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Cluster Based Routing With Isolated Nodes in WSN

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Abstract – In designing a cluster based routing in WSN, formation of clusters plays a vital role. The poor design of cluster formation algorithm results in isolated nodes. The data sensed by the isolated nodes should be transmitted to the sink. In this paper, a new technique called Routing with Isolated Nodes (RIN) is proposed for the transmission of data from the isolated nodes to the sink. The proposed algorithm is implemented and evaluated. The simulation results show that the proposed algorithm performs better than the other existing algorithms in terms of energy and network lifetime.
Keywords— Cluster based Routing, Cluster Head, Energy, Isolated Nodes, Wireless sensor networks

I.   INTRODUCTION

Wireless Sensor Networks (WSN) is an emerging technology in the Wireless Network field which is consists of tiny nodes. These sensor nodes are self - energized and have low computation power. Battery is the primary power source in a sensor node [1]. A sensor node carries limited and generally irreplaceable power sources. Therefore to achieve high quality of service provisions, sensor network conventions must concentrate fundamentally on power conservation [2]. Clustering sensor nodes is a successful topology control technique to reduce energy consumption of the sensor nodes for maximizing lifetime of WSNs [3]. Clustering the nodes has many advantages, such as scalability, energy efficiency and reducing routing delay [4]. Cluster based routing involves the creation of clusters, election of cluster heads and routing through the Cluster Heads (CH). The energy can be conserved more by the CH by collecting the data in the cluster, compressing it and then transmitting the aggregated data to the base station [6]. The two imperative steps in clustering scheme are CH determination and cluster formation [5]. Improperly designed clustering algorithms can cause nodes to become isolated from CHs as shown in Fig. 1. Communication of these isolated nodes with the sink will consume more energy. If the sink is far away from these isolated nodes, then isolated nodes cannot directly communicate with the sink. If these isolated nodes are not in the range of nearby current cluster heads, then isolated nodes cannot communicate with the current cluster head also. The authors in Regional Energy Aware Clustering with Isolated Nodes (REAC-IN) considered the regional average energy and the distance from sensors to the sink and it determine whether the isolated node sent its data to a CH node in the previous round or to the sink. The drawback in this paper is if the previous round CH is far away than any other neighbor node of the isolated nodes, then it consumes energy for transmitting the message to the sink. Moreover, in their work, the distance from the isolated node to sink through relay node was considered. But if the relay node is CH of previous round, then once again CH has to transmit the data to its current CH which they have not considered.
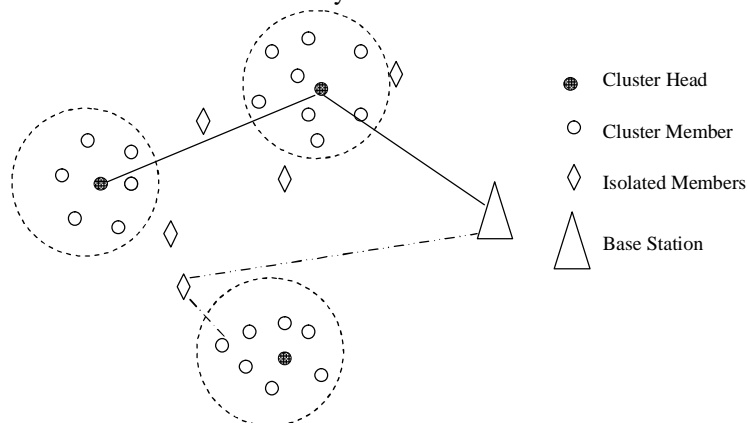

Fig.1. Wireless Sensor Network with Isolated nodes

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To overcome these issues of isolated nodes, in this paper, we propose a novel approach called Routing with Isolated Nodes (RIN) for conserving a lot of energy.   In this approach, each isolated nodes using fuzzy logic selects the node for transmitting its data based on the communication distance and energy of the nodes. The rest of this paper is organized as follows: In the next section, the research work carried out related to the proposed approach is briefly explained. In section 3, our proposed work is explained in detail. In section 4, evaluation of the proposed work and the detailed evaluation results and discussions are given. Finally, we concluded the paper with some future work in section 5.

II.   LITERATURE SURVEY

Many works carried out by the researchers on cluster based routing in the literature [7-9]. In LEACH [10], cluster head is selected based on the threshold considering a predetermined probability and in HEED[11], selects cluster heads randomly based on probability. Once the cluster heads are selected in these algorithms, the non cluster head nodes join the cluster head closest to them. If any of the nodes do not join with any of the cluster head then it is isolated from the network. However, it distributes cluster heads more uniformly across the sensor network by multiple iterations and smaller cluster ranges. At any iteration, each node can become a cluster head with its own probability when it is hearing no cluster-head-declaration from its neighborhood. A new regional energy-aware clustering method with isolated nodes for WSNs, called Regional Energy Aware Clustering with Isolated Nodes (REAC-IN) is proposed [12]. Based on the concept of LEACH, REAC-IN enables each node to consume energy uniformly by rotating the CH role among all nodes. REAC-IN selects the CHs based on the threshold involving the residual energy of each sensor and the regional average energy of all sensors in each cluster to try to evenly distribute CHs,. Furthermore, the regional average energy and the distance between sensors and the sink are considered to determine whether the isolated node sent its data to a CH node in the previous round or to the sink.

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III.   PROPOSED WORK

In this work, we proposed a novel routing technique for isolated nodes in cluster based routing called Routing with Isolated Nodes (RIN). In this technique, the isolated nodes transmit their data to the sink directly or through the neighbor node. The communication cost is the amount of distance from the isolated node to the sink or from the isolated node to the sink through neighbor node and cluster head. Let $Dist_{i,s}$ be the distance from the isolated node to the sink, $Dist_{i,n}$ be the distance from isolated node to the neighbor node, $Dist_{n,ch}$ be the distance from neighbor node to its cluster head and $Dist_{ch,s}$ be the distance from the cluster head to the sink. The isolated node send its data to the sink based on the communication cost and its residual energy.

A.   Routing With Isolated Node Algorithm
Step 1: Compute the distance between the isolated node directly to the sink and isolated node to the sink through neighbor node and cluster head.
Step 2: If $Dist_{i,s} < Dist_{i,n} + Dist_{n,ch} + Dist_{ch,s}$ and the residual energy is high then isolated node directly transmits its data to the sink.
Step 3: Else if $Dist_{i,s} > Dist_{i,n} + Dist_{n,ch} + Dist_{ch,s}$ and its residual energy is low then isolated node transmits its data to the sink through the neighbor nodes.
The main objective of this proposed work is to extend the lifetime of the network. To improve the lifetime, in this work the isolated node transmits its data to the sink based on the residual energy, more energy is conserved.

IV.   RESULTS AND DISCUSSIONS

The proposed RIN algorithm has been implemented using NS2. In this system, sensor nodes are randomly deployed over the given network area and the simulation parameters are given in Table 1. The proposed algorithm has been tested algorithm extensively and the experimental results are presented. The performance of the proposed algorithm is compared with REAC-IN and LEACH algorithm.

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TABLE I: Simulation Parameters

Parameter	Value
Area	200x200 m^2
Sensor Nodes	200
Initial energy	2J
Eelec	50 nJ/bit
ε_{fs}	10 pJ/bit/m2
ε_{mp}	0.0013pJ/bit/m4
Packet size	4000 bits

Fig. 1 shows the number of alive nodes for various algorithms. It is observed from the figure that the number of alive nodes for the proposed algorithm is more than the other existing algorithms. This is because for transmission the energy of the isolated nodes are also considered in addition to the distance to the sink.
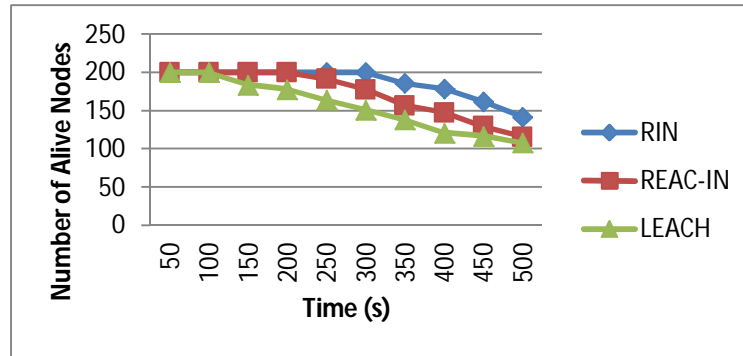

Fig. 2 The number of alive nodes

Fig. 3 presents the variance of the energy level for different experiments. From the figure it is observed that the proposed work conserves much energy and have very low variance when compared to other algorithms.
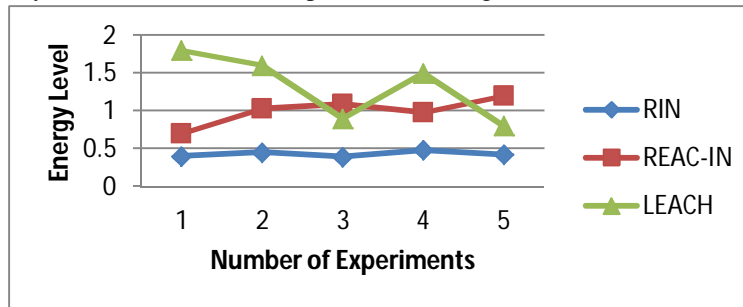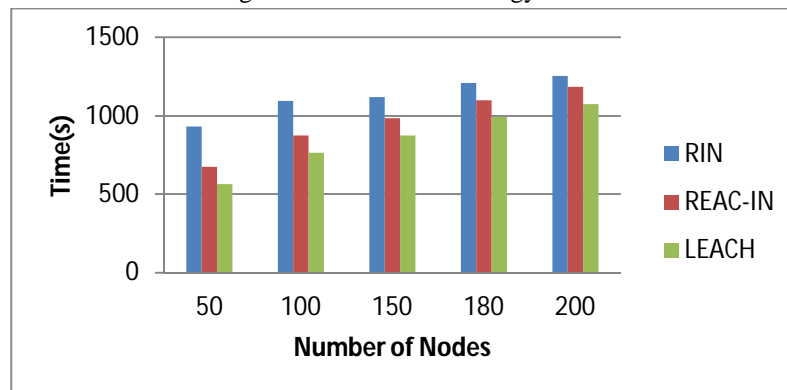

Fig. 3 The variance of Energy level

Fig. 4 Network Lifetime over Number of nodes

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In Fig. 4, the network lifetime over various numbers of nodes is presented. It is clear from the figure that the proposed work gives better system lifetime than the other existing algorithms. This is because the isolated nodes considers the distance and energy to transmit its data to the sink.

V. CONCLUSION

In this paper, we propose a new protocol for isolated nodes called Routing with Isolated Nodes (RIN). The isolated nodes in the cluster based routing transmit its data to the sink either directly or through its neighbor node. The distance from the isolated node directly to the sink or through neighbor node are evaluated and based on the residual energy the data is transmitted. The proposed algorithm is evaluated using NS2. From the simulation results, the performance of the proposed algorithm is examined with LEACH and REAC-IN. The results show that the proposed algorithm performs better than the other algorithms in terms of energy consumption and system lifetime.

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