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Intra and Inter Multihop Algorithm for LEACH Protocol in Wireless Sensor Networks

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ABSTRACT: This study designed an efficient mechanism for Inter & Intra Multi-hop mechanisms based on characteristics of node of LEACH protocol in WSNs.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 LEACH protocol.

KEYWORDS: wireless sensor networks,LEACH, Inter Multi-hop mechanisms, Intra Multi-hop mechanisms.

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].

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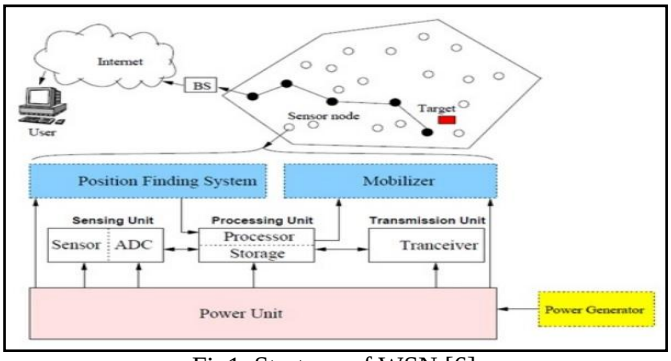

Fig1. Strategy of WSN [6]

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. Multi-Hop LEACH (MH-LEACH)

Direct communication with the BS is an issue for all CHs in large area network because more transmission cost is needed for sending data from CHs to the BS particularly when the BS is located far from the CHs. Multi-Hop LEACH (MH-LEACH), proposed in [21, 22], addresses the above issue, where the network nodes share their data with the CHs. The CHs then combine and send this data to the BS either through BS or directly. Same like LEACH, the MH-LEACH also selects the CHs randomly. An energy efficient path, which should also be the most feasible, is selected for the CH located far from the BS. Distance is considered as the method for intermediate CH selection between the BS and CH.
The CH, located near to the BS, acquires data from other CH that are placed far from the BS. This helps in saving energy of those CHs that are part of the clusters far from the BS. However, the selection of CH is random, therefore, the random selected node may not necessarily be high in power and energy, and hence decrease the network lifetime.

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III. PROBLEM STATEMENT

The LEACH method is founded on the idea of cycles (rounds) where it scuttles in several cycles [23, 24]. Every cycle includes two conditions/states, i.e., the steady one and the setup of a cluster [21, 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]. Likewise, a CH in the LEACH sends data to the source directly [21], thus, the energy consumption between the CH and the source is more than the energy consumed between two CHs [29]. As a result, energy is drained rapidly by the CH. In the multi-hop LEACH process, the entire network nodes may not die soon and therefore the network lifetime is prolonged in comparison with the normal LEACH process. This is done via specifying stability in the energy utilization among the entire sensor network [16].
Also, as a CH is connected to the source directly irrespective of their distance, majority of the energy is utilized if the distance is long and therefore it minimizes the whole lifetime of the network [30, 31]. To surmount this problem, various editions to the multi-hop LEACH are available, however, most of these editions (extensions) such as MR-LEACH [16] , produce extra communication overhead for a CH as these all utilize a kind of energy known as residual energy.

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 network lifetime. To accomplish this, proposed protocol uses schemes, the first scheme is designed that relevant to multi-hop inter routing in which all CHs (include in clusters) are able to forward information to other CHs in other clusters. The second scheme copes with “multi-hop intra routing” in which sensors in the clusters are able to transmit data to all nodes for satisfying the idea of “multi-hop routing”, as shown in Fig. 3. The designed two schemes focus on improving the lifetime of the network in line with minimizing usage of energy of the entire sensors in the system. Each of these phases is described in the following subsections comprehensively.

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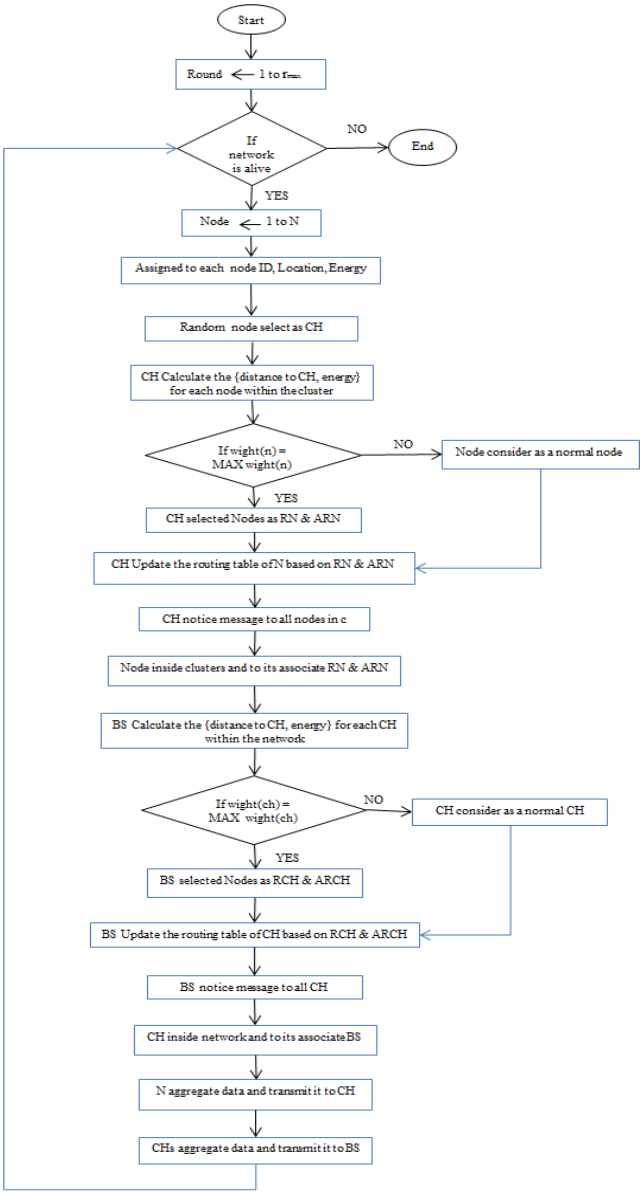

Fig3: Flowchart of the proposed protocol

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.

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,

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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.

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).

1. Intra-Cluster Routing.

The cluster of sensor nodes is formed on the basis of nodes. Some of the sensor nodes of a cluster can directly send data to the CH and some other node uses the relay node to send data to CH through multi-hop communication. For efficient multi-hop communication purpose, the cluster formation procedures are presented in algorithm No.1 as Intra-cluster routing.

Algorithm 2: Intra-Cluster_Routing ()

```
Input :  N; % N is the number of nods within the network;
Input :  energy , location , ID ; % for each node within the cluster
Output : RN; % Relay Node
Output: ARN ; % Alternative Relay Node.
Begin;
    BS selects the CH based on random  for each ci.
    determine K={n1,  n2,  …nm}inside  in  each  ci;  % which  are  in  single-hop
    communication with CH.
    identify sensor node ni which has the maximum energy and minimum distance ;
    CH selects ni as RN;
    CH constructs routing table
    CH selects 2nd nj as ARN;
    update routing table based on selected RN & ARN;
    CH notices remain nodes of ci on RN & ARN;
    K perform based on routing table then transfer data to respective CH by Multi-hope
    Communication;
End.
```

The considering the remaining energy of node each round and alive neighbours node, we can optimize the selection of RN and ARN. Thus, nodes having at the same time high residual energy, short distance, and high RSSI to the sink and several neighbours are chosen as RNs.

2. Inter-Cluster Routing

Some of the CHs of a network can directly send data to the BS and some other CHs uses the relay CH node to send data to BS through multi-hop communication. For efficient communication purpose, the cluster formation procedure is presented in algorithm 2 as inter-cluster routing procedure.

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Algorithm 3: Inter-Cluster_Routing ()

```
Input :  N; % N is the number of nods within the network;
Input :  energy , location , ID ; % for each node within the cluster
Output : RCH; % Relay Node
 Output: ARCH; % Alternative Relay Node.
Begin;
    BS selects the CH based on Algorithm_1 for each ci.
    determine sub set of CH={ch1, ch2, …chm}inside the network; % which are in single-hop
    communication with BS.
    identify sensor node ni which has the maximum energy and minimum distance ;
    BS constructs routing table ;
    BS selects nmax as RCH;
    BS selects 2nd nmax as ARCH;
    update routing table based on selected RCH & ARCH;
    BS notices remain CHs inside the network on RCH & ARCH;
    CH perform based on routing table then transfer data to BS by Multi-hope Communication;
    CH combine & forward data to the BS;
  End.
```

The considering the remaining energy of CH each round ,distance between CH to the BS and alive neighbours CH, we can optimize the selection of RCH and ARCH. Thus, nodes having at the same time high residual energy, short distance, and high RSSI to the sink and several neighbours are chosen as RCHs.

V. EXPERIMENTAL RESULTS

The effect of proposed protocol is simulated through the MATLAB simulator in 2 diverse setups: The first scenario consists of 50SNs; the second scenario includes 100 SNs. The selected amount of SNs changes and is sufficient for the performance evaluation and representing different network conditions

The functioning of the proposed protocolis 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 50 nodes in 10 different rounds, as shown in Figure 4.

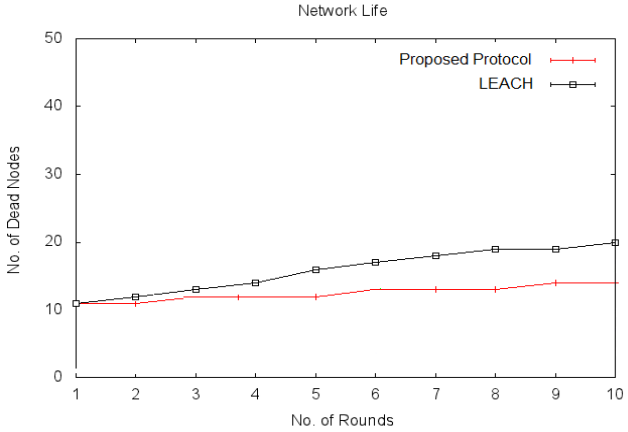

Fig 4: Lifetime of Network with 50 Nodes

This result was as follows: The basic LEACH lost 20 nodes in the last round, which were only 10 nodes in the first one, respectively. While our proposed protocol reached 14 nodes in the last round from eight nodes in the first one. In addition, these protocols were also tested with 100 nodes in 10 different rounds, as shown in Figure 5.

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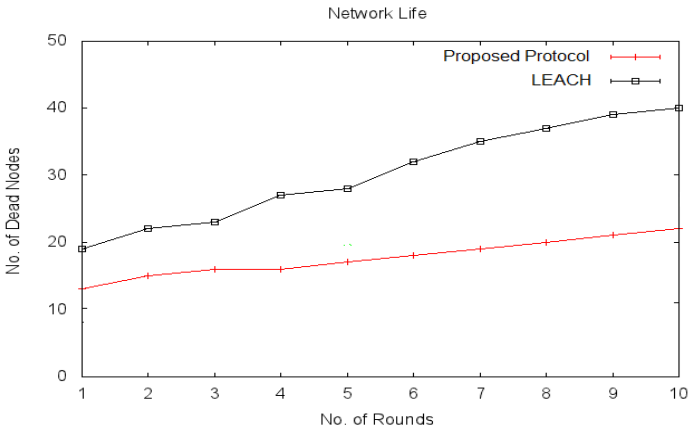

Fig5: Lifetime of Network with 100 Nodes

Investigating the showing figures, this may be observed that the amount of lost nodes is rationally minimized to a satisfactory degree in the proposed protocolin 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, proposed protocolworks the best in comparison with LEACH protocol. 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, protocolis proposed and developed in a way that entrenches entirely the features of LEACH protocol. In other words, similar to the LEACH protocol, this holds inter and intra routing in LEACH protocol. While, this is unlike as the LEACH such as that merely functions with single hope communication, however, our proposed scheme is assisted with various CHs.future works we will look for CHs and alternate CHs selection in LEACH protocol.

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