Design Analyze and Implement Wireless Sensor Network Performance using Energy Balance Routing Protocol

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Abstract

The quick growths in the network multimedia equipment have allowed real-time digital services such as video conferencing, games and distance education to grow on the conventional internet tasks. The Wireless Senor Network (WSN) has become a major area of research in the computational theory due to its wide range of applications. WSN is an emerging technology which is made up of thousands of low cost and low battery powered sensor nodes which are highly distributed with sensing, processing and communication characteristics. The sensor nodes have a limited battery power, and the battery replacement is not easy for WSN with thousands of nodes which makes the lifetime of WSN crucial. Protocols such as LEACH, HEED, PEGASIS, TBC and PEDAP are proposed in order to overcome the problems faced by the WSN networks. The GSTEB protocol improves the lifetime by 100% as compared with HEED. In this research work, a novel tree based routing protocol is proposed which constructs a routing tree using a process for each round, Base Station BS selects a root node and informs this selection to remaining sensor nodes in its vicinity. Subsequently, each node selects its parents by considering information of itself and its neighbor's information, thus making a dynamic protocol.

Keywords: Energy Balance, Network Lifetime, Routing

I. INTRODUCTION

The development of Wireless Sensor Network (WSN) was motivated by military application such as battlefield surveillance; today such networks are used in many industry and consumer applications, such as industrial process monitoring and control, machine health monitoring and so on. WSN has gained worldwide attention in the recent years; WSN is made of few to several hundred nodes, where each node is connected to other sensor node in the network. The sensor node has the typically several parts such as a microcontroller, an antenna and an energy source, usually a battery. The sensor nodes can sense the environment and based on some local decision can transmit the sensed data to the user. The sensor nodes have limited memory along with limited battery power and are typically deployed in difficult to access locations, a sensor node is deployed for wireless communication to transfer the data to the Base Station (BS). Battery is the primary and main power source of the sensors. Secondary power supply can be harvested from the environment such as inverters or solar panels may be added to the node depending on the strictness of the environment where the sensor will be deployed. Actuators may be incorporated in the sensor nodes depending on the application and type of the sensors used in the network.

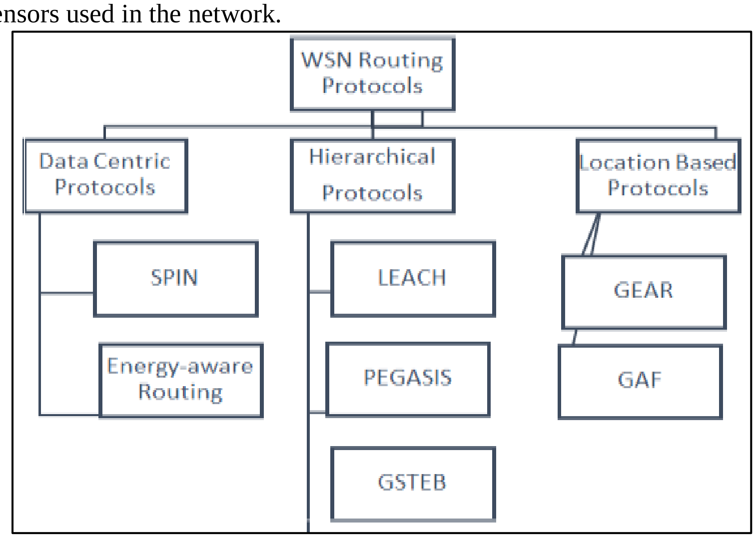

Fig. 1: WSN Routing Protocols

The WSNs can be classified into Unstructured WSN and Structured WSN; An Unstructured WSN is one that contains many collection of sensor nodes; they are be deployed in an ad-hoc fashion into the field. In Structured WSN, the sensor nodes are deployed in a pre-decided manner. The advantage of the Structured WSN is that fewer nodes can be deployed and low cost of management cost and maintenance. Fewer nodes can be deployed now since they are placed at specific places to provide coverage while ad-hoc deployment can have uncovered region. WSNs have military target tracking and surveillance applications along with Earthquake detection, Home Security, Home Control and Weather Sensing applications.

Wireless Sensor Network consist of a single Base Station and a number of wireless sensor nodes placed in the vicinity or far away. The sensor nodes sense the data, process it and then forwards it to the Base Station. There are various routing protocols defined till date as shown in the diagram. The research focuses on enhancing the Hierarchical protocol which is General Self-Organized Tree Based Energy Balanced protocol.

II. LITERATURE REVIEW

The whole literature review is focused on the following literature work being done by an array of scholars and researchers from the wireless sensor networks. The following papers are selected for review keeping in mind the traditional and conventional approaches of energy efficiency along with the emerging techniques. LEACH is the first and most popular energy-efficient hierarchical clustering algorithm for WSNs that was proposed for reducing power consumption. In LEACH, the clustering task is rotated among the nodes, based on duration. Direct communication is used by each cluster head (CH) to forward the data to the base station (BS). It uses clusters to prolong the life of the wireless sensor network. LEACH is based on an aggregation (or fusion) technique that combines or aggregates the original data into a smaller size of data that carry only meaningful information to all individual sensors. LEACH divides the a network into several cluster of sensors, which are constructed by using localized coordination and control not only to reduce the amount of data that are transmitted to the sink, but also to make routing and data dissemination more scalable and robust. LEACH uses a randomize rotation of high-energy CH position rather than selecting in static manner, to give a chance to all sensors to act as CHs and avoid the battery depletion of an individual sensor and dying quickly. PEGASIS is an extension of the LEACH protocol, which forms chains from sensor nodes so that each node transmits and receives from a neighbor and only one node is selected from that chain to transmit to the base station (sink)., PEGASIS still requires dynamic topology adjustment since a sensor node needs to know about energy status of its neighbors in order to know where to route its data. Such topology adjustment can introduce significant overhead especially for highly utilized networks. The GSTEB protocol builds a routing tree using a process where base station assigns a root node and broadcast a selection to all sensor nodes. Each node selects its parents by considering itself and its corresponding neighbors. The GSTEB is divided into four phases which is Initial Phase, Tree construction phase, Data collection and transmission phase and information exchange phase. The initial phase compromising of BS broadcasting the packet and calculating the residual energy; then each node sends its packet to the neighboring node computes its neighbors for a given specific range. Each node sends the information of its neighbors and neighbor neighbors to each other with the range. The tree construction phase consists of the node selecting a parent hence making GSTEB a dynamic protocol. The data collection phase consists of the sensor nodes sensing the data and transmitting it to the parent the parent in turn transmits to the root. The information exchange phase deals with broadcasting the change of the tree structure when a node dies.

III. RESEARCH METHODOLOGY

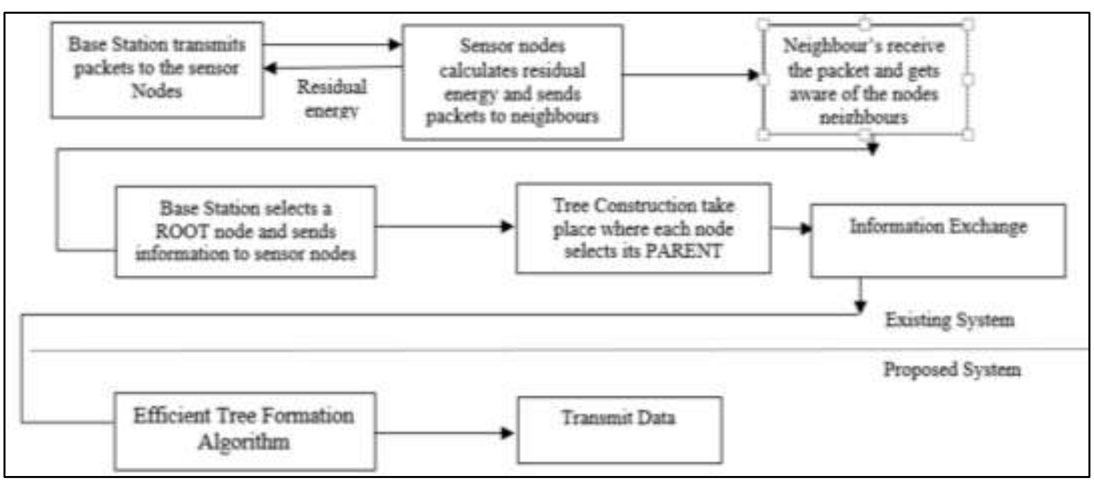

Fig. 2: System Architecture

The various energy efficient protocols discussed in the literature survey so far in the research work are either based on a homogeneous network, heterogeneous network or hybrid network. In the subsequent sections the focus is going to be made on the GSTEB protocol in detail. In the existing system, a General Self-Organized Tree-Based Energy-Balance routing protocol (GSTEB) is proposed which builds a routing tree using a process where, for each round, BS assigns a root node and broadcasts this selection to all sensor nodes. Subsequently, each node selects its parent by considering only itself and its neighbor's information, thus making GSTEB a dynamic protocol. The Methodology proposed in this research work is based improving the GSTEB protocol which in turn increases the network lifetime. The above mentioned work is divided into various modules as follows: Initialization Phase, Root Node Selection Phase, Parent Selection Phase, Data Transmission Phase, Information Exchange Phase, and Analysis.

IV. PROPOSED METHODOLOGY

The Methodology proposed in this research work is based improving the GSTEB protocol which in turn increases the network lifetime. The above mentioned work is divided into various modules as follows:

A. Initialization Phase

In the Initialization Phase we consider 100 nodes randomly place in a network field of 600m x 600m. The nodes are allocated energy randomly and the Base Station is allocated 100J energy. The Base Station is fixed and the remaining nodes are heterogeneous in nature with a mobility functionality. The co-ordinates of the nodes must be stored for further distance calculation.

B. Root Selection Phase

The ROOT node is selected by the Base Station which has the highest energy among the sensor nodes. Once the Base station selects the ROOT it will broadcast the root id to the remaining nodes in the network field.

C. Parent Selection Phase

In this phase each node searches for neighbors in the region of 250m range. Each neighbor count of the node is stored and processed. The node will select the parent from its neighbors having highest residual energy. The parent which is selected will in turn forward to the Base Station.

D. Data Transmission Phase

Each node will calculate distance from the parent and the root by using Euclidean distance formula. The distance which is shorter is selected for transmission. If the root is near the node, the node will send to the root directly. If not then it will send via parent.

E. Information Exchange Phase

If a node is getting exhausted with energy then the Base Station will in turn inform all the sensor nodes that the node is getting exhausted.

V. PROPOSED ALGORITHM

Energy Value Calculation
set alpha 10
select each node and fetch its energy
calculate EL(node) =expr energyL(i) / alpha
display and store the Energy Level Value of All Nodes
Neighbour Count
1) For each node set count = 0
For each node calculate neighbour within range of 250m
- for each node calculate {
  - if node within 250m range {

[Increment count]
Set count
}
2) Save the node with its neighbour count
}
Weight Calculation of Nodes
- Node weight= w1 * EL + w2 * NC
- Calculate for all nodes
- Save in file
- Display

Weight Calculation of Neighbours
- For each node
- Access the weights of the neighbours
- Save neighbour weight values.

Sorting of Highest Weight

```
3) for {set i 1} {node(i)} { incr i } {
     – for {set m 1} {m <= neighbour count } { incr m } {
         – for {set x 1} {x <= count(i) } { incr x } {
if { $NODE_NB(1) > $NODE_NB(2) } {
set swap node with highest energy
   }
         }}
4) Save the sorted neighbours in the file for each node
   }}
```

Parent Selection

```
5) for {set i 1} {i < total nodes} { incr i } {
   – for {set g 1} {g <= neighbour  count} { incr g } {
       – if { highest neighbour weight == node weight } {
  set node ==Parent
          } }
               }
```

VI. EXPERIMENTAL RESULTS

In this project we have compared the results of GSTEB (General Self-Organized Tree-Based Energy Balanced) Protocol with AGSTEB (Advanced General Self-Organized Tree-Based Energy Balanced) with the Quality of Service parameters of the Wireless Sensor Network such as packet delivery ratio, dead node ratio, network lifetime, and throughput. The simulation is done by the help of NS-2 (Network Simulator Version 2). The simulation setup parameters such as energy allocation and the placement of the sensor nodes are random. The base station is assumed to possess infinite energy and must be place far away from the deployment of wireless sensor node.

Table – 1
Simulation Model

Simulator	*Network Simulator 2*
Number of Nodes	*Random*
Topology	*Random*
Interface Type	*Phy/WirelessPhy*
Mac Type	*802.11*
Queue Type	*Droptail/Priority Queue*
Antenna Type	*Omni Antenna*
Propagation Type	*Two ray Ground*
Routing Protocol	*AODV*
Transport Agent	*UDP*
Application Agent	*CBR*
Initial Energy	*100Joules*
Area	*600 * 600*
Simulation Time	*200seconds*

Table – 2
Comparison of GSTEB and AGSTEB protocol

Parameters	*GSTEB (Existing)*	*AGSTEB (Proposed)*
Dead Node Ratio	*0.044*	*0.033*
Throughput	*11.28 kbps*	*65.52 kbps*
Network Lifetime	*1986 seconds*	*2103.27seconds*
Packets Dropped	*7545*	*3449*
Routing Load	*388848*	*54502*
PDR	*6%*	*37%*
Energy Consumed	*870.97J*	*637.253J*

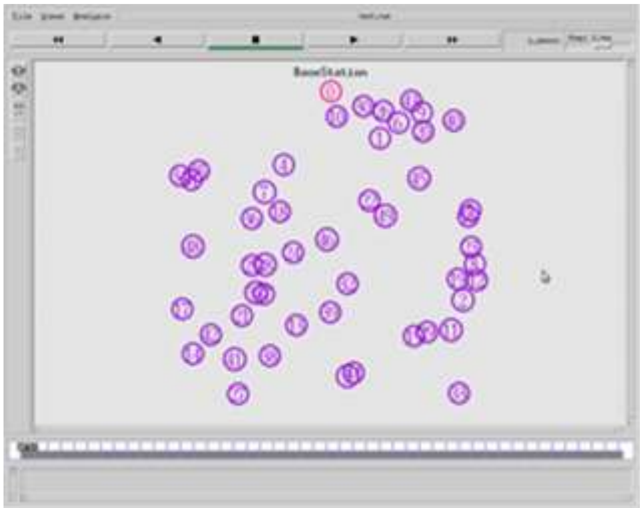

Fig. 3: Initialization Phase

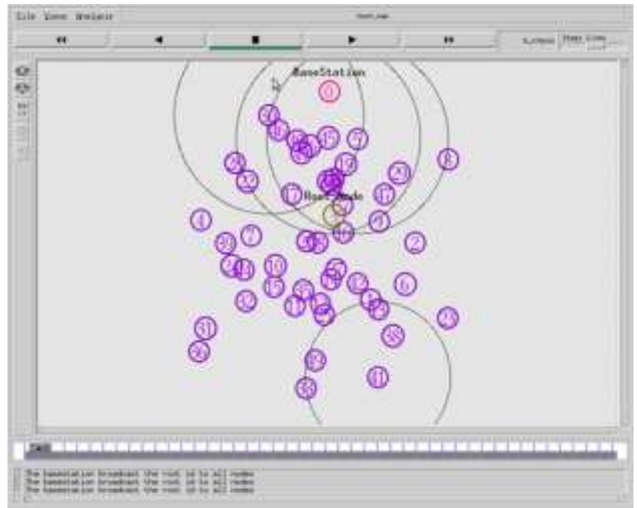

Fig. 4: Root Selection Phase

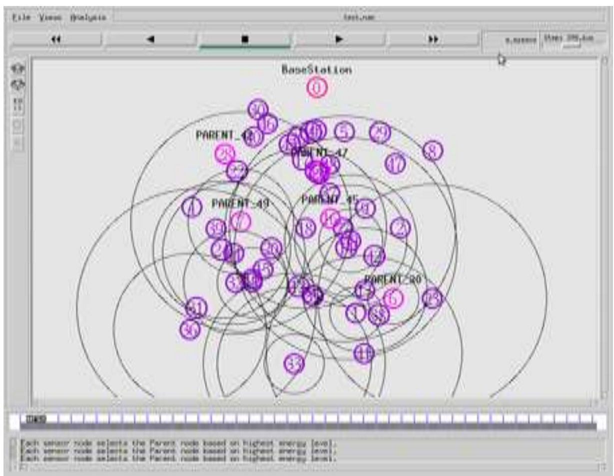

Fig. 5: Parent Selection Phase

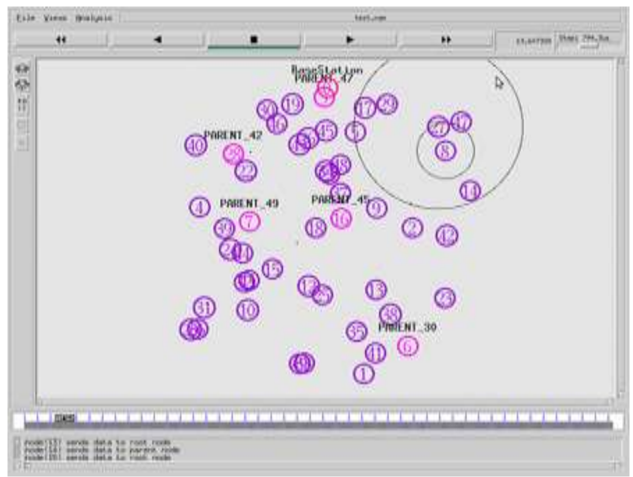

Fig. 6: Data Transmission Phase

F. Summary of Results

The comparison shows that GSTEB and EGSTEB in terms of Network Lifetime with varying number of nodes.

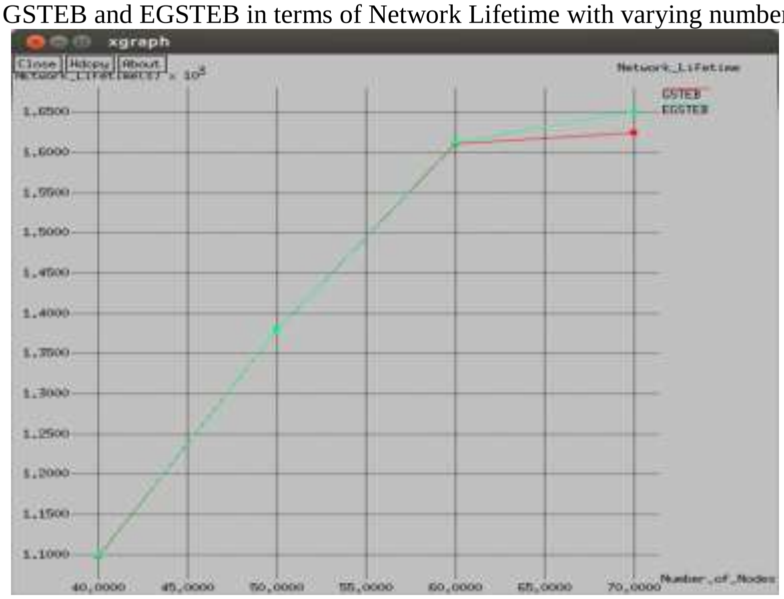

Fig. 7: Network Lifetime

VII. CONCLUSIONS

Routing in sensor networks is a new area of research, with a limited, but rapidly growing set of research results. In this paper, AGSTEB protocol is presented with a comprehensive survey of routing techniques in wireless sensor networks which have been presented in the literature. The protocol in this research also highlights the design tradeoffs between energy and communication overhead savings in some of the routing paradigm, as well as the advantages and disadvantages of each routing technique. Although many of these routing techniques look promising, there are still many challenges that need to be solved in the sensor networks.

VIII. SCOPE FOR FURTHER RESEARCH

The future vision of WSNs is to embed numerous distributed devices to monitor and interact with physical world phenomena, and to exploit spatially and temporally dense sensing and actuation capabilities of those sensing devices. These nodes coordinate among themselves to create a network that performs higher-level tasks. Although extensive efforts have been exerted so far on the routing problem in WSNs, there are still some challenges that confront effective solutions of the routing problem. First, there is a tight coupling between sensor nodes and the physical world. Sensors are embedded in unattended places or systems. This is different from traditional Internet, PDA, and mobility applications that interface primarily and directly with human users. Second, sensors are characterized by a small foot print, and as such nodes present stringent energy constraints since they are equipped with small, finite, energy source. This is also different from traditional fixed but reusable resources. Third, communications is primary consumer of energy in this environment where sending a bit over 10 or 100 meters consumes as much energy as thousands-to-millions of operations

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