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AN EFFICIENT FRAMEWORK FOR THE ENERGY CONSUMPTION REDUCTION OVER WIRELESS SENSOR NETWORKS

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***Abstract*:**
Low power sensors that are dispersed across remote locations are mainly deployed in Wireless Sensor Networks (WSNs). Clusters of sensors are arranged, where each cluster identifies a crucial node called a cluster head (CH). To communicate the sensed data to a base station, each CH gathers it from its sensor nodes (BS). Sensors with non-replaceable batteries have been deployed. For WSN, energy use is a significant concern. This work presents an efficient framework that reduces the energy consumption over WSNs to lower energy consumption and prolong network lifetime. The energy loss can be reduced over the network connections has been achieved by enhancing the energy balance over all the clusters at each sensor nodes. The cluster head selection is an important phase of the network deployment where additional TDMA is also attached to the cluster head. The existing LEACH is compared with the proposed protocol and shown an improvement of proposed protocol with respect to the network-lifetime, energy consumption, how many more nodes are linked to the base station. Results from MATLAB 2015a simulations and mathematical analysis demonstrate the viability of the suggested strategy. Compared to LEACH, WSN has a 73% longer network life cycle and a 60 percent lower energy consumption.

Keywords: Deployment-Region, MS-Mobile Sink, Cluster Head, Wireless Sensor Networks

I. INTRODUCTION

WSNs are made up of variety of devices that communicate with another while using only a little amount of electricity. In a real-world setting, these wireless sensors are set up to detect various environmental influences. The data collected from the target environment is transferred directly to the base station (BS) from all sensors due to the restricted power available to sensor nodes. (Sinha, 2013; Othman, 2015). WSN technology has been expanded to be used in many other applications.

Many of the monitoring systems, intelligent buildings and the objecting systems are used in the military applications [1,3,4,6] uses the sensors to detect various activities. A global addressing method must be established for all sensor nodes, and this places serious limitations on WSN due to variables including low computational power, non-rechargeable and low battery, security, and restricted memory. For sensor nodes designed to operate responsibly for a prolonged period of time, energy efficiency is a challenging issue.

Energy usage also depends on the demands of the application. Additionally, it is sometimes used in hostile environments where it is impossible to replace or recharge the sensor nodes batteries. As a result, batteries are essential to WSN since they serve as a lifetime indicator. The majority of the energy used by wireless networks is used for data transmission. Thus, the protocols for energy-efficient routing are required. Numerous genres of literature use this information to create WSN that are more energy-efficient. For energy conservation, several types of research are introduced. These studies are based on how to improve data collecting methods, starting from the physical layer of routing protocols (Batra, 2016).

2. Literature Survey

Authors in Hong et.al. presented a threshold-based method for replacing cluster heads during clustering operations. The selection of cluster heads is decreased by using the residual energy threshold. A unique strategy known as the MODLEACH procedure is presented in [6] et. al. a procedure known as MODLEACH. By utilizing a powerful cluster head and fewer transmissions, they extend the network's lifetime. The replacement process keeps the power level of communication between and within clusters.

Authors in [7] et al. presented a method for lowering energy consumption per node.

According to the nodes with neighbor nodes closest to the base station that had the maximum residual energy, they decided which sensor node would become the cluster leader.Algorithm in [8] et al. takes into account the existence of tiny clusters. The cluster chiefs, who are mostly concerned with the nodes' remaining energy and threshold energy needs, also pass away unexpectedly.

The Authors of Murali (2020) provided a concerted communication strategy. Their experimental results show that the network consumes less energy overall when cooperation is present than it does when it is missing. However, if there are numerous sensor nodes in a cluster region, the traffic overhead increases at the start of each round. To solve the energy hole problem, various mechanisms can be applied:

Assistant strategy [12] A number of assistance nodes with more powerful batteries and greater transmission range are installed in the TTDD scheme. On the upper side of the sensor's having lower initial energy sensor, these nodes create a relay region.

Using a distribution approach based on nodes: If additional nodes are found close to the RN region, a predetermined distribution technique must be utilized to utilise them.

Adjusting the transmission's range: the ranges for sensor communication that can be adjusted. However, there are limitations on the sensor field's size.

Sink Mobility: In event-driven networks, the base station's mobility is seen as a crucial factor in determining how well a node can transport energy. The protocol presented by the authors in [23] et. al will create an energy hole problem which will result in an imbalance in the already-existing energy-efficient procedures like LEACH and Improved LEACH protocols. Here, the multi-hop connection that sends data from source to destination nodes is the foundation upon which the clusters are constructed.

WSNS uses the improved energy-aware uneven distrusted cluster protocol presented in [15] uses the heterogeneous way of communication. The radius of this is calculated using three different inputs a) based on the quantity of the nodes b) based on the amount of energy left and c) based on the distance from the base station.

3. Proposed Methodology

The goal behind the introduction of the RN node in the I-EADUC RN model is to increase the network's useful lifetime, as a result, the network's lifetime before 25% of its nodes die is greater than it is for other existing protocols. Different phases of the proposed protocols are a) Set up and the b) Steady state phases.

3.1 First: Set-Up phase:

During this initial phase, Nodes are dispersed throughout the network at random., with the mobile station situated on the y-axis. Here, the base station will broadcast the beacon signal with lower energy levels, while the nodes closest to it will receive the strongest signals. Until all nodes have gotten the base station's beacon signals, this cycle will go on. This procedure will establish the separation between the BS and the signal that was picked up during setup.

All of the nodes, the rendezvous region is identified in the sensor field at the beginning of setup phase, and this phase will again divide the module into three distinct sub parts, where each module is given with specific amount of time slots (t1, t2, and t3). These sub phases are referred to as a) CH Competition (CHC), b) Collection of neighbor node information (NNIC), and c) Formation of Cluster (FC). yi is the fraction of the RN region that must be covered, and ym stands for the y-axis dimension [16]. As the number of sub-phases is reduced and computational power is increased, the lifetime extension increases. Each sub-phase completes its duty during the designated time intervals.

At the start of "T1," each node broadcasts a node message including its residual energy and node id, gathering information about its neighbors for sub phase (1). Similar to this, every sensor node in the field shares its excess energy with its neighbors. Thus, a network node can acquire constant energy from nearby nodes at a predetermined distance. Each node determines its average neighbor energy using the data it has received. For the CH, the node with more energy than the average has a chance to contend.

$$Eavg = \frac{\sum_{sj-1}^{m} Er}{nb} \text{------------------------} (1)$$

Sj stands in for the current node, Er for the remaining neighbor nodes, and Nb for the total number of neighbors. At the end of neighbor node information gathering sub phase, the wait times of each node are determined. According to this estimated wait time using Eq. 1, the node is only to be elected as a CH for the present round or in subsequent rounds.

Using this Vr [0.9, 1], which presume that all randomly generated Values differ from each other reduces the likelihood that two nodes calculated will be transmitted to Head-Msg at the same time. The node designated as the CH sends a Head Msg to demonstrate that they have chosen to lead the round. The node that hasn't gotten a Head Msg sends one inside its competition radius.

The CH computation begins to fulfill its goal at the beginning of time "T2" at the conclusion of time "T1". The variables used in Eq. 2, to calculate the competition radius are residual energy, distance from the base station, and the number of neighbor nodes. Based on the computation radius, the number of member nodes to be included is decided.

$$Rc = [1 - \propto \left(\frac{dmax - d(si,Bs)}{Dmax - dmin}\right) - \beta\left(1 - \frac{Er}{Emax}\right) + \gamma(1 \frac{sj(nb)}{nbmax})] \text{-------------}(2)$$

The weights of the transmission nodes at levels (0,1) are calculated using the afore mentioned equation. Here, Rmax is utilized to calculate the transmission's largest possible radius. The maximum node distance from the base stations, where the distance for each i^{th} node to the base station is computed for the leftover node energy,which is determined by the values of Dmin and Dmax. For each node to satisfy the greatest residual energy, the neighbors and radius of the nodes must provide the appropriate bandwidth.

These neighboring nodes send a Joint MSG to the CH, which receives it, approves the request, and updates its member list. The CH then delivers a TDMA schedule to the member nodes after acceptance. Less energy is expended by the nodes when they employ this TDMA schedule to sense the channel. As a result, each node in the neighborhood is granted a unique time slot. The nodes that make up a cluster will only be awake for the duration given before entering sleep mode. The network's energy is preserved in this way. Information is sent from the cluster's nodes to the CH in a single hop.

The selection of cluster heads has a considerable impact on the WSNs' effectiveness, and hence has a significant impact on how the network is implemented. Based on residual energy and the distance between the base station and sink node, a process is used to gather data to determine the cluster head in the network. To deliver the bulk aggregated data, each cluster head node must keep a longer connection with the BS, therefore when the number of cluster head nodes is decreased, the energy consumption also increases. According to Eq.3, these CHS will finally pass away sooner taking into consideration the greatest Erelay value

$$Erealay - \frac{Sj[Er - Sj.count + 1 + ED \ * DM - ETx * Dm}{Dmax} \text{-----------}(3)$$

We can derive the EDA value from the equation with the aid of Sj, and the Er value from the network relay and node distance.

The largest amount is the network's remaining initial accessible energy, or Emax. In other words, the relay node for the next hop will depend on which node has the most energy left. Any CH elected must traverse a minimum distance in order to be picked as an RN node, with reference to the highest Erelay value. In the event that the RN node disappears, the next RN node that is nearby is taken into account as the RN from cluster node for that CH.

Table 1: Formation of Sizeable and Tiny slots

Form Cluster Head	Form Cluster	Formation of Neighbor node	Tiny Slot-1	Tiny Slot-2	Tiny Slot- 3	Sizable Slot-M	Tiny Slot-m

In addition to these improvements, the concept of a main slot and a micro slot improves the protocol. The cluster that has formed is maintained for a few stages of the data transmission. The data transmission phase is divided into a number of sizable slots (marked with the letter "M"), each of which contains a number of tiny slots (designated with the letter "m"). The tiny slot is when the actual data transfer occurs, and when all the tiny slots have been used, a sizeable slot begins.

The CH rotation occurs during the sizeable slot phase. Within a previously established cluster, a fresh CH is chosen. Using the energy that is still available, the new CH is chosen. The node that is closest to the current CH and has more energy left over than the CH itself does. Every important position has this CH rotation method in place. The overhead of the CH during each setup phase might be decreased as a result of this approach. Therefore, this method of static and dynamic clustering conserves the energy used in control message transmission.

Proposed Algorithm

- Consider all nodes from 1: n
- Role of the node (i)==’N’
- If ( )
- Fix the Role of node (i)=’R’
- End
- If (distance (i, j) <= d && Role7(i)==’N’)
- Average Energy= Sum of (Average Energy and Remaining Energy)
- Compute Average Energy for node ‘i’ = Average Energy / Count
- if (Status of Average Energy > Status of Remaining Energy)
- Compute wait time =(Average Energy / Er) * T2* Vr
- if(Status of Average Energy <=Status of Remaining Energy)
- Compute wait time= T2 * Vr
- Rank the nodes based on waiting time
- Set the role of node with less wait time as (role(i)==’C’)
- Rank the CH based on distance, the near one is the CH for that node
- Set role(i)==’M’
- Initiate data transmission to CH from cluster member
- Initiate data transmission to selected relay node from CH
- The RN which is at a minimum distance receives data from relay node
- THEN THE BS RECEIVES DATA FROM RN NODE IN SINGLE HOP.

4. RESULTS AND DISCUSSION

Modeling of the suggested method completed in MATLAB 2015a. It uses a 2D elliptical Gaussian distribution. The WSN consists of 100 sensor nodes that are dispersed throughout 100 zones, each of which is 100 m2 in size. The base station is located at (50, 175). Each sensor node contains a starting energy of 5 J. An average of 20 simulations of the proposed approach are performed.

The outcomes are evaluated primarily in light of the simulated outcomes attained in each round utilizing different protocols, including LEACH-MAC, A-LEACH, and the LEACH protocols. The comparison is conducted using the simulated results of each protocol with various performance characteristics, such as the network's lifespan, the quantity of packets received at the base station, and the nodes aggregate energy consumption, as displayed in table 2.

Table 2: Simulation Parameters Considered

Parameters	**Value**
No. of. Rounds	100
p	0.1 or 100%
E_{elec}	50 nJ/bit
E_{fs}	10 pJ/bit/m^2
E_{DA}	5 nJ/bit/message
$Eamp$	0.0013 pJ/bit/4
Control Packet Size	25 bytes

4.1 Cluster head Selection

The effectiveness of the WSNs is significantly influenced by the number of cluster heads selected, hence the selection of cluster heads has a significant impact on how the network is implemented. Based on residual energy and the separation between the base station and sink nodes, a method is used to gather data to identify the cluster head in the network. Energy usage increases when the number of cluster head nodes decreases since each one needs to maintain a stronger connection with the BS in order to convey the bulk aggregated data. This will speed these CHS's disappearance.

The CH numbers must remain consistent in succeeding rounds around an ideal number to achieve balanced energy usage. Here, in each round the cluster head is compared to the Leach Protocols shown in Figure 1 and the current A-LEACH, IB-LEACH, and other protocols. According to the trials' findings, three rounds of counting five cluster heads is the best number.

Figure 1: Number of round for each cluster head

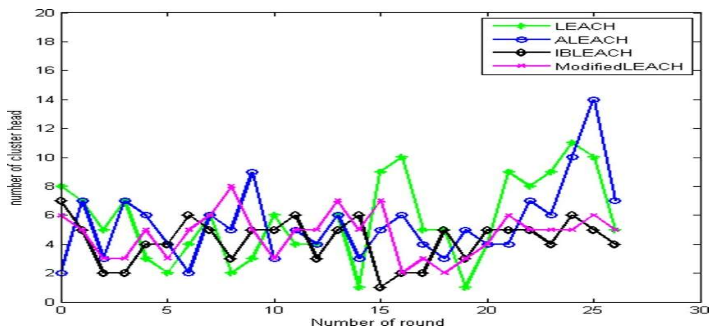

Table 3: Describes Protocols vs. Number of rounds

Protocols	**Rounds**		
	R 5	**R 12**	**R 26**
LEACH	2	4	5
IBLEACH	4	3	4
ALEACH	4	4	7
Modified LEACH	3	5	5

The number that performs the best among all others is the optimum one. This modified cluster head selection method has been enhanced by adding extra nodes per round. Table 3 includes three separate rounds for a comparison of all the methods. IBLEACH is able to stabilize a maximum number of cluster heads equal to 5 in some rounds by dividing the task of the cluster heads among its members, dispersing energy consumption among all sensor nodes.

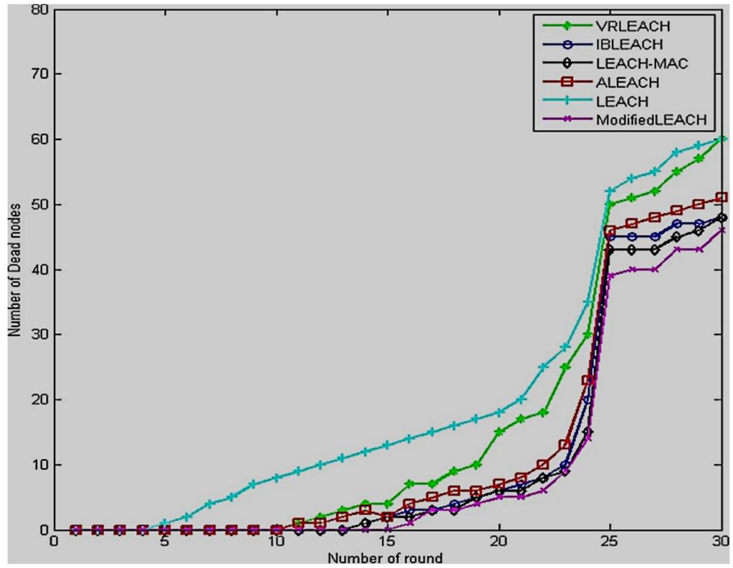

Figure 2: Number of Dead Nodes vs. Network Life Time

4.2 Network lifetime

The network lifetime is the time span between the first and last node deaths. The stability of the node is necessary because the findings are primarily impacted by the loss that occurs from one sensor node to the most resilient sensor nodes. Figure 2 compares the lifetimes of the several protocols, including LEACH, ALEACH, LEACH-MAC, and IB-LEACH, with the suggested protocol. The comparison of the suggested protocol with the IB-LEACH and LEACH-MAC protocols using 16 rounds also reveals an improvement in the first node death value. 13 different sensor nodes were lost during cycle 16 compared to 3 for the VRLEACH, 2 for the LEACH-MAC, and 4 for the IBLEACH.

5. Conclusion

In order to cut energy use and increase network lifetime, this work proposes an effective framework that lowers the energy usage over WSNs. By improving the energy balance across all clusters at each sensor node, the energy loss via network connections can be decreased. Here The selection of the cluster head is crucial in determining the best nodes. A modified TDMA schedule has also been implemented. The development strategy exhibits improvement in terms of network life-time, the number of cluster heads, energy consumption, and the amount of packets sent to BS when compared to LEACH and other comparable protocols. Mathematical analysis and simulation results using MATLAB 2015a show that the suggested approach works. WSN's length is 73% more than LEACH's.

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