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A Study and Performance Analysis of LEACH and LACBRP Routing Scheme in Wireless Sensor Network

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Abstract - Wireless Sensor Networks have formed new opportunities across the variety of human efforts including engineering design, forest fire tracking, and battlefield surveillance. It is a group of sensor nodes that comprised of sensing, computing, and communication elements that gives an administrator the ability to observe and react to events and phenomena in a specified environment. Minimizing Energy consumption is considered as one of the most important principles in the development of routing protocols for Wireless Sensor Networks (WSN). This research paper describes the characteristics of hierarchical routing scheme for sensor network Low Energy Adaptive Clustering hierarchy (LEACH) and Location Aware Cluster Based Routing Protocol (LACBRP) based on the performance matrices like Energy Values, Latency Values, Packet Delivery Ratio and Residual Energy Values. This comparative study proves that LACBRP performs well than LEACH routing scheme.

Keywords - *LEACH, LACBRP, Routing, Wireless Sensor Network.*

1. Introduction

Wireless Sensor Network (WSN) is a collection of sensor nodes, capable of collecting information from their environment. These nodes have the capability of sensing, computing, and wireless communicating. Wireless sensor networks are widely being used in different environments to perform various monitoring tasks such as search, rescue, disaster relief, target tracking and a number of tasks in smart environments. In many such tasks, Clustering is one of the fundamental challenges in wireless sensor network. Wireless Sensor Networks is a focused wireless network made up of a large number of sensors and at least one base station. The primary difference between the WSN and the traditional wireless networks is that sensors are extremely sensitive to energy consumption. Energy saving is the crucial issue in designing the wireless sensor networks [1]. In order to maximize the lifetime of sensor . nodes, it is preferable to distribute the energy dissipated throughout the wireless sensor network. So it is essential to design effective and energy aware protocols in order to enhance the network lifetime. In this paper, Low Energy Adaptive Clustering Based Routing (LEACH) and Location Aware Cluster Based Routing (LACBRP) which are the part of network structure protocol is carried out. Energy consumption and network life time has been considered as the major issues wireless sensor network (WSN) requires a huge breadth of knowledge from an enormous variety of disciplines, so its study becomes challenging [1].

By knowing [2] the location of a sensor node, cluster the sensor nodes based on the highest energy and least distance. In that group of nodes, one node is select as a Cluster head (CH). This is to avoid communication over head between the sensor nodes. Clustering of nodes shows that the network is more stable and efficient. This increases the overall network lifetime and reduces traffic of the network. Each node in a cluster can directly communicate with their Cluster head. The Cluster head can forward the sensed information to the Base station (BS) through other Cluster heads.

Sensor nodes are battery-constrained [2] and inexpensive nodes. They have limited communication, processing and memory storage resources. Each sensor node can act as a cluster head or a cluster member. A cluster member directly communicates with its cluster head; there is no communication between sensors. In other words, there is 1-hop communication between a node and the CH.

Further, Cluster heads can communicate with each other or directly to the base station, and there is multi-hop communication between the Base station and the Cluster head. This paper is categorized as follows. Section 1 presents the Introduction. Section 2 provides the overview of Routing protocols. Section 3 describes the simulation environment .Section 4 presents the Experimental results and Section 5 concludes the paper.

2. Overview of Routing Protocols

2.1 LEACH

It is Dynamic Hierarchical Routing for sensor network, called Low Energy Adaptive Clustering Hierarchy (LEACH). A routing protocol is considered adaptive if certain system parameters can be restricted in order to adapt to current network conditions and available energy levels. LEACH randomly selects a few sensor nodes as cluster heads (CHs) and rotates this role to evenly share out the energy load among the sensors in the network. In LEACH, the CH nodes compress data arriving from nodes that belong to the respective cluster, and send an aggregated packet to the BS in order to reduce the amount of information that must be transmitted to the BS. LEACH uses a TDMA/code division multiple access (CDMA) MAC to reduce inter cluster and intra-cluster collisions. However, data collection is centralized and performed periodically. Therefore, this protocol is most appropriate when there is a need for constant monitoring by the sensor network. A user may not need all the data immediately.

Hence, periodic data transmissions are unnecessary, and may drain the limited energy of the sensor nodes. After a given interval of time, randomized rotation of the role of CH is conducted so that uniform energy dissipation in the sensor network is obtained. The operation of LEACH is separated into two phases, the setup phase and the steady state phase. In the setup phase, the clusters are organized and CHs are selected. In the steady state phase, the actual data transfer to the BS takes place. The duration of the steady state phase is longer than the duration of the setup phase in order to minimize overhead. During the setup phase, a predetermined fraction of nodes, *p*, elect themselves as CHs as follows. A sensor node chooses a random number, r, between 0 and 1. If this random number is less than a Threshold value, T(n), the node becomes a CH for the current round. The threshold value is calculated based on an equation that incorporates the desired percentage to become a CH, the current round, and the set of nodes that have not been selected as a CH in the last (1/p) rounds denoted as G. it is given by:

$$T(n) = (p/(1-p(\mathrm{mod}(1/p)))) \text{ if } n \in G$$

Where, *G* is the set of nodes that are involved in the CH election. All elected CHs broadcast an advertisement message to the rest of the nodes in the network that they are the new CHs. All the non-CH nodes, after receiving this advertisement, decide on the cluster to which they want to belong. This decision is based on the signal strength of the advertisement. The non-CH nodes inform the appropriate CHs that they will be a member of the cluster. After receiving all the messages from the nodes that would like to be included in the cluster and based on the number of nodes in the cluster, the CH node creates a TDMA schedule and assigns each node a time slot when it can transmit. This schedule is broadcast to all the nodes in the cluster. During the steady state phase, the sensor nodes can begin sensing and transmitting data to the CHs. The CH node, after receiving all the data, aggregates it before sending it to the BS. After a certain time, which is determined a priori, the network goes back into the setup phase again and enters another round of selecting new CHs. Each cluster communicates using different CDMA codes to reduce interference from nodes belonging to other clusters.

Limitation: It is not applicable to networks deployed in large regions. It also assumes that nodes always have data to send, and nodes located close to each other have correlated data. It is not obvious how the number of predetermined CHs (*p*) is going to be uniformly distributed through the network.

2.2 LACBRP

The location aware cluster based routing uses three phases in wireless sensor networks. In the first phase, the location information of each sensor node is computed by using the localization algorithm such as Trilateration, Triangulation etc; in the second phase, the sensor nodes are clustered to minimize the residual energy and maximize the network performance then the Cluster head is elected based on the minimum distance between the cluster node's and the centroid; in the third phase, Routing takes place between the cluster head and the cluster members and also between the cluster head and the base station.

A. ***Location of Sensor node:*** The location information of each sensor node should be known to form a cluster in the wireless sensor network. The nodes which are deployed in the sensor network, knows their location information. The coordinates (xi, yi) of each sensor node are used to estimate the distance between two sensor

nodes. Trilateration is a geometric principle which is used to find a location, if their distances from other nodes are known. It computes a node's position via the intersection of three circles. To calculate the unknown node's location, trilateration uses the known locations of two or more reference points, and the measured distance between the unknown node and each reference point.

The distance between reference nodes is computed by using this formula:

$$\text{Distance}=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2} \quad \textbf{(1)}$$

Here, (x_1, y_1) and (x_2, y_2) are the coordinates of the reference node.

The new coordinate is computed by using this formula,

$$x=\frac{y(y_a-y_b)-v_b}{(x_b-x_c)} \quad \textbf{(2)}$$

$$y=\frac{v_b(x_b-x_c)-v_a(x_b-x_a)}{(y_a-y_b)(x_b-x_a)-(y_c-y_b)(x_b-x_c)} \quad \textbf{(3)}$$

Where,
x, y is the new coordinate.
V_a and V_b are the relative distance between two spheres.
x_a, x_b, x_c and y_a, y_b, y_c are the x and y coordinates of three reference points

B. *Cluster Formation:*
In the first step, randomly select c cluster head with their x_i, y_i coordinates. Then calculate the distance between each sensor node and the randomly selected cluster head and also get the energy of each node.

C. Cluster Head Selection:
After the formation of cluster, re-compute the centroid of the clusters resulting from the calculated distance. Calculate the centroid point of each cluster in the wireless sensor network. The centroid point is the new coordinate which is not equal to any position of sensor node in the wireless sensor network.

3. Simulation Environment

The aim of this simulation is to evaluate the characteristics of hierarchical routing scheme for sensor network Low Energy Adaptive Clustering hierarchy (LEACH) and Location Aware Cluster Based Routing Protocol (LACBRP) based on the performance matrices like Energy Values, Latency Values, Packet Delivery Ratio and Residual Energy Values. This simulation of Clustering is done in ns2. the Number of nodes considered here is 40.

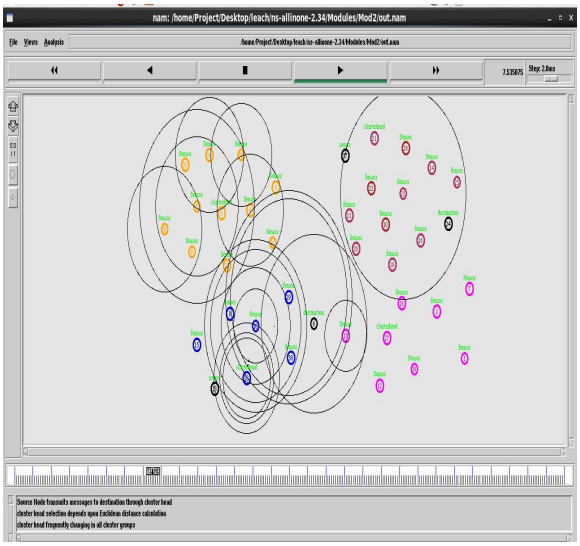

Fig. 1: Layout of LEACH Simulation

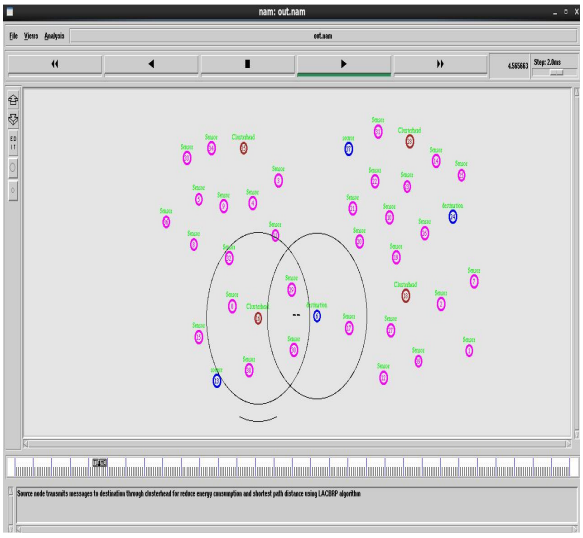

Fig. 2: Layout of LACBRP Simulation

4. Results and Performance Analysis

In this paper we have compared the performance of LEACH and LACBRP based on various factors. Now an analysis is made on the achieved results. based on various factors like percentage of Energy Values, Latency Values, Packet Delivery Ratio and Residual Energy Values during different mobility conditions.

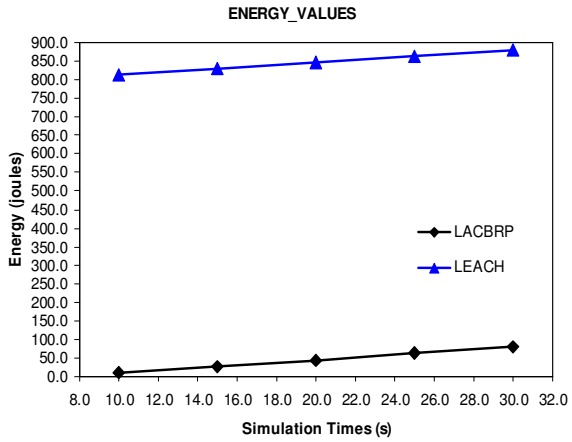

Fig3: Energy Values of LACBRP vs LEACH

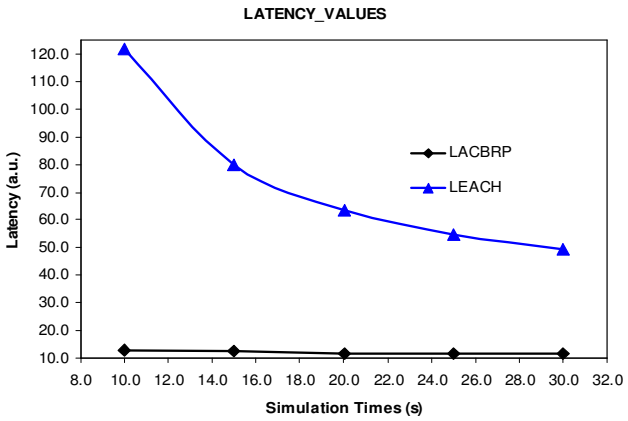

Fig. 4: Latency Values of LACBRP vs LEACH

From Fig. 3 it can be observed that the Energy Values of LACBRP is approximately ten times lesser than the LEACH values. From the Energy Values point of view the LACBRP performs better than LEACH. The Latency values of the LACBRP scheme also shows the smaller value in comparison to LEACH scheme as can be seen from fig. 4. The Residual Energy Values (fig. 5) and Packet Delivery Ratio (fig. 6) show higher values for LACBRP in comparison to LEACH. So from the above discussion it can be observed that the overall performance of the proposed scheme i.e., LACBRP is better than LEACH routing scheme.

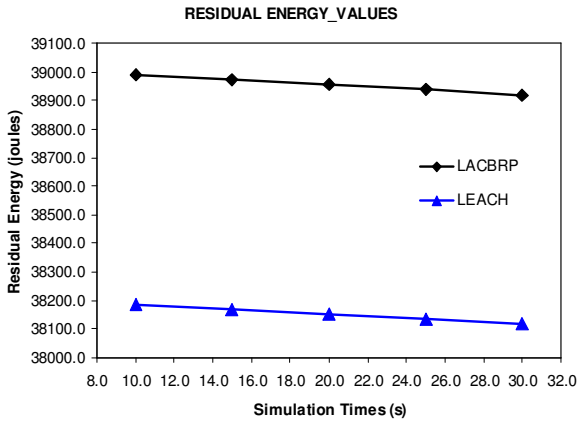

Fig. 5: Residual Energy Values of LACBRP vs LEACH

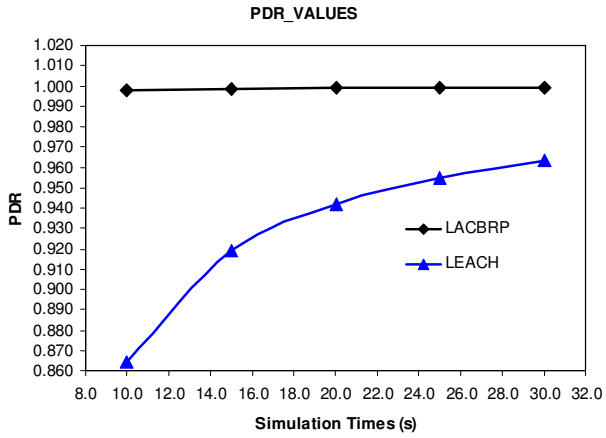

Fig. 6 : Packet Delivery Ratio Values of LACBRP vs LEACH

5. Conclusions

This paper presents the results of the experiments carried out on Wireless Sensor Network routing protocols LEACH and LACBRP. The performance analysis is made to verify the effect of mobility on the factors Energy Values, Latency Values, Packet Delivery Ratio and Residual Energy Values. Experimental results show that LACBRP better utilizes than LEACH routing scheme.

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