Efficient Ch-Selection Method for Pegasis-Mh Protocol In Wireless Sensor Network For Lifetime Improvement

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***Abstract*: Wireless Sensor Networks have limited resources with traditional data gathering techniques Sensor nodes are energy-constrained devices and the energy consumption is generally associated with the amount of gathered data, since communication is often the most expensive activity in terms of energy. For that reason, algorithms and protocols designed for Wireless Sensor Networks should consider the energy consumption. In this paper, a modified algorithm for Power-Efficient Gathering in Sensor Information Systems-Multi Hop (PEGASIS-MH) is proposed. The modified protocol called "Enhanced PEGASIS-MH protocol (EPEGASIS-MH) for WSN" is aimed at prolonging the lifetime of the sensor networks by balancing the energy consumption of the nodes. The enhanced version of PEGASIS-MH uses these approaches CH-selection method for Cluster head selection and Minimum Euclidean distance and Energy index of node is used to select the cluster head (CH). The performance of EPEGASIS-MH with that of the PEGASIS-MH protocol is compared using simulations. Simulation result shows that EPEGASIS-MH improves the network lifetime over PEGASIS-MH.**

Keywords: Wireless sensor networks, EPEGASIS-MH, routing protocols, Energy Efficiency, PEGASIS-MH.

I. INTRODUCTION

Wireless Sensor Networks [4] communicates over a short distance through wireless channels for information sharing and cooperative processing to accomplish a common task. The unique feature of sensor networks is the cooperative effort of sensor nodes. Sensor nodes are embedded with an onboard processor. Instead of sending the raw data to the nodes responsible for the fusion, they use their processing abilities to locally carry out simple computations and transmit only the required and partially processed data. Currently, wireless sensor networks are beginning to be deployed at an accelerated pace, with unlimited potential for numerous application areas including environmental, medical, military, transportation, and homeland defense.

In general, based on the network structure routing in wireless sensor network can be flat-based, location-based and hierarchical. In hierarchical-based [8] routing, nodes will play different roles in the network. The main aim of hierarchical routing is to efficiently maintain the energy consumption of sensor nodes by involving them in multi-hop communication within a particular cluster. Here data aggregation and fusion is performed in order to decrease the number of transmitted messages to the sink. Each protocol is adapted to a specific situation and must take into account the type of the application.[9][10]

The expectancy of longer lifetime of sensor nodes has put researchers to work on every possible aspect of sensor nodes in gaining energy efficiency. PEGASIS-MH is one of the widely used Greedy based approach used for chain formation multi-hop hierarchical routing protocol for sensors networks. In the following section, we will describe PEGASIS-MH protocol. To avoid the shortcomings of PEGASIS-MH protocol here new EPEGASIS-MH protocol is proposed to reduce average energy consumption of network and enhance the network lifetime.

II. RELATED WORK

Here a brief overview of PEGASIS-MH protocol and its advantages and shortcomings are described.

A) PEGASIS-MH Protocol:

Zibouda Aliouat, Makhlouf Aliouat introduced PEGASIS-MH [1] protocol follows an approach based on the clusters and chains. This protocol is a more efficient combination of the well known protocols hierarchical LEACH and PEGASIS.

In PEGASIS-MH protocol, an improvement to PEGASIS hierarchical protocol allowing the use of multi-hops routing between the cluster-heads (say inter-clusters multi-hops routing) in order to attain the BS with minimum energy cost. In PEGASIS hierarchical protocol, because the CHs located far from the base station are prone to rapidly deplete their energy budget since they must use strong signals to reach BS. Fig. 1 shows PEGASIS-MH Topology. . In PEGASIS-MH when a cluster head is too far from the sink node it searches for nearby cluster head in order to route to the sink, so that the cluster head loses minimum energy in routing. So PEGASIS-MH as per Zibouda Aliouat it only searches and chooses cluster head based only on minimum distance.

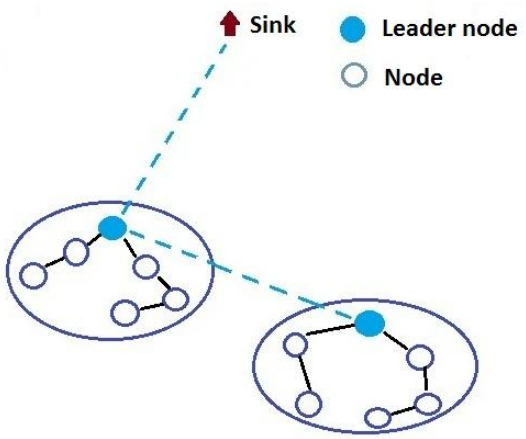

Fig 1: PEGASIS-MH Topology

PEGASIS-MH protocol working Phases:

A) Announcement Phase

Out of ALL nodes 5% of node got selected as CH

B) Intra-Cluster formation Phase

Remaining node send membership request to nearby CH to form chain and transmit data.

C) Inter-cluster formation Phase

It only searches and chooses CH based on minimum distance for multi hop routing.

D) Data Transmission Phase

Transmit data towards sink.

B. Advantages of existing protocol:

1. Transmission distance for most of the node is reduced.
2. Applicable to networks deployed in large regions.
3. Greedy based approach used for chain formation multi-hop hierarchical routing protocol increases lifetime of the network.

C. Limitations of existing protocol:

In PEGASIS-MH when Inter-cluster formation phase is performing a cluster head which is too far from the sink node searches for nearby cluster head in order to route to the sink, so that the cluster head loses minimum energy in routing. PEGASIS-MH only searches and chooses cluster head based only on minimum distance.

1. The CHs are selected randomly and Residual Energy of the node is not considered for cluster formation.
2. No. of CHs are predefined i.e. 5% of total nodes. It might not be sufficient to cover entire area when sensor nodes are not uniformly distributed.
3. It assumes that nodes always have data to send & the nodes including CH are started with the same initial energy.

III. PROBLEM IDENTIFICATION AND WORK DONE

The most restrictive factor in the life-time of wireless sensor network is limited energy resource of the deployed sensor nodes. Goal of this work is to propose a routing protocol with cluster heads selection method that efficiently manage energy budget of sensor nodes leading to increase the whole WSN life time.

Limitations of existing protocol And Parameters to work on for proposed technique are as follows:

1. In PEGASIS-MH when Inter-cluster formation phase is performing a cluster head which is too far from the sink node searches for nearby cluster head in order to route to the sink. EPEGASIS-MH considers least distance from the center of cluster as a criterion for a node to be chosen as a CH during cluster head selection procedure (from second round onwards).
2. PEGASIS-MH protocol does random selection of CH, This again may lead to very poor selection of CHs which will consequently lead to highly inefficient energy retention by the network. EPEGASIS-MH considers Energy index of node to choose CH. It selects CH with high energy index.

Energy index of nearby CH is calculated by.

$$Ein = \frac{Eresidual}{Etx} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where, E (in)-energy index

E (residual)-remaining energy

E_{tx} -Transmitting energy

Proposed protocol working Phases:

A) Announcement Phase

Out of ALL nodes i.e.: 5% (p %) of node got selected as CHs, *r* is the current round in equation.

$$T(n) = \frac{p}{(1-p)(rmod\frac{1}{p})} \quad \ldots\ldots\ldots (2)$$

B) Intra-cluster formation phase:

If node is not CH

1. Send membership request to selected CH.
2. Find nearby neighbor in the cluster.
3. Send Data to neighbor.

C) Inter-cluster formation phase:

If node is CH

1. Wait for membership request.
2. Find nearest CH towards BS based on Distance and Energy index of Next CH; Select the CH which has high energy if distance is same.
3. Aggregate Data in CH.
4. Transmit data towards BS.

D) Data Transmission Phase

Transmit data towards sink.

A. RADIO ENERGY DISSIPATION MODEL

The following Radio Energy Dissipation Model [7] is used by traditional protocol as well as by the proposed protocol. In this model, the transmitter dissipates energy to run the radio electronics and the power amplifier, and the receiver dissipates energy to run the radio electronics. Thus, to transmit *k*-bit message a distance *d*, the radio expends:

$$E_{Tx}(k,d) = E_{Tx\text{-}elec}(k) + E_{Tx\text{-}amp}(k,d)$$

$$E_{Tx}(k,d) = E_{elec}*k + \epsilon_{amp}*k*d^2 \quad \ldots\ldots (3)$$

And to receive this message, the radio expands:

$$E_{Rx}(k) = E_{Rx\text{-}elec}(k)$$

$$E_{Rx}(k) = E_{elec}*k \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where,

- E_{elec} = Energy dissipation for electronic device
- ϵ_{amp} = Energy dissipation for transmit amplifier
- k = Packet size in bit
- d = Distance
- E_{tx}=Transmitting energy
- E_{rx}=Receiving energy

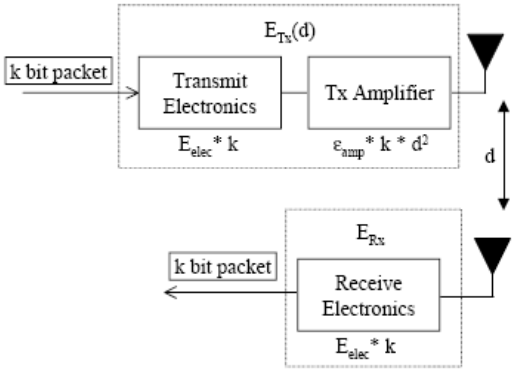

Fig 2: Radio Energy dissipation model [7]

The electronics energy (E*elec*) depends on factors such as the digital coding, modulation, filtering, and spreading of the signal, whereas the amplifier energy depends on the distance to the receiver and the acceptable bit-error rate.

B. SYSTEM MODEL

There are several assumptions that are considered in PEGASIS-MH protocol, so we will also focus on these assumptions in our proposed technique [1][2]:

(1) Nodes are location-aware, i.e. equipped with GPS capable antenna.
(2) Nodes are left unattended after deployment. Therefore, battery re-charge is not possible.
(3) All the nodes are homogeneous and immobile.

IV. SIMULATION AND RESULTS

Here the simulation is performed in NetBeans-Jprowler and the outputs have collected after specific number of rounds. The same simulation parameters are used for both PEGASIS-MH and EPEGASIS-MH to simulate it. Fig.3: shows Enhanced PEGASIS-MH Protocol Flowchart.

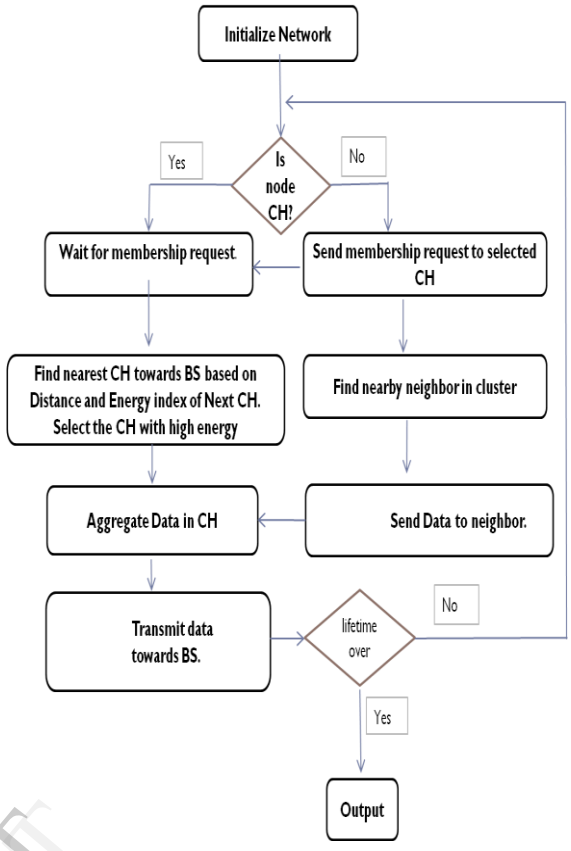

Fig.3: Proposed (EPEGASIS-MH)Protocol Flowchart

We ignore the effect caused by signal collision and interference in the wireless channel and the radio parameters used are shown in Table-1. The simulation parameters and the results of simulation are shown below.

TABLE I
SIMULATION PARAMETERS

Parameter Name	Value
Network area	600m*600 m
No. of nodes	100
No. of clusters	0.05
Initial Energy	5 joule/node
Sink location	(x=300m,y=20m)

In the simulation, we compared the performance of our proposed EPEGASIS-MH algorithm with PEGASIS-MH, PEGASIS, and LEACH Protocols. In simulation results, we evaluated the wireless sensor network life duration. The network life time is nothing but the number of rounds performed.

The WSN life time is defined by using three metrics: FND (First Node Dies), HNA (Half of the Nodes Alive), and LND (Last Node Dies). This context complies with the metric FND i.e. the elapsed time until the first sensor comes to a halt.

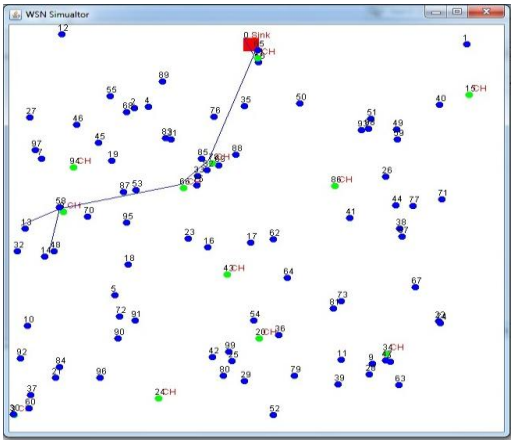

Fig. 4: EPEGASIS-MH Protocol after 1st round, with 100 nodes for 600m*600m network. Green nodes represents the cluster heads (CHs), Red square is sink

Above fig.4 shows the clustering after 1st round for EPEGASIS-MH algorithm. Fig.5 Graph shows the network life time for the four protocols: LEACH, PEGASIS and PEGASIS-MH and Enhanced PEGASIS-MH. Latency graph show numbers of rounds performed for number of nodes for each protocol.

Table-2 shows improvement of Enhanced PEGASIS-MH compared to PEGASIS-MH. Fig.6 shows this comparison in terms of FND, HND and LND in graph.

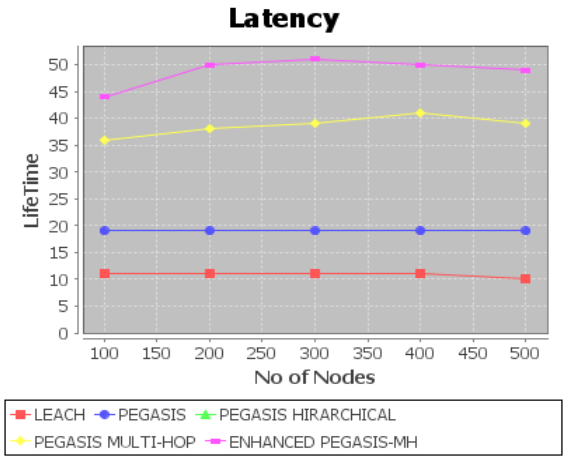

Fig 5: Latency (Network Lifetime) Graph

TABLE II
IMPROVEMENT OF EPEGASIS-MH COMPARED TO PEGASIS-MH

Protocol	FND (First node dies)	HNA (Half Nodes Alive)	LND (Last node dies)/ (5% alive node)
PEGASIS-MH	39	38	41
EPEGASIS-MH	51	48	44
Improvement	13.07%	12.63%	10.73%

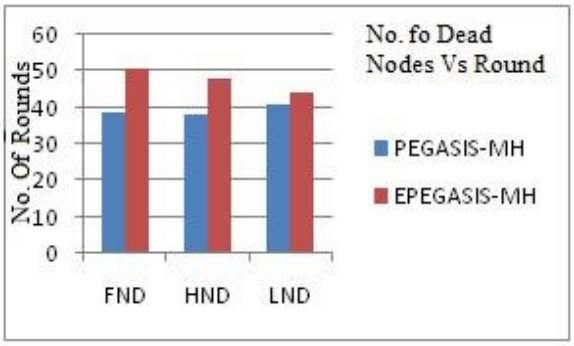

Fig. 6: Comparison of PEGASIS-MH and EPEGASIS-MH results

V. CONCLUSIONS

Wireless sensor network is an innovative research area for various disciplines of science, information technology and communication, The goal of our work was to devise a routing protocol managing efficiently the energy budget of sensor nodes leading to increase the whole WSN life time. In this Paper we observed the performance of Enhanced PEGASIS multi-hop routing protocol for wireless sensor network, and also it has been compared with available traditional algorithm like LEACH, PAGASIS, and PAGASIS-MH.

According to results, parameters like distance between two nodes, and energy index of node make a huge impact on the network lifetime of wireless sensor network. Results shows that proposed algorithm is efficient than traditional algorithm in terms of network life time. As result one can clearly observe that performance of Enhanced PEGASIS-MH was improved by 10 to 13 % compared to other protocols like PAGASIS-MH.

In future one can get performance of this work with sleeping mode mechanism for sensor nodes not participating in routing. As well as try to include network traffic parameter.

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