basic LEACH protocol. Future work should be done to apply the proposed KS-LEACH algorithm in different WSN routing protocols to minimize network traffic and the best path for data to travel from cluster to sink.

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