Balanced Energy Efficient Hierarchical Tree Based Routing Scheme in Wireless Sensor Network

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***Abstract*—Wireless Sensor Network (WSN's) has many applications which collects sensitive data from the environment and forwarded it to the data processing centre for further processing. Resource limitation is important component for designing of the WSN which include energy as a prime factor. Unbalance energy consumption is inherent problem in WSN. This paper proposes a new routing algorithm FGSTEB based on the existing GSTEB routing protocol in coordination with the fuzzy approach. This method finds optimal hierarchical route from child node to base station with minimum energy consumption as compared to previous routing protocols which helps to improve the network lifetime. To demonstrating the proposed concept we compare our protocol with basic hierarchical routing protocol. Simulation result demonstrate the proposed system perform better than existing protocol.**

Keywords:-Energy efficiency, Fuzzy rule, Hierarchical routing, Wireless Sensor Network

I. INTRODUCTION

Wireless sensor network is network of small, low powered, inexpensive wireless sensors which are densely deployed in the large region where the human existence is not possible [1]. These sensor nodes collect the data from such hostile environment periodically or iteratively and it continuously monitors the environment to sense generated data. This generated data transferred to the Base Station (BS) with different routing mechanism such as flat routing , sequential routing, hierarchical routing or location based routing . These routing techniques are mostly used in the transferring the generated data from the different wireless sensor node deploy in the environment to the sink node i.e. the Base Station node which is present at some specific region where all the data gathered for further experimentation purpose[2].

For all these stuff the energy is the important parameter when we consider the wireless network rather than wired network, because there is no such energy source present in wireless sensor network which can provide the energy to the sensor node for long time. Hence there is a need of minimizing the energy consumption or improving the power utilization of components or the techniques used in WSN. The energy consumption can be reduced at large extent by using most efficient routing scheme. As mention earlier the hierarchical routing mechanism is most energy efficient than other approaches. In the hierarchical routing wireless node forms a multi hop tree structured route from itself to the base station using the data fusion. Data fusion means the data of the child node is fused with the data of its parent node till the base station [2][3][4].

There are so many protocols are already implemented on tree based Hierarchical model of data fusion transmission technique. PEGASIS, PEDAP, TEEN, APTEEN, GSTEB and TBC are the protocols based on this assumption and perform far better than LEACH and HEED protocol. The LEACH and HEED are the basic protocol of this family. The length of the message which is sends from leaf to BS is consistent i.e. every node transmits same measure of information regardless of the amount of information it gets from its leaf node and sends forward in the same manner. Energy consumption in a sensor node is due to either "useful" or "wasteful" work. The useful work include transmitting or receiving data messages from other nodes ,and processing requests of nodes .On the other hand, the wasteful energy consumption is due to the work of construction of routing tree, overloading, retransmission of data because of harsh environment, dealing with redundant broadcast and idle listening to the media[6-10].

The Hierarchical routing structure is shown in the fig 1. The WSN forms the hierarchy of the routing path from each child node i.e. leaf node to its parent and from respective parent to the Sink node

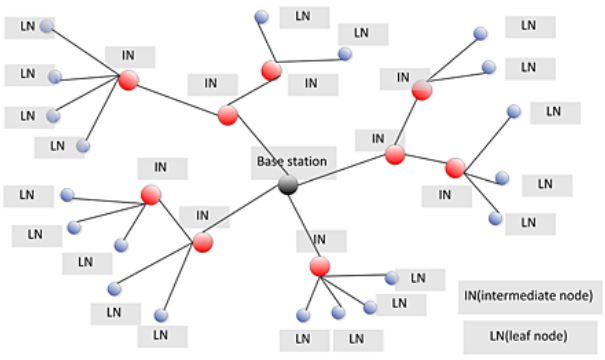

Fig 1: Hierarchical tree structures in Wireless Sensor Network

In this paper we propose a new protocol called as FGSTEB which is the extension of a General Self-Organized Tree based Energy Balance routing protocol (GSTEB). Here we used

Fuzzy rules for reducing the energy consumption in the routing procedure of the existing GSTEB protocol which result in the improvement of the network life time [5].

The remainder of the paper is organized as follows: Section II reviews related works. The network and system models of our proposal are discussed in Section III. Section IV describes the architectures and details of FGSTEB. In Section V we present our simulations in contrast to the simulations of other routing protocols. At last in Section VI we conclude the paper.

II. RELATED WORK

Normally the work of the Wireless sensor network is to periodically or iteratively collect the data from the environment and send it for further processing to the base station using hierarchical routing. The simple method for sending the data is direct transmission from child to BS. But the problem is that the BS is far away from the leaf node due to which the lots of energy consumption is occur for reducing the energy consumption different protocols are already implemented these are LEACH, HEED, PEGASIS, TBC, GSTEB, PEDAP,TEEN,APTEEN[1][6-10].

In LEACH protocol the cluster heads are selected according to the fraction parameter using this fraction all nodes can serve as a CH in particular round of data transmission. Each round is consist of two phase setup phase and steady state phase , In setup phase each node decide to become CH according to predefined value. After the setup phase other node which are near to the cluster head and send data to it and Custer node forward the fused data to BS Communication from the CH to BS is one hop which somewhat reduces the consumption but not on large extent because BS is far away from the CH and there is singe hop communication in between them [11].

HEED protocol is the improvement of the LEACH protocol itself in which the CH selection technique is different. The Cluster head is selected using the residual energy of each node and node proximity i.e. node degree. There is one CH in certain range results in uniform distribution of the nodes. As compared to the LEACH HEED protocol consumes less energy [12].

In PEGASIS uses greedy method for sending data from leaf node to BS. It structures a chain of node sending the information in combined way. Here the (i mod N)th hub is picked as a CH and the CH is the particular case that correspond straightforwardly with BS in round i. N is the number of nodes. Data gathering began from both endpoints of the chain, and transmitted along the chain till cluster head, and combined every time when it transmits starting with one node then onto the next until it reaches to the CH [13].

In GSTEB data transmission is perform using the multi hop communication from node to BS using intermediate node i.e.CH. The CH act as a relay node in the transmission. The selection of CH is same as the HEED protocol buy using the residual energy of the node and the geographic location of the sensor node. In GSTEB the BS sends its location to the every node of the network and initiates the routing procedure each node finds its neighbours and maintain table of it. The largest energy of the node from the neighbours table consider as a parent. In such away each node finds its parent using energy level and location of the BS [2].

Tree based clustering (TCB) is also improved version of LEACH. The network is divided into several clusters and each cluster is associated with CH. Nodes in the cluster forms a tree within cluster and CH act as a root node. Each node of the network is location aware, it can estimate the distance from root and itself. The clusters are divided into some layers on the basis of distance between node and root. The CH is at level 0 and node in level L (i) will choose the node in L (i)-1 and nearest to itself as its parent node. TCB is best protocol in which each node maintains their neighbour's information and construct the routing tree as in the GSTEB protocol but some cluster-heads in the network consume more energy than other nodes when BS is located far away[14].

These hierarchical routing protocols are consuming less energy than other routing methods. This work also performs with the help of fuzzy concept which reduce the energy consumption and improve the network lifetime in large extent by applying the different fuzzy rules in the routing mechanism.

III. SYSTEM MODEL

In this work, the topology of wireless sensor network is modelled as a directed graph G (N, A), where N is the set of nodes, and A is the set of links from nodes to node which forms a routing path. In this work we assume that the sensor nod has following properties.

- N sensor nodes are randomly placed in the 1000*1000 square area and BS deployed far away from the area.
- Nodes are stationary and having limited energy. Once deployed in environment they will keep operating until their energy is exhausted.
- BS is stationary, but it's not energy constrained.
- All sensor nodes have power control mechanism; each node can change its power level and communicate with BS directly.
- Sensor nodes are location-aware. All sensor nodes can get there location information through GPS or position algorithms.
- Each node has its unique identifier (ID).

IV. PROPOSED WORK

In this work we are designing energy efficient and routing efficient tree based routing protocol for WSNs with aim of overcoming the limitations of GSTEB protocol. The proposed protocol is based on GSTEB with new algorithm to handle the energy efficient topography computation for BS node in network. We introduce the use of fuzzy rules to select BS node to compute topography which can improve the delay

performance and prevent the heavy consumption of energy. The new protocol is named as FGSTEB.

V. SIMULATION RESULTS

Simulations are carried out through the Network simulator (NS2) for HEED, GSTEB and FGSTEB protocol under the different scenarios with varying the number of nodes from 50 through 300 in the given 1000 *1000 square area having 100J energy and constant reporting rate for all node. We compare the results of the simulation for different parameters like throughput, end to end delay, energy, Routing load, PDR and lifetime of network. Following graphs shows the comparative results of the simulation between HEED, GSTEB and FGSTEB protocols.

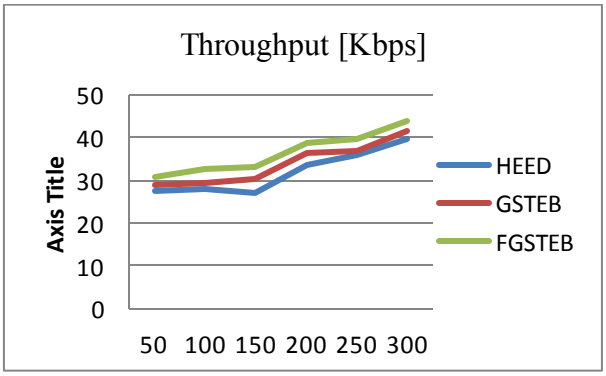

Fig 2: Avg. Throughput as function of node density

Fig 2 shows the avg. Throughput as a function of Node Density, it is showing that performance of throughput is increases as compared to HEED and GSTEB routing protocols due to the dynamic nature of FGSTEB protocol. This protocol complete outperformance the existing methods of WSN.

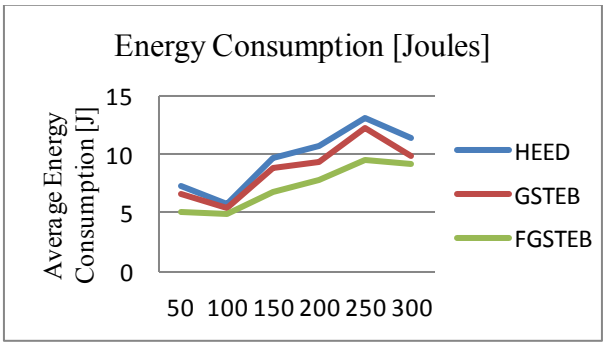

Fig 3: Avg. Energy Consumption as a function of node density

Fig 3 Shows avg. Energy consumption is a function of node density. Energy efficiency is most vital task of any WSN. Most protocols and methods presented on WSN are targeted to improve the efficiency of energy. Above graph is showing, for every network scenario FGSTEB is having less energy consumption as compared to HEED and GSTEB.

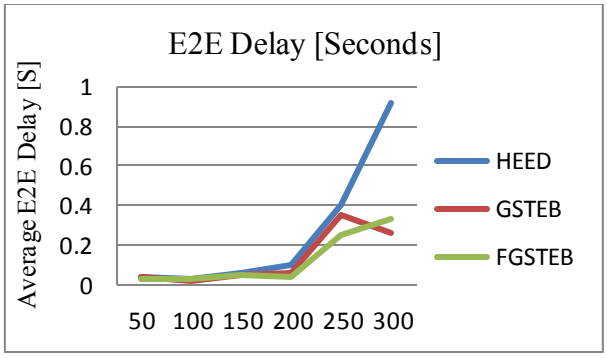

Fig 4:E2E Delay as a function of node density

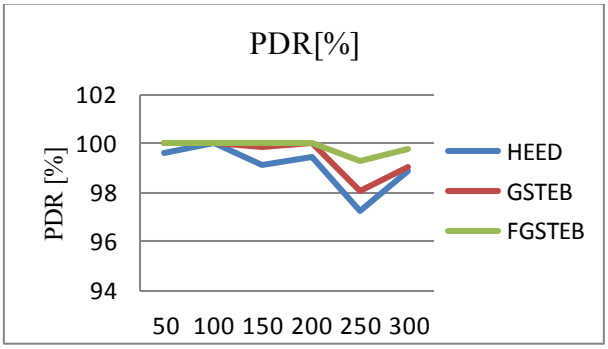

Fig 5: PDR as a function of node density

Above two figures fig 4 and fig 5 are factions of routing load and PDR with varying number of nodes in network. As Delay and PDR are complement to each other, if PDR is more, delay is less. Above two graphs are showing results for end to end delay and packet delivery ratio. In both cases, HEED and GSTEB protocols are having poor performance as compared to FGSTEB protocol due to the dynamic nature of the FGSTEB protocol.

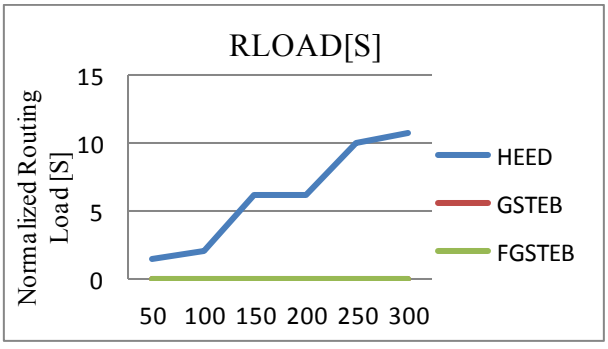

Fig 6: Routing Load as a function of node density

Fig 6 shows the routing load as a function of node density. Minimizing the network congestion was another aim of FGSTEB, above graph showing Routing Load of the HEED protocol is more as compared to the GSTEB and FGSTEB Protocols because the dynamic nature of these protocols.

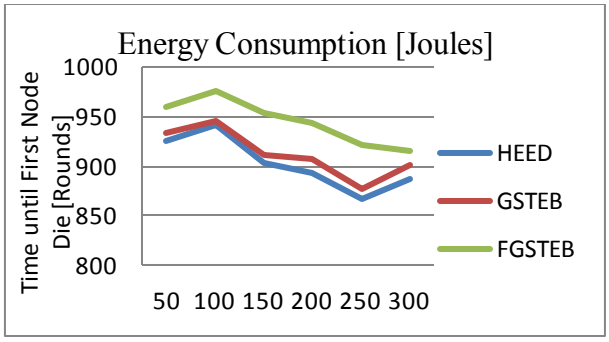

Fig 7: No of Rounds until first node die as a function of node density

Finally Fig 7 showing, the round carried out by the network until first node is dying in network which shows how network lifetime enhances using FGSTEB as compared to HEED and GSTEB routing protocols.

VI. CONCLUSION

In this paper, we design a new routing protocol using fuzzy rule on GSTEB algorithm. Simulation result shows that the GSTEB protocol performs better than HEED protocol because of its dynamic nature. The new method is capable of finding the optimal route to BS with minimum energy used. The performance of the proposed method is compared with other method under the same network scenario. The simulation result shows the proposed method is effective which enhance the network lifetime of the wireless sensor network.

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