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Energy Efficient Cluster Head Selection Based On Mobile Sink Using Leach Protocol In Wireless Sensor Networks

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ABSTRACT

The energy near the static sink normally suffers from energy depletion issue since the node near the sink propagates signals to other nodes and acts as a convener, which leads the energy dissipation of sensor nodes near to the mobile sink, resulting in a network energy hole. In order to resolve these concerns, we have proposed a protocol known as Improved Mobile Sink Low Energy Adaptive Clustering Hierarchy (IMS-LEACH) protocol toreduce the problems with wireless sensor networks and to extend the life of sensor nodes. The proposed mechanism uses two methods, the first method organizes the cluster and a cluster head is selected for every cluster. And in the second technique, the selected cluster is in charge of gathering data from the cluster's sensor nodes and eventually transmitting it to the sink node. In the proposed methods Sink Node can move to any sensor node in a cluster to gather data and it leads to minimized energy consumption compared to other protocols.

Keywords: WSN, LEACH, Cluster Head, Mobile Sink.

Introduction

The Wireless Sensor Devices are tiny devices with limited resources [1], nodes are battery powered and energy is a constraint for such nodes. Wireless Sensor Networks has a huge number of sensor nodes, and network contains several wireless nodes capable of sensing environmental data [2]. The batteries of sensor nodes are difficult to replace, since in most cases, sensor nodes are put in a hostile [3] environment.The sensor network's lifespan is determined by how well the battery is used. The efficient technique which can be used to achieve maximum energy usage is with the help of clustering of sensor nodes within the network [4]. Based on the maximum available energy, each cluster must elect a Sensor Node as Cluster Head (CH).Each cluster head has the ability to send information obtained from the cluster to the sink node on a regular basis.In the case of static sink, the data received from the CH nodes must relay through the many sensor nodes and the sink node receives data causing nodes in close proximity to the sink to lose energy, because these nodes transmit a large amount of data and lead to sink hole problems [5]. To overcome this problem, mobile sink can be used rather than using the static sink because static sink normally creates energy hole problems. Because the sensor nodes in the vicinity of the static sink die fast and make a hotspot or a problem of energy hole, the SNs near the static sink must transmit the data packets to the SNs further away from the static sink.Many researchers have found that SNs that are located distant from the static sink may be able to retain more than 91% of the energy and the SNs with one hop distance die soon [7]. The proposed work uses the Low Energy Adaptive Clustering Hierarchy (LEACH) protocol, a randomization-based clustering techniqueto disperse the energy load across the network's sensor nodes [9]. The LEACH protocol divides the network into multiple clusters and allocates a head for a cluster based on amount of energy remaining. If the cluster head selected has low energy, then the possibility of increasing the network's life expectancy will reduce [10]. So, leach protocol does the randomization of high energy cluster head and rotation will occur with a purpose of not to drain the energy of single sensor nodes [11]. Once cluster is formed by the network, the cluster head broadcasts its status to each sensor and sensor nodes will elect its cluster heads and determine their cluster by knowing the minimum energy requirement for the communication. To avoid energy dissipation, each non-cluster head node radio component is used only during the transmission. Finally, in light of permitted time periods, data is obtained from non-cluster heads by the cluster head, which is subsequently relayed to the sink node. In this course of action of transmission cluster heads require comparatively more energy. If the sink node is static, then distance taken for transmission is more, if the sink node moves though a rendezvous point at certain intervals, then when the sink node reaches a particular rendezvous point [12] then data can be transmitted with minimum transmission range and minimum energy.

Related Works

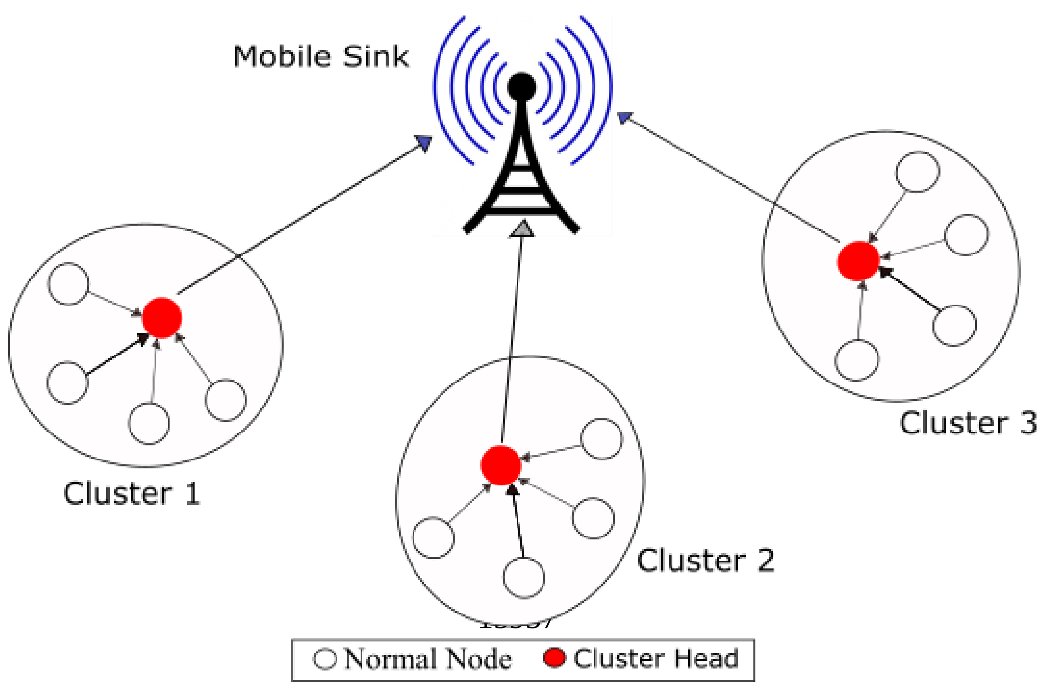
Many researchers have worked on several algorithms to keep energy use to a minimum of the sensor nodes. The LEACH is a clustering protocol, in this protocol the clustering of the network is formed Cluster Head is chosen at random at the start of the network. The load is evenly distributed among all cluster members and the data sent by cluster members will be collected by the Cluster Head. and send it to the node that used as a sink. The main advantage of LEACH protocol is, the cluster members will remain awakened only during the transmission of packets to the cluster head otherwise the nodes can be at sleep mode with low power consumption and the member nodes can wait until their turn comes. If the cluster heads of the cluster are selected using the randomization method, then there is a possibility that the same node or node low residual energy is selected as a cluster head, which is key drawback of the LEACH protocol. Various types of techniques are used to overcome these problems. A new protocol [13] is used to resolve the issue of selecting the cluster head called amend LEACH (A-LEACH). This protocol chooses the cluster head in light of amount of energy left. Another [14] new protocol called PR-LEACH is introduced and this protocol is used to avoid energy dissipation by the cluster head. Since this protocol uses multi hop inter-cluster traffic, it is more reliable and efficient than LEACH. This protocol uses more energy and creates overhead at the sink. The genetic algorithm-based protocol called GA-protocol is in light ofthe node's best chance of becoming CH. The protocol [15] called energy efficient clustering approach (EECA) uses two phases for selecting the CH. In the first phase an anchor CH is chosen according to leftover energy and the selection of another node known as candidate CH is performed. In the second phase, based on the delayed broadcast system a competition to become the cluster head can be observed by this protocol.

A protocol [16] called power-efficient gathering in the sensor information system (PEGASIS)in which the chain rule is introduced, and the chain is built using the greedy method, the chain head is chosen immediately a network formed and the selection of furthermost node for a chain head and data fusion will occur at each node. A node can communicate only with its adjoint neighbour. And a node fuses its own data with neighbouring node data, both having the same length data. A protocol [17] called RZ-LEACH is used rendezvous nodes and sink node to minimize energy consumption. This protocol makes a sensor node decide to become a rendezvous node or CH node. For selecting CH nodes, the maximum remaining energy and threshold are evaluated, and this method is considered more efficient compared to previous methods by many researchers.

The literature survey has concluded that Cluster Head selection has several issues in the traditional selection system, such as predicting thesink node's position, node count and the dimensions of the sensing area.

Proposed Work

In this work, we have concentrated on the problem of hot spots or energy holes in the network, and attempted to overcome the problem of energy hole, by using mobile sink. Some assumptions are made before the start of the network. The sink is thought to be migrating from one location to another, and the sink node is supposed to have enough energy to move at the network's core. [17]. The LEACH protocol is the basis for the protocol employed in this suggested researchand LEACH protocol has several drawbacks because it is a hierarchical cross layer protocol, to overcome the problem of energy dissipation LEACH protocol uses a hierarchical approach and this method must follow many iterations. A preparatory phase and a sustained data transmission phase make up the majority of iterations. During the preparatory phase, the cluster will be dynamically created and cluster heads will be selected at random.The cluster heads are switched after e rounds in the steady data transmission phase, and



Cluster Heads Selectionis dependent on the percentage R value and also on the threshold value, which is described in the following equation.

$$P(m) = \begin{cases} \frac{R}{1 - R * \left(e \bmod \frac{1}{R}\right)} & \text{if } m \in Q \\ & \text{otherwise} \end{cases}$$

The LEACH protocol uses the threshold value to determine whether the cluster head belongs to Q, where Q denotes the node count that were not cluster heads in the preceding 1/R rounds.Once the cluster head node has been chosen,it will send out a broadcast message to all other cluster members to let them know that it is the cluster head. When a node is selected to serve as the cluster head, it uses TDMA to schedule and assign transmission slot to each member node, which denotes when to transmit [18]. P(m) is set to zero if one of the nodes has previously been a cluster head and has been chosen every iteration as a cluster head, and the same node will not be chosen as a cluster head for the 1/R iterations.

The fundamental difficulty and incorrect selection method of the standard LEACH procedure is that it does not account the position of the base station and Remaining energy when selecting Custer Head.

The cluster head is chosen using residual energy and a threshold value in the planned work. When a node's mobility is enabled, the movement of the node is tracked. Each node in the network is aware of the movements of its neighbours, and route discovery and maintenance are launched [19].

The route discovery method is used to determine the nearest route between a source and a destinationand the packets are transmitted once the route is established. The source node when it transmits packets route is not established, then the route discovery algorithm is used to accomplish the task. The route discovery algorithm can be invoked more than once to fix the failed routes and reestablishment of the paths from point A to point Bis possible.

The algorithm listed below can be used to locate the Cluster Head, in this algorithm initially location of the node is identified and the cluster is built based on the node's location and each node initial energy is calculated with the help of this algorithm. Also, it is essential to know the network's total number of nodes, so that the cluster count can be calculated. The nodes in the network are clustered in to $K_C$cluster count with the help ofthe k-means algorithm. Cluster Head is chosen based on the highest asset value 'C_a' and calculated using the given equation.

C_a =kl * N_E + k2/d_i + k3*n -------------- (1)

In the above equation, NE represents the node's residual energy, d_i is the measure for how far the node is from the Sink Node, and n represents the network's total node count. Weightage given to the above parameters are k1, k2, and k3.

Algorithm

Input: N_a, $N_{E,}$ I_E

Output: Cluster Head

Begin

Obtain the number of alive nodes N_a, update location;

The cluster formation based on location;

Estimate and calculate all node's energy N_a;

If (N_{IEN}< N_E || N $_{IEN}$ = N_{EN})
If (N_{DIS} < B_{DIS} || N_N = N)
Based on equation (1) choose a node with highest asset value as CH and assign a slot;
end
end
Observe the slot;
If a slot becomes available,
observe E_R to P (m);
If (P (m) > E_R)
Choose a Head node;
end
end
End procedure

Based on the three criteria of Residual Energy, Distance from the Base Station or Mobile Sink, and Number of Neighbors, the algorithm above selects the most effective sensor as the Cluster Head. In the algorithm N_{IEN} is the initial energy of the node, slots are allocated by comparing the initial energy and total energy N_E, if N_{IEN} is lesser than the $N_{E,}$ the distance between the current node N_{DIS} and B_{DIS} is compared and if the current node distance is lesser than the base node, The cluster leader is selectedand assigned slots accordingly.
The determination of sink node and the cluster head farness is computed in the Improved Mobile Sink Leach Protocol because the difference is directly proportional to the energy consumed.

Algorithm for IMS-LEACH
Input: P (m), E_R, N_i
Output: Relay Selection and Transmission
Begin
Initiate transmission a TDMA round and update the position of the node;
Search for a one-hop-distance neighbour node
If (N_R Ɛ N_i’s)
If (E_R> P (m))
Pick a node being relayed
end
end
If (N_R = dst)
Data are transmitted with help of CH
If (CH_B > MAX)
packets are transmitted to the temporary buffer
end
terminate the selection
End
Endprocedure

In the above algorithm, initially finds nearest neighboring node N_R from the list of neighbors N_i and then based on the threshold value the relay node is selected and the actual transmission is initiated.

Result Analysis

The proposed work is simulated using MATLAB simulator for network analysis and observation. The network parameters are based on Table 1.

Parameters	Value
Simulator	MATLAB
Simulation area	200 × 200m2
Node Count	100
Energy at the start	0.5 J
Rounds Count	1000
E_{elec}	50 nJ/bit
E_{fs}	10 pJ/bit/m^2
E_{mp}	0.0013 pJ/bit/m^4
E_{da}	5 nJ/bit/signal
Packet size	4000-bits

Table 1. Simulation Parameters

In Fig.2 illustrates the monitoring of the network, and nodes are evenly distributed in the entire region.

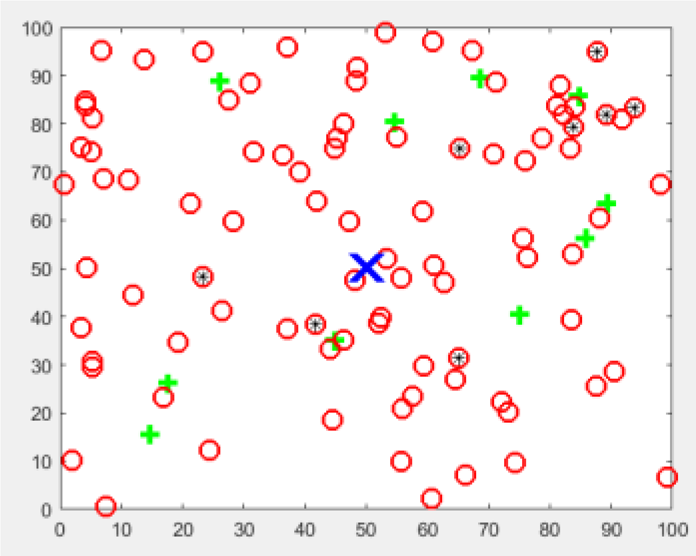
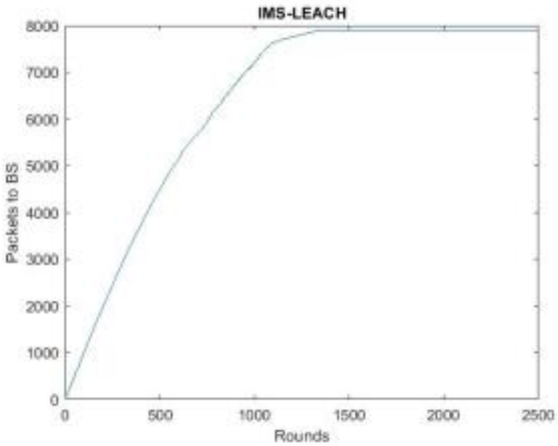
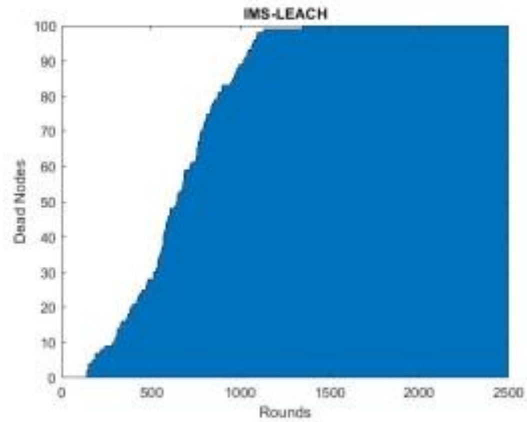


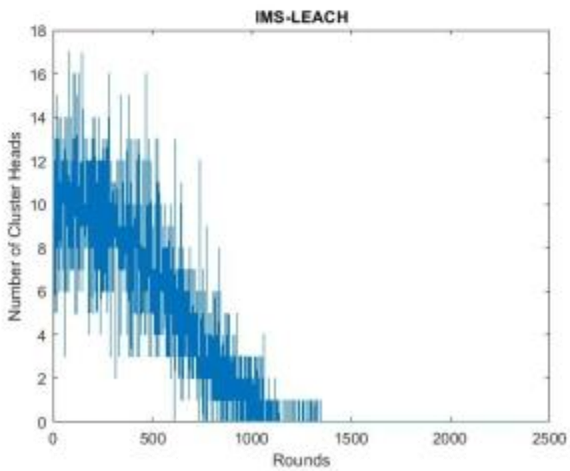
Fig.2 Clustered Scenario with CH nodes of a Network

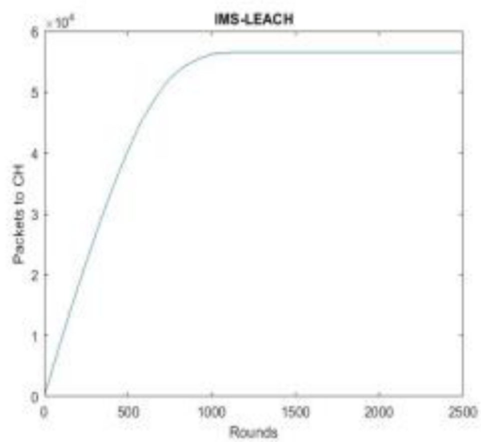
The cross blue denotes the mobile sink, and the oval-filled objects are cluster heads, and the green plus sign nodes are dead nodes.





(a) (b)





(c) (d)

Fig.3. Evaluation of IMS-LEACH based on packet transmission and cluster formation

In the above statistics fig 3. (a) displays how many packets there are transmitted to the sink node at each iteration. fig 3. (b) indicates the count of nodes that are no longer alive. And fig 3. (c) displays the total count of cluster heads and fig 3. (d) shows the count of packets transmitted to CH from the member nodes.

Conclusion

In the proposed work, we have observed that the Improved Mobile Sink LEACH protocol uses mobile sink other than static sink to overcome the problem of energy holes or hot spot near the sink. In addition, the protocol's cluster head selection is dependent on three parameters: residual energy, node count, and distance to the mobile sink. The proposed cluster head algorithm can select the cluster head based on the highest asset value based on the aforementioned parameters. The IMS-LEACH enhances by increasing the number of nodes improves node efficiency. sent from to the cluster head's member nodes, as well as from the cluster's main node to its sink node. Also, IMS-LEACH enhances the performance network'slife time and each node lifetime by 5% compared to LEACH protocol.

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