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Enhanced iMODLEACH for Maximum Energy Utilization in WSN

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ABSTRACT

In day to day life various types of applications has been established which are tremendously used in wireless sensor networks for various human activities like communication, supervision, sensing, deployment so on, on a valuable data. For this purpose number of sensing devices are used called sensors, a tiny electronic device. When these sensors are grouped called clusters. Each sensor has a life which depends upon the energy of a sensor, but the energy has a limit so during communication the energy of a sensor is used. There may be the failure of the network as battery life of a sensor vanishes. Number of clustering and energy efficient protocols are designed, one of them is iMODLEACH protocol (improved modified leach protocol) which is the improved and modified form of LEACH protocol designed by Heinzelman, et al. In iMODLEACH the performance of the network is determined only by varying the values of probality p (from 0.1 to 0.9), value of threshold h (from 100 to 800) and the value of soft threshold. This concept only performs the life time of the network and packets send to the base station but do not concentrate on the individual energy consumption and packet size transferred. In this proposed method we will further improve the performance and life time of a network by introducing the residual energy technique on individual sensor node in iMODLEACH and validates the performance by using different values of p, h and s. By varying these parameters we will determine that how and what values are improved and which varying value is directly/inversely proportion to the parameters (p,h,s) during rounds.

Keywords :— WSN, LEACH, iMODLEACH, Threshold, Clustering, Residual energy.

I. INTRODUCTION

A wireless sensor network (WSN) consist of hundreds to thousands of low power multi-functional sensor nodes work in an unattended environment and have sense, computation and communication ability. The basic components of a node are a sensor unit, an ADC (Analog to Digital Converter), a CPU (Central Processing Unit), a power unit and a communication unit. Sensor nodes are micro-electro-mechanical systems (MEMS) that make a computable response to a change in some physical condition related to temperature and pressure. Sensor sense or compute the physical data of the area to be monitor [5]. The frequent analog signal sense by the sensors is digitized by ADC and send to controller for further processing. Sensors nodes are of very small size, use extremely low energy, are operated in high volumetric densities and can be independent and adaptive to the environment. Wireless micro-sensor networks represent a new paradigm for extracting data from the environment. Conventional systems use large, expensive macro-sensors that are often wired directly to an end-user and need to be accurately placed to obtain the data. For example, the oil industry uses large arrays of geophone sensors attached to huge cables to perform seismic exploration for oil. These sensor nodes are very expensive and require large amounts of energy for operation. The most difficult resource constraint to meet is power consumption in wireless sensor networks. The use of wireless sensor networks is increasing day by day and at the same time it faces the problem of energy constraints in terms of limited battery lifetime. As each node depends on energy for its activities, this has become a major issue in wireless sensor networks. The failure of one node can interrupt the entire system or application. Every sensing node can be in active, idle and sleep modes. In active mode, nodes consume energy when receiving or transmitting data. In idle mode, the nodes consume almost the same amount of energy as in active mode. While in sleep mode, the nodes shutdown the radio to save the energy. Energy constraints end up creating computational and storage limitations that lead to a new set of architectural issues. A wireless sensor network platform must provide support for a suite of application-specific protocols that drastically reduce node size, cost, and power consumption for their target application.

The following steps can be taken to save energy caused by communication in wireless sensor networks.

- To schedule the state of the nodes (i.e. transmitting, receiving, idle or sleep).
- Changing the transmission range between the sensing nodes.
- Using efficient routing and data collecting methods.
- Avoiding the handling of unwanted data as in the case of overhearing.

In WSNs, the only source of life for the nodes is the battery. Communicating with other nodes or sensing activities consumes a lot of energy in processing the data and transmitting the collected data to the sink. In many cases (e.g. surveillance applications), it is undesirable to replace the batteries that are depleted or drained of energy [4]. Many researchers are therefore trying to find energy-aware protocols for wireless sensor networks in order to overcome such energy efficiency problems as those stated above.

All the protocols that are designed and implemented in WSNs should provide some real-time support as they are applied in areas where data is sensed, processed and transmitted based on an event that leads to an immediate action. A protocol is said to have real-time support if and only if, it is fast and reliable in its reactions to the changes prevailing in the network. It should provide redundant data to the base station. The base station or sink using the data that is collected among all the sensing nodes in the network. The delay in transmission of data to the sink from the sensing nodes should be small, which leads to a fast response [1],[4]. In this paper we will enhance iMODLEACH by using residual energy concept on it and check the performance of network by varying different parameters of the network like probability (p) and Thersholh(h,s).

The main objectives of this paper are

- To study the LEACH, MODLEACH and iMODLEACH clustering protocols.
- To get the better Cluster heads on the basis of residual energy with threshold energy.
- To achieve the better performance by varying value of p from 0.1 to 0.9.
- To achieve the better performance by varying value of s from 100 to 800.
- To improve the overall WSN life time and energy consumption.
- To compare different value of p and h.

II. SENSOR NODES

Wireless sensor networks (WSNs) consist of a large number of tiny, cheap, computational, and energy-constrained sensor nodes that are deployed in network service area and since it's nature is wireless , it is easy to add more sensor nodes or move deployed/mounted nodes for better coverage and reach . In a Wireless Sensor Network, the sensor nodes perform two main functions: sensing and relaying data. The sensing component is responsible for probing their environment to track a stimuli/target. The collected (sensed) data are then relayed to the gateway(s). Nodes that are more than one hop away from the gateway send their data through relaying nodes [6].

As wireless sensor nodes are typically very small electronic devices they can only be prepared with a limited power source. Each sensor node has a specific area of contact for which it can reliably and properly report the particular quantity that it is observing. Some sources of power consumption in sensors are signal sampling and conversion of physical signals to electrical ones, signal conditioning and analog-to-digital conversion. There are three categories of sensor nodes as:

(i) Passive, Omni-directional Sensors: Passive sensor nodes sense the environment without manipulating it by active analytical. In this, the energy is needed only to increase their analog signals and there is no concept of direction in measuring the environment.

(ii) Passive, Narrow-beam Sensors: These sensors are passive and they are concerned about the direction when sensing the environment.

(iii) Active Sensors: These sensors actively explore the environment.

Since a sensor node has limited sensing and computation capacities, communication performance and power, a large number of sensor devices are distributed over an area of interest for collecting information (temperature, humidity etc.). These nodes can communicate with each other for sending or getting information either directly or through other intermediate nodes and thus form a network, so each node in a sensor network acts as a router inside the network. In direct communication routing protocols (single hop), each sensor node communicates directly with a control center called Base Station (BS) and sends gathered information. The BS is fixed and located far away from the sensors [6].

BS can communicate with the end user either directly or through some existing wired network. The topology of the sensor network changes very repeatedly. Nodes may not have global identification. Since the distance between the sensor nodes and base station in case of direct communication is large, they consume energy quickly. In another approach (multi hop), data is routed via intermediate nodes to the base station and thus saves sending node energy.

III. LEACH

This section presents the working of LEACH protocol. Which is the base for all clustering protocol used in WSN, it is Low-Energy Adaptive Clustering Hierarchy protocol invented by W. B. Heinzelman et al. the working of the protocol depends upon the node type and the nodes in this protocol are divided into two types of categories as normal sensor nodes and cluster heads (CH). At first the normal sensor nodes are grouped together and form clusters and among all the sensor nodes in a cluster one node are selected as a CH node [2], [3].

The LEACH protocol also consist the concept of rounds. LEACH protocol during running uses many rounds. Each round is divided into two states: cluster setup state and steady state.

There are some drawbacks of LEACH protocol

- CHs selection is random, which does not take into account the residual energy of every node.
- The high frequency of selecting CHs wastes a certain amount of energy.
- It can't cover a large area. CHs are not uniformly distributed, where CHs can be located at the edge of the cluster.

IV. MODLEACH

This is the modified version of LEACH protocol. As LEACH gives birth to many protocols. The procedures of this protocol are compact and well coped with homogeneous sensor environment. According to this protocol, for every round, new cluster head is elected and hence new cluster formation is required [4]. This leads to unnecessary routing overhead resulting in excessive use of limited energy. If a cluster head has not utilized much of its energy during previous round, than there is probability that some low energy node may replace it as a cluster head in next cluster head election process.

Besides limiting energy utilization in cluster formation, we also introduce two different levels of power to amplify signals according to nature of transmission. Basically there can be three modes of transmission in a cluster based network.

1) Intra Cluster Transmission
2) Inter Cluster Transmission
3) Cluster Head To Base Station Transmission

When a node act as a Cluster head, routing protocol informs it to use high power amplification and in next round, when that node becomes a cluster member, routing protocol switches it to low level power amplification. Finally, soft and hard threshold schemes are also implemented in MODLEACH that gives better results.

MODLEACH performs better considering metrics of throughput, network life time, and optimized cluster head formation of network. MODLEACH is further improved by using the concept of soft and hard threshold.

V. IMODLEACH

This protocol is the improved version of MODLEACH, the improvement is done using different parameters and their comparison. The Parameters like p (probability of choosing a CH), s (software threshold) and h (hard threshold) which have been used in this protocol to further enhance the performance of the MODLEACH protocol. By varying the values of the p,s and h parameters and analyzed their effect on the performance of the network [1]. This shows some better improvement over MODLEACH.

VI. PROPOSED METHOD

This section represents the overall idea about the proposed method and the objectives that we are achieving in our research. The proposed method uses the iMODLEACH protocol and enhanced the protocol by implementing residual energy and by varying the probability (p) and hard threshold (h) from 0.1 to 0.9 and 100 to 800 respectively.

VII. RESULT AND DISCUSSION

In this section the comparison of proposed technique is discussed. The comparison will show the improvement on network life time.

The evaluation and the implimentation is done in MATLAB. The simulation has been peformed in the network of 100 nodes and are placed randomly in the network. The nodes are in the diameter of field 400m x400m.

The different parameters and their values used in the network is shown Table 1.

TABLE 1: PARAMETERS USED

Parameter	Values
Area (x, y)	400,400
Base station (x, y)	200,200 or mobile
Nodes (n)	100
Probability (p)	0.1
Initial Energy	0.5J
Transmitter energy	$50*10^{-9}$
Receiver energy	$50*10^{-9}$
Free space(amplifier)	$10*10^{-12}$
Multipath(amplifier)	$0.0013*10^{-12}$
Effective Data aggregation	$5*10^{-9}$
Maximum lifetime	2500

After applying the residual energy technique on iMODLEACH the comparison of different metrics of the protocols are shown below.

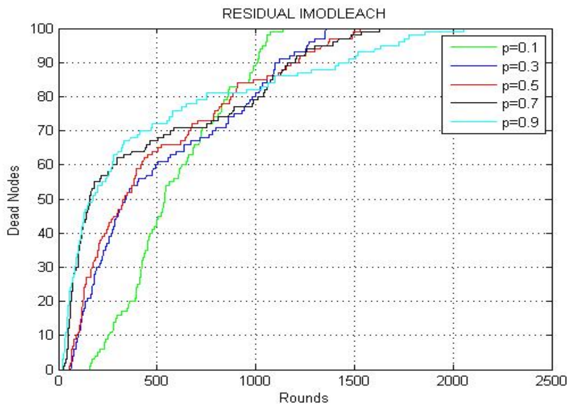

Fig 1 Compressions of dead nodes of the network

Figure 2 shows that the alive node.

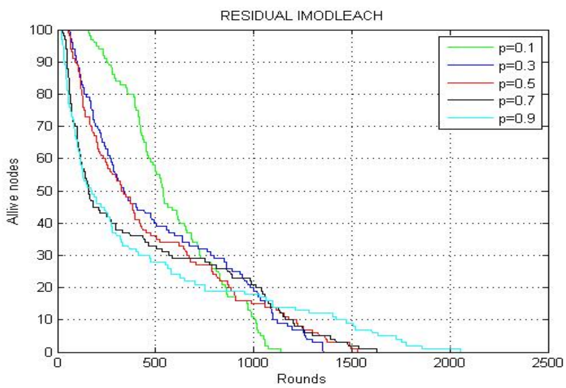

Fig 2 Comparison of Alive nodes of the network

Fig 3 shows comparison for packet to BS.

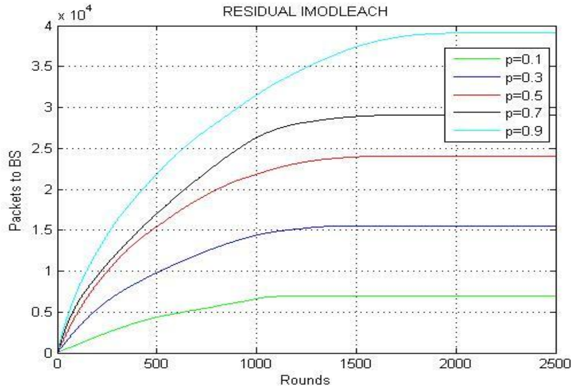

Fig 3 Comparison for packet to BS

Fig 4 shows comparison for packet to BS.

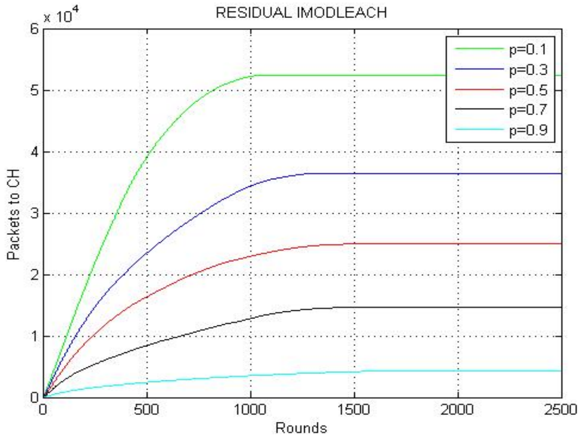

Fig 4 Comparison for packet to CH

Fig 5 shows comparison for number of CHs.

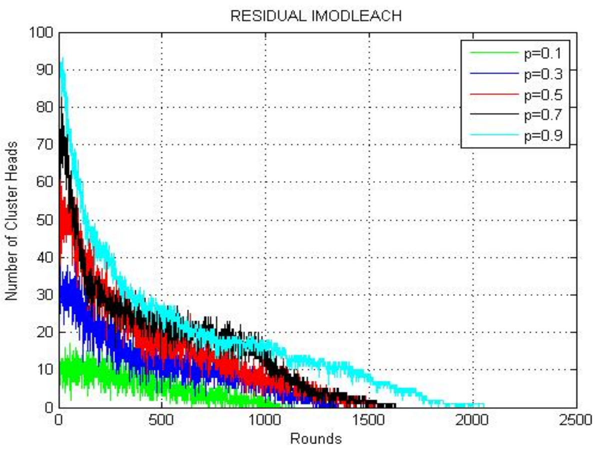

Fig 5 Comparison for number of CHs

The varying vales of h from 100 to 800 are shows below the implementation is at p=0.1

Fig 6 shows comparison for alive nodes.

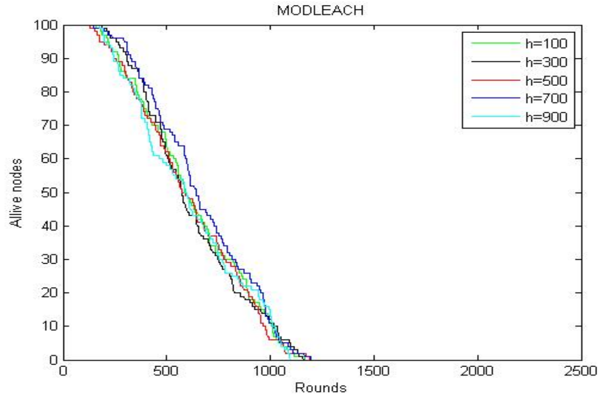

Fig 6 Comparison of Alive nodes of the network

Fig 7 shows comparison for packets to BS.

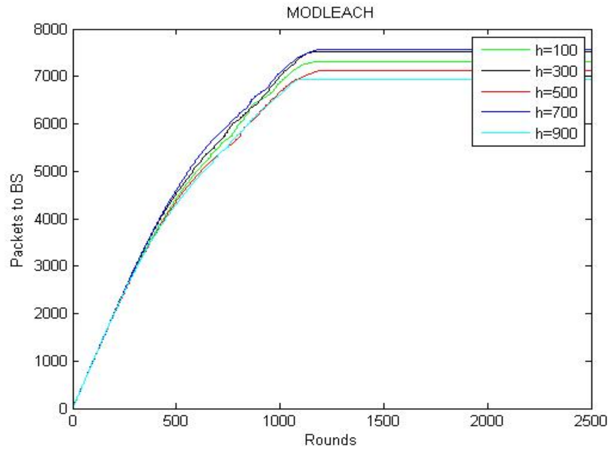

Fig 7 Comparison for packet to BS

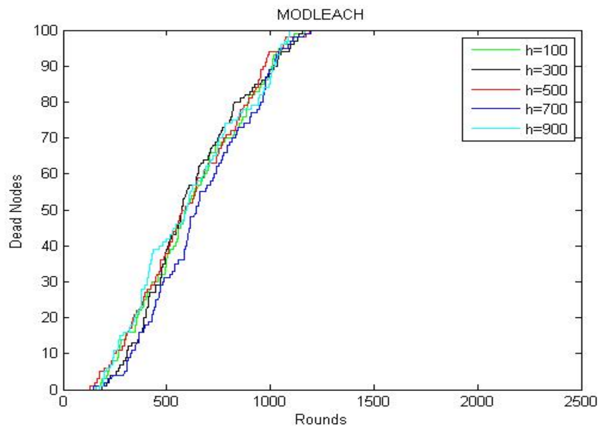

Fig 8 Compressions of dead nodes of the network

VIII. CONCLUSIONS

In this paper we implement the enhanced iMODLEACH with enhanced residual energy for better performance of the network. We consider the values of probability and the threshold p and h and checkout the performance and the network life time by varying values.

ACKNOWLEDGMENT

The about contents and research method we used is true to our knowledge and the result at every step we concluded is according to our research work.

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