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A New Algorithm for cluster head selection in wireless sensor networks

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ABSTRACT: This study is an extension of LEACH protocol, the proposed protocol is a new mechanism for determination of the optimal Cluster Head (CH) in succession to accomplish the major purpose of reducing the energy dissipation and enhance network endurance in Wireless Sensor Network environment. The simulation scenario was set up in MATLAB framework with various topologies that depends upon the mechanism examined, the simulation confirms that the proposed methods serve adequately and provides reliable results associated with the primary LEACH.

KEYWORDS: wireless sensor networks,LEACH, cluster head, Alternative cluster head.

I. I.INTRODUCTION

It is observed in the last few years that Wireless Sensor Networks (WSNs) have been utilized in various applications wirelessly. These applications include industrial applications such as mining, smart cities, smart emergency systems, and smart virtual power plants. WSNs may be categorized into infrastructure-less and infrastructure-based networks [1, 2]. The former one includes Base Station (BS) for sending data inside the network. Data networks that normally send data wirelessly are deployed either multi-hop or single-hop between the BS and all wireless nodes. Nevertheless, this category is unable to fulfill the demands of end users, even though the progress in this class has obtained a prodigious growth [3].

On the other hand, the latter class does not fix to a particular infrastructure and therefore known as ad hoc networks [4]. In this mode of transmission, the infrastructure is not involved as a BS, which connects other networks. Data transmission among contributing devices is achieved same as done in the infrastructure-less class, i.e., either through multi-hops or a single hop [5]. In this class of transmission, wireless devices share data with each other in a uniform communication range of an ad hoc network. Suppose, the required terminal is not in the range of the transmitting device, transmission is achieved indirectly, that is, in a multi-hop fashion [6, 7].

A wireless network has a number of pros in comparison with a fixed network where these benefits are obtained due to the class of the network, as this is implemented on demands when requires. The second feature of this network is such that it has unrestricted connectivity. Nonetheless, restrictions are employed when needed so that it differs its nature from the conventional network demonstration. Quality of service (QoS), security, and routing are prominent issues, which these architectures must face so that to achieve a trustworthy and accessible interaction [8].

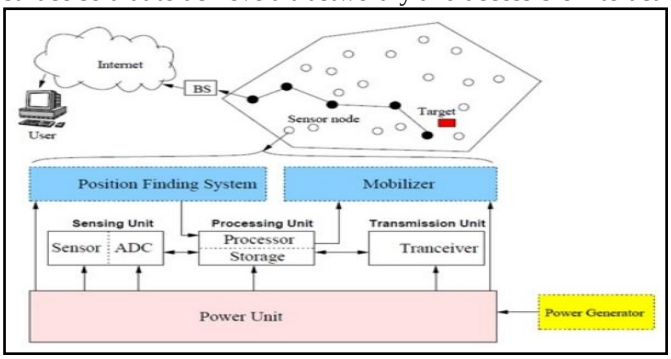

Fig1. Strategy of WSN [6]

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Currently, WSN has been evolved as a novel influential network [1-7], which is a subclass of ad hoc network. Fig1.1 demonstrates the WSN idea wherein this includes several minute sensor nodes (SNs) that are connected to the BS. All SNs hold sensing capabilities, wireless transmission, and calculations. In addition, (see Fig 1), an SN comprises a transmitter that is utilized for connecting SNs to the remaining network, a processor that has the compatibility facility with allocated sensing jobs, a power-unit that aids the determination of offering power to all SNs, and a sensing area that is distributed among sensing devices.

II. LITERATURE REVIEW

A. Low Energy Adaptive Clustering Hierarchy (LEACH)

LEACH [9] is a procedure, which is the most appropriate for the WSN routing [10, 11]. LEACH depends upon an adapted clustering procedure. The LEACH manipulates clusters and a single tier structure on the basis of a two-stage maneuver. A CH in the LEACH is arbitrarily shaped and the CH gathers the sensed information in all clusters [12]. This also has several features associated with supplementary protocols. This may attain some stable energy utilization because of three features. Principally, a CH is interchanged on random basis. Next, sensors identify the beginning of every novel cycle on the basis of coordinated clocks for the whole system. Further, the remaining devices inside the network (in any of the cluster), which do not perform as CHs may switch off the radio till the allotted time slots of devices. Besides, features of the LEACH are such that all sensors may send and receive data from/to others without the demand of earlier data regarding locations. Lastly, the LEACH is able to improve the gathered information in all clusters with the intention that the information sent to the BS may be reduced to the lowermost level [13, 14].
Nevertheless, as identified in the existing studies, for example, [15-20], in spite of the features that bring about utilizing the LEACH, this is restricted by a few weaknesses, for instance, every single device sends data direct to the source and CHs in a single-hop application. Therefore, in the coverage of a huge area structure, a single-hop fashion is inapplicable. Likewise, an extra complexity happens in the dynamic LEACH clustering, for example, additional ads and CH variations that need extra energy. A random selection procedure can collect all heads in a single zone. In LEACH protocol, the procedure of dispensing the same energy level to every device allots an identical energy significance to CHs that are nonfunctional.

B. Vice LEACH

Vice-LEACH, shortly called V-LEACH presents an associate sensor within the network to function being a CH if the central CH expires [21]. This is considered as a single hop due to the fact that it consists of merely one CH for the entire WSN. While an associate CH is chosen that begins working when the main CH expires, merely one node functions as a CH at one time. When a vice CH promotes to become the main CH, a third sensor is chosen to become the vice CH, etc.
With this phenomenon, the selection of a new CH is not necessary every time when the main CH expires and thus the entire lifetime of WSN can be augmented. On the other hand, the vice CH is chosen on random basis, thus, this could be faraway, or would have a little amount of energy as well as battery life. Hence, that could expire immediately due to elongated distance data transmission.

III. PROBLEM STATEMENT

The LEACH method is founded on the idea of cycles (rounds) where it scuttles in several cycles [22, 23]. Every cycle includes two conditions/states, i.e., the steady one and the setup of a cluster [24, 25]. In the former one, the information is forwarded from the source to other network devices whereas in the latter one the cluster is shaped in a way called self-adaptation. The concept of selecting a CH is such that the LEACH protocol selects a CH in every cycle [26-28]. Therefore, some of the sensors would utilize energy quite soon when they are chosen as CHs many times [29].

IV. PROPOSE PROTOCOL

The proposed protocol divides the communication process into several numbers of rounds. Each round comprised of a setup phase and data transmission phase. As previously mentioned, the setup phase is an overhead over actual data transmission. The primary focus of proposed protocol is to reduce this overhead which causes improvement over the

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network lifetime. To accomplish this, proposed protocol uses Alternative Cluster Head (ACH). This ACH hierarchy help to reduce the energy required to transmit necessary information for the setup phase to perform clustering operations. It also reduces the frequency of the setup phase using two schemes. As shown in Fig 2. The designed scheme focuses on improving the lifetime of the network in the system. This phase is described in the following subsections comprehensively

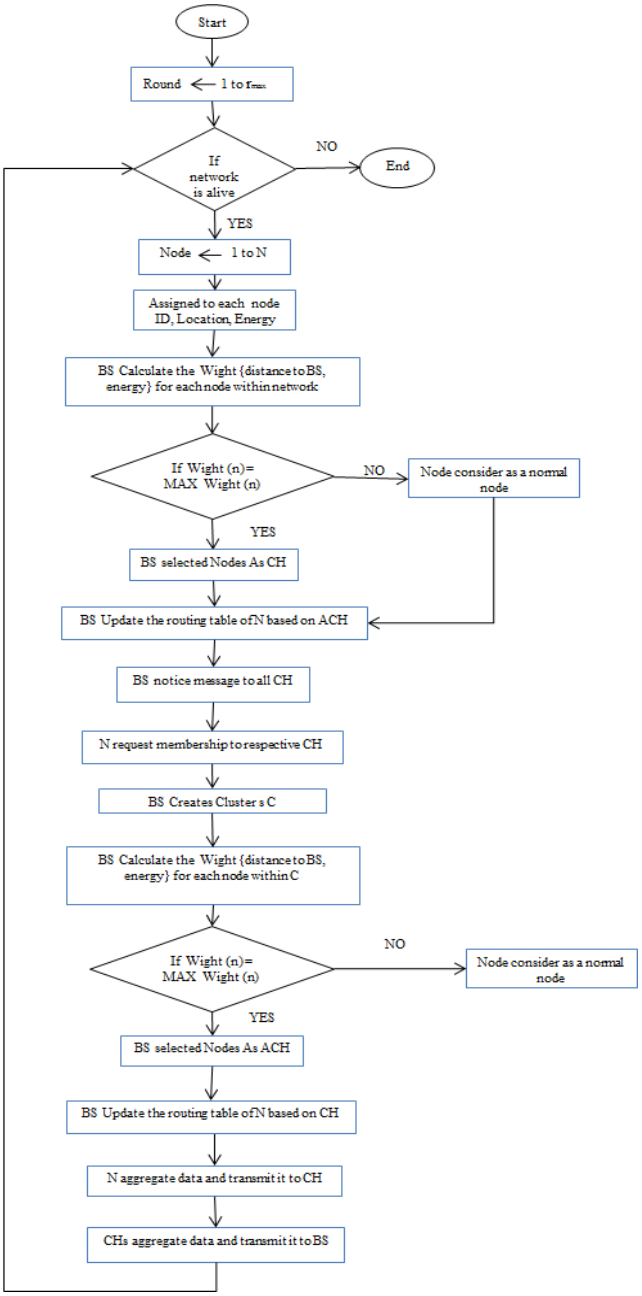

Fig 2: Flowchart of the proposed protocol

A. Setup Phase

The setup phase is not identical for all communication rounds. It differs based on whether the network has clusters or not. When the network has zero clusters, each alive node forwards a control message to the BS that consists of the ID, location and energy information.

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1. Selection of CHs

The main shortcoming of LEACH is the random selection of CH that is applied to all sensor nodes without taking into account any factor. In reality, to increase the lifetime of network and energy efficiency, we need to change the threshold of selecting CH. In other words, we must consider four essential factors: the distance between the nodes and the BS, the residual energy, RSSI and nodes degrees within the transmission range, to calculate the threshold, which are calculated presented in algorithm 1.

Algorithm 1:Cluster_Head_Selection

```
Input :  N; % N is the number of nods within the network;
Input :  energy , location , ID ; % for each node within the cluster
Output : CH ;
Begin,
    BS send a short message to N;
    N receives the message from BS, it will return its own status
        information, such ID, location and remaining energy to BS.
    BS constructs routing table
    identify sensor node ni which has the maximum energy and minimum
    distance ;
    BS selects ni as CH node;
    update routing table based on selected CH;
    BS notice message to CH;
    CH broadcast adv. message to all N;
    N request membership to respective CH;
    BS creates Cluster ci based on CH;
End.
```

2. Cluster Formation

For the first-round, the clusters are formed using K-medoids cluster formation algorithm[13]; conditions send their CH announcement information to inform other nodes. The other nodes send cluster joining information to CH. CHs prepare their TDMA schedule. The sensor nodes joint with closest CH node by calculating the distance between node and each CH.

3. Alternative Cluster Head Selection

By consider four essential factors: the distance between the nodes and the BS, the residual energy, RSSI and nodes degrees within the transmission range within cluster, to calculate the threshold, which are calculated presented in algorithm 2.

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Algorithm 2:Alternative_Culster_Head_Selection

```
Input : N; % N is the number of nods within ci;
Input : energy , location , ID ; % for each node within the cluster
Output : ACH ;
Begin,
    BS selects the CH based on Algorithm_1
    BS creates Cluster ci based on join cluster based on K-medoids algorithm ;
    identify sensor node ni which has 2nd node it has the maximum energy and
    minimum distance ;
    BS selects 2nd ni as ACH node;
    BS notice message to ACH;
    update routing table based on selected ACH;
    ACH broadcast adv. message to all N within ci;
End.
```

B. Transmission Phase

Nodes in a cluster, sends their data according to TDMA schedule (Intra-cluster routing), and cluster head receives, and aggregates the data. (2) The cluster heads will send their data directly to the base station (Intra-cluster routing).

V. EXPERIMENTAL RESULTS

The effect of proposed protocol is simulated through the MATLAB simulator in 2 diverse setups: The first scenario consists of 500 SNs; the second scenario includes 1000 SNs. The selected amount of SNs changes and is sufficient for the performance evaluation and representing different network conditions

The functioning of the proposed protocol is evaluated in comparison with the LEACH protocol. The functionality of these schemes is evaluated in all scenarios with 100 rounds. Chosen metric is: network lifetime.In presented figures; the x-axis demonstrates the amount of rounds in such a way that 10 and 100 are represented by 1 and 10, respectively.

A. Network Lifetime

The network lifetime of a sensing device means that a node may consume its energy in how much time that it dies after that. Thus, the device is counted as a dead node and is unable to function further in terms of information transmission. The protocols were tested with 500 nodes in 10 different rounds, as shown in Figure 3.

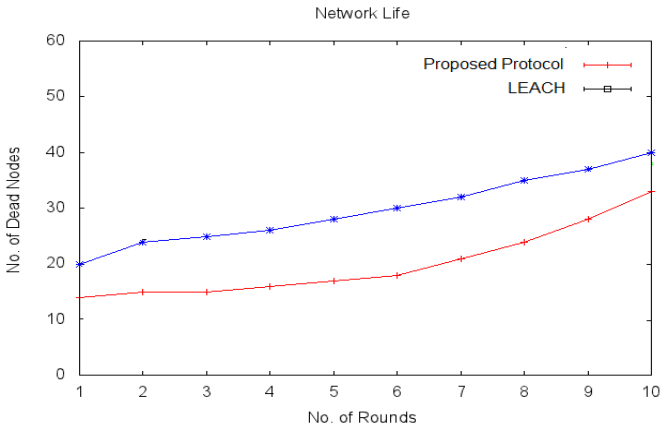

Fig3: Lifetime of Network with 500 Nodes

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This result was as follows: In the LEACH protocol, the nodes reached 40 from 19 in the last round and first one, respectively. While our proposed protocol reached 29 nodes in the last round from 14 nodes in the first one. In addition, these protocols were also tested with 1000 nodes in 10 different rounds, as shown in Figure 4.

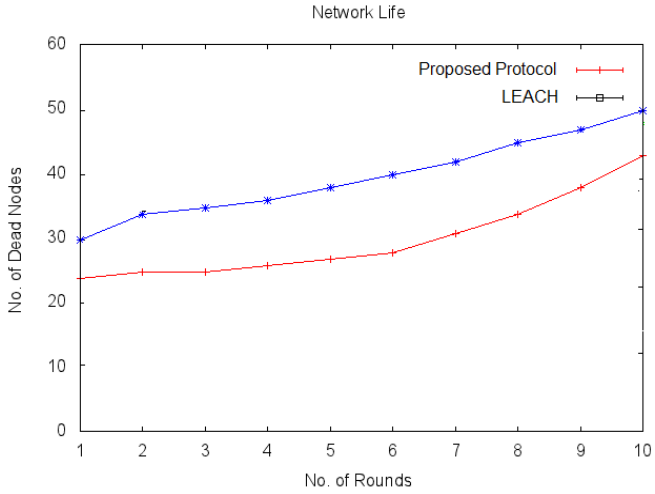

Fig 4: Lifetime of Network with 1000 Nodes

Investigating the showing figures, this may be observed that the amount of lost nodes is rationally minimized to a satisfactory degree in the proposed protocol in comparison with other protocol. Looking at all figures, i.e., 4to 5, this can be seen that if the amount of nodes is less or more, the proposed protocol works the best in comparison with LEACH. Therefore, this would have appropriateness for deploying in the WSN so that to increase the entire lifetime of the network.

VI.CONCLUSION AND FUTURE WORK

This paper analyzed the functionality of our proposed scheme with regards to network lifetime, with certain parameters, namely the quantity of sensors as well as rounds. Based on our discussions, the proposed protocol and developed in a way that entrenches entirely the features of LEACH approach. In other words, similar to the LEACH protocol, this holds an alternate CHs. While, this is unlike as the LEACH such as that merely functions with one CH, however, our proposed scheme is assisted with various CHs.future works we will look for inter and intra multi hope routing in LEACH protocol .

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