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Performance Analysis of Location Aware Cluster Based Routing Scheme in Wireless Sensor Network

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Abstract: *Wireless Sensor Networks have created new opportunities across the variety of human efforts including engineering design, forest fire tracking, and battlefield surveillance. It is a cluster of sensor nodes that comprised of sensing, computing, and communication elements that gives an administrator the ability to view and react to events and phenomena in a specified environment. Scheming of energy efficient routing protocols is significantly important in WSN. Design of an energy efficient and reliable routing protocols for mobility centric applications of WSN such as wildlife monitoring, battlefield surveillance and health monitoring is a great challenge because of the frequent changes in topology of the network. Clustering-based routing protocols has proven to be more useful in the context of energy efficiency where several sensor nodes in the communication range of one another form a cluster. Each cluster in WSN has a cluster head (CH), which coordinates all the nodes of a cluster. In WSN there may be a number of base stations (BS) also known as sink that communicate with other networks. In this paper a modified clustering algorithm has been used to cluster the sensor nodes based on highest energy and shortest path distance. Here we also evaluate the performance of this routing scheme based on the performance matrices like Energy Values, Latency Values, Packet Delivery Ratio and Residual Energy Values.*

Keyword: *WSN, Energy Values, Latency Values, Packet Delivery Ratio, Residual Energy Values*.

I. Introduction

Wireless Sensor Network (WSN) is a compilation of sensor nodes, able of collecting information from their environment. These nodes have the ability of sensing, computing, and wireless communicating. Wireless sensor networks are extensively 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 enormously sensitive to energy consumption. Energy saving is the essential issue in designing the wireless sensor networks [1]. In order to exploit the lifetime of sensor nodes, it is preferable to allocate the energy dissipated throughout the wireless sensor network. So it is crucial to design effective and energy aware protocols in order to enhance the network lifetime.

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 perform 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.

Clustering of the sensor nodes are formed by knowing the location of a sensor node, based on the highest energy and least distance. In the cluster of nodes, one node is selected as a cluster head (CH). Cluster head is formed to avoid communication over head between the sensor nodes. Clustering of nodes shows that the network is more stable and efficient. Clustering also 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 mainly battery-constrained and inexpensive nodes. They have limited communication, processing and memory storage resources. An individual sensor node can act as a cluster head or a cluster member. The cluster member can directly communicate with its cluster head. However, there is no communication between sensors. In other words, there is single-hop communication between a node and the CH. Further, the 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 I presents the Introduction. Section II provides the Proposed Scheme. Section III describes the simulation environment .Section IV presents the Experimental results and Section V concludes the paper.

II. Proposed Scheme

In this section, we present the working principle of our proposed LACBRP algorithm in several phases. The proposed algorithm works with the following assumptions.

- Once a node is selected as a CH, it remains in the same cluster.
- Initially, all sensors have the same energy.
- A node in each cluster is work only for localisation. This node is known as an anchors node.
- Sensors are heterogeneous in terms of their roles since they work as anchor nodes, cluster heads and cluster members.

The location aware cluster based routing, mainly uses three phases in WSNs. 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 to maximize the network performance, then the Cluster head is selected 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.

Sensors localisation is very important since without location information sensors data are meaningless for many WSN applications e.g wild fire detection. However, localizing mobile sensors nodes and keeping the updated location information of mobile nodes is a great challenge. This localisation approach uses sensing range to communicate with nodes, where a pair of nodes communicates each other only when their sensing circles intersect each other.

The location information of each sensor node should be known to form a cluster in the WSN. The nodes which are deployed in the sensor network, knows their location information. The coordinates (x_i, y_i) of each sensor node are used to estimate the distance between two sensor nodes. Based on minimum distance and highest residual energy, the sensor nodes are clustered by using modified clustering algorithm.

A node can compute its own position using any one of the localization method, if it possesses the information about distances or angles and positions,. Several methods can be used to compute the position of a node such as trilateration, multitrilateration, triangulation etc.

Trilateration is a geometric principle 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., Trilateration uses the known locations of two or more reference points and the measured distance between the unknown node and each reference point in order to calculate the unknown node's location. Moreover, in order to determine the relative location of a node accurately and uniquely using trilateration, at least three reference points are needed. The three reference nodes are assumed like a GPS enabled node.

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

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

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,

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

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

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,

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.

III. Simulation Environment

The aim of this simulation is to evaluate the characteristics of hierarchical routing scheme for sensor network Location Aware Cluster Based Routing Scheme (BSP) 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.

SIMULATION PARAMETERS:

```
#=================================
#        Simulation parameters setup
#=================================
set NS                  /home/Project/Desktop/leach/ns-allinone-2.34/ns-2.34/
set val(chan)           Channel/WirelessChannel          ;# channel type
set val(prop)           Propagation/TwoRayGround         ;# radio-propagation model
set val(netif)          Phy/WirelessPhy                  ;# network interface type
set val(mac)            Mac/802_11                       ;# MAC type
set val(ifq)            Queue/DropTail/PriQueue          ;# interface queue type
set val(ll)             LL                               ;# link layer type
set val(ant)            Antenna/OmniAntenna              ;# antenna model
set val(ifqlen)         50                               ;# max packet in ifq
set val(nn)             40                               ;# number of mobilenodes
set val(rp)             LACBRP                           ;# routing protocol
set val(x)              1407                             ;# X dimension of topography
set val(y)              732                              ;# Y dimension of topography
set val(stop)           30.0                             ;# time of simulation end
set val(em)             EnergyModel                      ;# energy model
set val(Energy)         1000                             ;#Joules
set speed               0.5                              ;#
set packet_size         811                              ;#
set interval .05                                         ;#
source $NS.ns1
#=================================
```

IV. Results And Performance Analysis

In this paper we have evaluated the performance of 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.

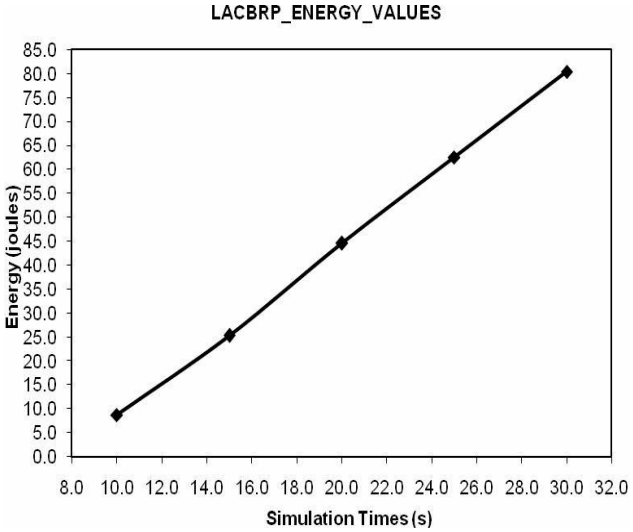

Figure 1: Simulation Time Vs Energy Values

The Energy Consumption Value at 10 sec Simulation Time is observed to be 8.777 for Proposed Location Aware Cluster Based Routing Algorithm, at 15 sec, 20 sec, 25 sec, 30 sec are 25.342, 44.595, 62.524, 80.417 respectively. So it can be clearly seen in Figure 1 that the variation of Energy Values with simulation time is increasing.

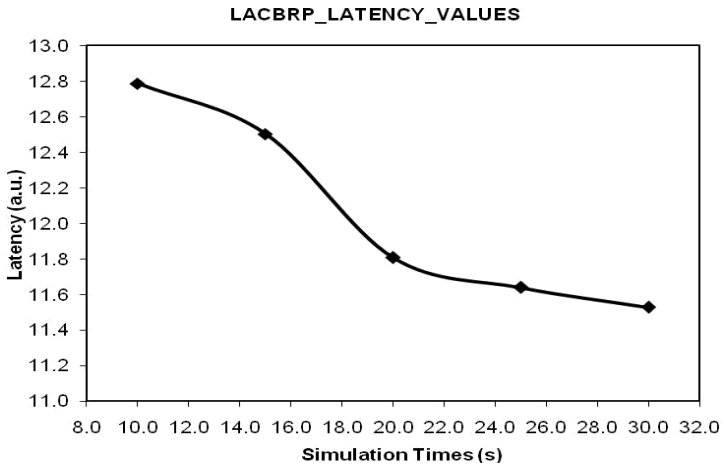

Figure 2: Simulation Time Vs Latency Values

Form the Figure 2 it is shown that the Latency Value at 10 sec Simulation Time is 12.7867. Then at 15 sec, 20 sec, 25 sec and 30 sec are observed to be 12.5031, 11.8059, 11.6385, and 11.5275 respectively. So from the above results we can say that the variation of Latency Values with Simulation Time is increasing

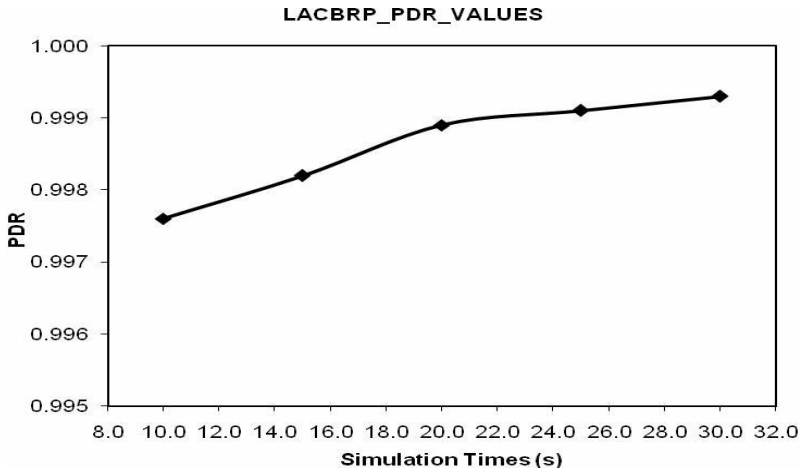

Figure 3: Simulation Time Vs PDR Values

Figure 3 shows the variation of Packet Delivery Ratio (PDR) values with simulation time from 10 sec to 30 sec at an interval of 5 sec. The PDR values are observed to be 0.9976, 0.9982, 0.9989, 0.9991 and 0.9993 respectively.

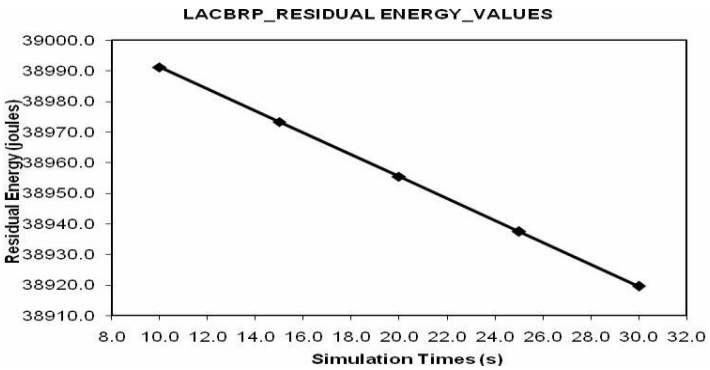

Figure 4: Simulation Time Vs Residual Energy Values

The Residual Energy Values at 10 sec Simulation Time is observed to be 38991.2 for Proposed Location Aware Cluster Based Routing Algorithm, at 15 sec, 20 sec, 25 sec, 30 sec are 38973.3, 38955.4, 38937.5, 38919.6 respectively.

V. Conclusions

In this work we have measured the performance of the Proposed Location Aware Cluster Based Protocol in terms of network energy consumptions and lifetime. Network energy consumption is defined as the total energy consumed by all the sensors nodes for routing data over a certain period of time. Network energy consumptions also reflect the lifetime of the network, that is, the remaining network energy since network energy consumptions is inversely proportional to the network lifetime. We have measured the end-to-end delay as the time that is required to transmit data from any source sensor node to the BS based on the traversed Euclidean distances. Another important parameter to measure the performance of a mobile routing protocol is the packet delivery ratio which is defined as the total number of packets received at the BS to the total number of packets transmitted by the senders. We have also measured the Residual Energy Values.

The present simulation represents the variation of different performance parameters for the Location Aware Clustering Scheme. Efficiently use of energy in the network has been the main issue in WSNs for prolonging lifetime of the network. This graph shows the Energy values, Latency values, Packet Delivery Ratio and Residual Energy Values using this algorithm. This shows the better performances of Energy values, Latency values, Packet Delivery Ratio and Residual Energy Values after using this clustering algorithm.

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