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K-Means based General Self-Organized Tree-Based Energy Balancing Routing Protocol for Wireless Sensor Networks

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Abstract – Wireless Sensor networks (WSN) is a system collection of huge number of low cost sensor nodes spread over the geographic area in order to sense the data. This network is used to collect data and transmit the messages to base station(sink). In earlier days, WSN has been received a tremendous concentration from academic, defence and industrial services etc. Yet, they have many different constraints, such as computational capabilities, storage capacity, energy supply etc. In order to overcome these problems and to improve the performance of network need not only to minimize total energy consumption but also to balance energy consumption and load in order to enhance network lifetime In recent years researchers have proposed many protocols such as LEACH, HEED, PEGASIS,TBC and PEDAP,GSTEB. In this research paper we propose, a k-means based GSTEB routing protocol which organise network in to the form of clusters by using k-means clustering algorithm and then builds a routing tree by using a process where, for each round, BS selects a root node and broadcasts root coordinates to all sensor nodes in network. After that each node selects its parent. Thus k-GSTEB IS a dynamic protocol. The simulation results shows that the proposed approach performs better that other existing approaches.

Keywords-- Wireless Sensor Network, Routing, Network Lifetime, Clustering, balanced k-means algorithm, Tree Based Routing

I. INTRODUCTION

Today's internet has been developed for more than forty years. Recently many networks researchers are studying networks based on new communication methodologies, especially wireless communications. Wireless networks allow their hosts to transfer data wirelessly over long distances via radio communications without the constraints of wired networks. People can deploy wireless networks easily and quickly. Wireless networks plays a very important role in military, industrial and civilian systems such as fire alarm systems in buildings, offices etc.

As the importance of computer and technology increases in our daily life, it also sets new demands for connectivity across the world. Wired solutions have been around for a long but there is increasing demand on wireless solutions. Wireless sensor networks have become a growing area of research and development due to the tremendous number of applications that can greatly benefit from such systems and has lead to the development of tiny, low cost, disposable and self attached battery powered mini computers, known as sensor nodes which can accept input from an attached sensor node, then process this input data and transmit the results wirelessly to the transit network or base station.

Advances in sensor technology and wireless communication have made ad hoc wireless sensor networks (AWSNs) a reality. Unlike traditional wired networks, the connection between sensor nodes in AWSNs is dynamically changing. A short-lived network is set up only for the communication needs of the moment. Take the example of battlefield which provides daunting challenges to sensor fusion networks. Low weight, inexpensive, highly specialized sensors are usually deployed with irregular patterns in a hostile environment. Each individual sensor node may come and go, and they may also suffer intermittent connectivity due to high error rate of wireless link, and it can be further dominated by environmental hazards. Therefore, an effective sensor fusion network must Be able to provide robust communication infrastructure and survivability to cope with node failures, connectivity failures, and individual service failures.

Wireless sensor networks have been become very popular in different application of daily life considering the following factors: ease of installation, reliability, cost, bandwidth, total required power, security and performance of network. All other networks were made however based on fixed infrastructure. But wireless sensor networks play a tremendous role in our day to day life.

A sensor network is a network of many tiny disposable low powered devices, called sensor nodes, which are geographically distributed in order to perform an application-oriented global task. These nodes create a self organised network by communicating with each other either directly or through other nodes by following multi-hop path. There will exists one or more nodes among sensor nodes those will serve as sink(s) that are capable of communicating with the user either directly or through the existing wired networks. The main component of the network is the sensor, which is necessary for monitoring real world physical conditions such as weather conditions such as sound, temperature, humidity, relative intensity, vibration, pressure, motion, pollutants etc. at different locations. The tiny sensor nodes, which consist of sensing, on board processor for data processing, and communicating components, leverage the idea of sensor networks based on collaborative effort of a large number of nodes.

Two categories of Wireless Sensor Networks are possible based on their consisting elements these are:

Heterogeneous Sensor Networks[5], consists of static sensor nodes, advanced nodes, mobile elements and a static base station (BS).The advanced nodes always have more resources than other nodes, so that they can act as rendezvous points (RPs) for data aggregation. Also the number and position of these advanced nodes must be constrained to limit the tour length of MEs, which in turn shorten the data gathering latency

Homogeneous Sensor Network [5], some sensor nodes with shorter distance to the BS or mobile sink trajectory are recruited as polling points for the MEs to visit. This category of algorithms always limits the relay hops to a small value to reduce the energy consumption of multi-hop transmissions.

In general, WSN may produce quite a substantial amount of data, so if data fusion could be used, the throughput could be reduced [39]. Because sensor nodes are deployed densely, WSN might generate redundant data from multiple nodes, and the redundant data can be combined to reduce transmission. Most of the protocols implement data fusion, but approximately all of them consider that the length of the message transmitted by each relay node be supposed to be constant. PEGASIS [29], and TBC [20] are representative protocols based on this consideration and perform far better than LEACH [17] and HEED [28] .

Hence, several energy efficient and energy balancing techniques has been proposed till now. But still some issues regarding energy consumption still need to be addressed those effect the network performance. Such constraints on sensor networks are very essential to be addressed in order to improve network lifetime and network performance. In this research work a new k-means clustering based GSTEB routing protocol is proposed in order to overcome aforementioned issues in previous studies.

The remainder of the paper is organized as follows: Section II reviews related works. Existing GSTEB[39] is explained in Section III The network and radio models of our proposal are discussed in Section IV . Section V describes the architectures and details of k-GSTEB[39]. In Section VI we present our simulations in contrast to the simulations of other known protocols. Finally, Section VII concludes the paper.

II. LITERATURE SURVEY

A main task of WSN is to periodically collect information from the sensing area and transmit the information to BS located far away from the sensing area. A simple approach to fulfilling this task is that each sensor node transmits data directly to BS. However, when BS is located far away from the sensing field, the sensor nodes will exhaust their energy quickly due to much energy consumption. On the other hand, since the distances between each node and BS are different, direct transmission leads to unbalanced energy consumption also. To solve these kinds of problems, many protocols have been proposed. Of the protocols proposed, hierarchical protocols such as LEACH [17], HEED [14], PEGASIS [13], TBC [6] gains satisfactory solutions.

In LEACH [17] for the entire network, nodes selected according to a fraction p from all sensor nodes are chosen to serve as cluster heads (CHs), where p is a design parameter. The operations of LEACH are divided into several rounds. Each round includes a setup phase and a steady-state phase. During the setup phase, each node will decide whether to become a CH or not according to a predefined criterion. After CHs are chosen, each of other nodes will select its own CH and join the cluster according to the power of many received broadcast messages. Each node will choose the nearest CH. During the steady-state phase, CHs fuse the data received from their cluster members and send the fused data to BS by single-hop communication. LEACH uses randomization to rotate CHs for each round in order to evenly distribute the energy consumption. So LEACH can reduce the amount of data directly transmitted to BS and balance WSN load, thus achieving a factor of 8 times improvement compared with direct transmission.

Improved general self-organized tree-based routing protocol for wireless sensor network extended version of GSTEB which states overcomes the problems of GSTEB by considering assumption that to improve the performance need not only to minimize total energy consumption but also to balance WSN load. In this paper a novel tree based routing protocol was 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 neighbours' information, thus making a dynamic protocol.

General self-organized[21] tree based energy-balance routing protocol is a tree based routing protocol. General self-organized tree based energy-balance routing protocol is classified under hierarchical routing protocols. The operation of IGSTEB[21] is basically divided into four phases namely: initial phase, tree construction phase, self organized data collection and transmition phase and information exchanging phase.

K-means is a partitioning[8] methodology that partition the network based on different criteria's. K-means based clustering approach makes use of basic k-means approach to create clusters into the network. In this paper the author proposed a balanced K-mean [8] based clustering algorithm to create energy efficient clusters for routing in wireless sensor networks. The LEACH protocol is enhanced by using K-mean to create energy-efficient clusters for a given number of transmissions. The K-mean outcome identifies the suitable cluster heads for the network. It works into two phases: setup phase and steady state phase. During set up phase, the sensor nodes are divided equally into clusters which are selected by K-Means. Depending on the size of the network and number of sensor nodes, the sensor nodes can be equally divided into n numbers of clusters while selected cluster by each node if in a cluster number of nodes exceed than the maximum permissible node than they choose another cluster. During Steady State Phase each sensor node senses and transmits data to its cluster head based on the TDMA schedule. The cluster heads receive all the data aggregate it and sends it to the base station. After transmission that network starts next round and again execute the setup and steady state phase.

The Analytic Hierarchy Process (AHP)[15] is a methodology for analytical Hierarchy weight decision .This method is designed as a convenient decision approach to those multi-objective, multi-criteria or non-structural complex decision-making problems through mental

mathematization based on the in-depth analysis of the nature, affects and internal relations between the involved issues with less quantitative information.
A new tree based routing protocol (TBRP)[22] is introduced for improve network lifetime of the sensor nodes. TBRP accomplish with a better performance in lifetime by balancing the energy load with respect to all the nodes .TBRP presents a new clustering factor for cluster head election, which can efficient to handle the heterogeneous energy capacities. It also introduces a fuzzy spanning tree for sending aggregated data to the base station. This routing protocol finds an optimal route with less length and less computational time.
In this LEACH Based on k-means[36] a new low energy consumption clustering algorithm based on LEACH is presented. In this protocol firstly, a method for obtaining the number of clusters k is given, then using the k-means algorism to divide all the sensor nodes in WSN to the k clusters, in the whole network life cycle the cluster will not changed, and when the energy of cluster head is lower than some threshold, it will be changed. The data transmission between cluster heads to sink node use mixed model, namely, the cluster near the sink node using the single hop and the one far from it using the multiple hops.

III. General Self-Organized Tree Based Energy-Balance Routing Protocol

The operation of GSTEB is divided into[39]

- Initial Phase
- Tree Constructing Phase,
- Self-Organized Data Collecting and Transmitting Phase, and
- Information Exchanging Phase.

In Initial Phase, BS assigns a root node and broadcasts its ID and its coordinates to all sensor nodes. Then in Tree Constructing Phase, the network computes the path either by transmitting the path information from BS to sensor nodes or by having the same tree structure being dynamically and individually built by each node. GSTEB[39] can change the root and reconstruct the routing tree with short delay and low energy consumption. In • Self-Organized Data Collecting and Transmitting Phase, after the routing tree is constructed, each sensor node collects information to generate a DATA_PKT which needs to be transmitted to BS.
The TDMA time slot is also used for collecting the information from each and every node. In Information Exchanging Phase, the collected data is transmitted to the base station. The GSTEB protocol is compared with the other existing protocols LEACH, PEGASIS and HEED. The author showed that the performance of GSTEB is better than the others and it achieves the energy consumption. Although GSTEB protocol achieves it has some problems such as difficult to distribute the load evenly on all nodes in tree structure. Even though GSTEB needs BS to compute the topography, which leads to an increase in energy waste and a longer delay. Distribute the load evenly on all nodes in tree structure. Even though GSTEB needs BS to compute the topography, which leads to an increase in energy waste and a longer delay.

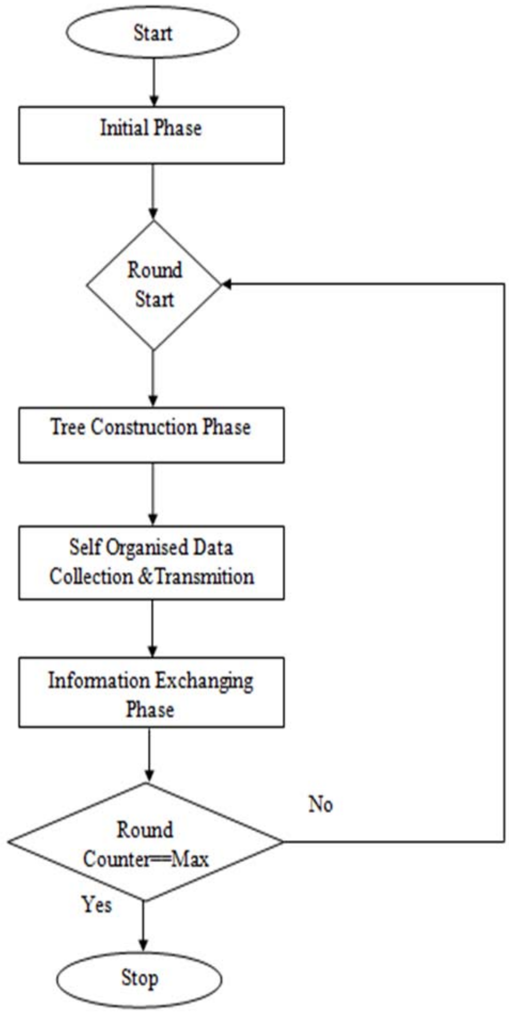

Figure 1 GSTEB Flow Chart

IV. Network And Radio Model

In our work, we assume that the system model has the following properties:
•Sensor nodes are randomly distributed in the square field and there is only one BS deployed far away from the area.
•Sensor nodes are stationary and energy constrained. Once deployed, they will keep operating until their energy is exhausted.

- BS is stationary, but BS is not energy constrained.
- All sensor nodes have power control capabilities; each node can change the power level and communicate with BS directly.
- Sensor nodes are location-aware. A sensor node can get its location information through other mechanisms such as GPS or position algorithms.
- Each node has its unique identifier (ID).

Recently, there is a significant amount of work in the area of building low-energy radios. In our work, we used the first order radio model presented in HEED [12] routing protocol. In the specified radio model, the energy dissipation of the radio in order to run the transmitter or receiver circuitry is equal to $\epsilon_{elec} = 50nJ/bit$, and to run the transmit amplifier it is equal to $\epsilon_{mp} = 100pJ/bit/m^2$. It is also assumed an r^2 energy loss due to channel transmission. Therefore, the energy expended to transmit a k-bit packet to a distance d and to receive that packet with this radio model is:

Transmitting: $ET_x(k, d) = \epsilon_{elec} \times k + \epsilon_{amp} \times k \times d^2$

Receiving: $ER_x(k) = \epsilon_{elec} \times k$

This model uses both the free-space propagation model and two-ray ground propagation model to approximate the path loss due to wireless channel transmission. When $d \le d_0$, the free-space ϵ_{fs} propagation model is employed and uses ϵ_{fs}= 10 pJ/bit/m for the transmitter amplifier. When $d > d_0$, the two-ray ground propagation model which leads to r^4 a path loss is employed and usesϵ_{mp} = 0.013 pJ/bit/m for the transmitter amplifier. d_0 is a threshold transmission distance which can be computed by:

$$d_0 = square\ root(\epsilon_{fs}/\epsilon_{mp})$$

It is also assumed that the radio channel is symmetric, which means the cost of transmitting a message from A to B is the same as the cost of transmitting a message from B to A.

V. K-MEANS BASED SELF-ORGANIZED TREE-BASED ENERGY-BALANCE ROUTING PROTOCOL(K-GSTEB)

To overcome the aforementioned issues in GSTEB protocol and also obtaining efficient results, proposing a k-GSTEB routing algorithm based on k-means based clustering algorithm.

In our proposed approach, assume that the system model has the following properties:

- Sensor nodes are randomly distributed in the square field and there is only one BS deployed far away from the area.
- Sensor nodes are stationary and energy constrained. Once deployed, they will keep operating until their energy is exhausted.
- Sensor nodes are location-aware. A sensor node can get its location information through other mechanisms such as GPS or position algorithms.
- Each node has its unique identifier (ID).

The proposed algorithm k-GSTEB consists of the phases which are similar to existing GSTEB but the operations of each and every block are different.

The main phases or blocks of the proposed algorithm are:

- Initial Phase
- Tree Constructing Phase,
- Self-Organized Data Collecting and Transmition Phase
- Information Exchanging Phase

A. Initial Phase

In initial phase, the network parameters are initialized and the nodes are formed into group of

Clusters using k-means based clustering approach

A k-means based clustering approach [12] to cluster-head selection is proposed based on two phases.

- Setup phase
- Steady state phase

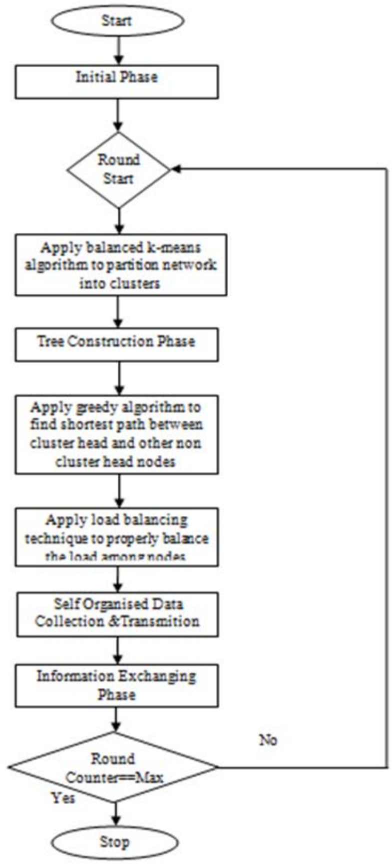

Figure 2 Proposed K-mean based GSTEB

During set up phase, the sensor nodes are divided equally into clusters which are selected by k-means. Depending on the size of the network and number of sensor nodes, the sensor nodes can be equally divided into n numbers of clusters while selected cluster by each node if in a cluster number of nodes exceed than the maximum permissible node than they choose another cluster.

During steady state phase when node is selected as cluster head, the cluster broadcast the signal (Advertisement message, ADV) to the other nodes. Each node receives ADV from different cluster heads, according to the strength of the signal, it chooses to join proper cluster, and rely to the corresponding cluster head.

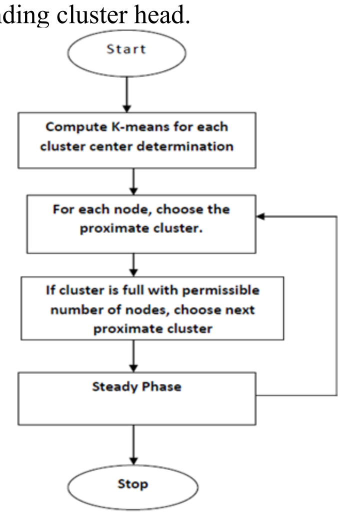

Fig 3 Balanced k-means based clustering algorithm

1) Cluster formation algorithm

Calculate the number of clusters is very important for the operation of k-means algorithm, so we use the value from literature [36] as follows:

$$k = \sqrt{(\frac{N \times \times H^2}{2\pi \in_{amp} \in_{fmp} d^2})}.......(1)$$

In the above equation, N represents the number of sensor nodes, and the sensor node is distributed in H×H area.

2) K-Means Clustering Algorithm

Initialize: The number of the clusters can be obtained from Equation (1), iteration time $t = 1$，the max iteration time T:

Step 1: Choose k sensor nodes from all the n sensor nodes as the initial data centres; c={c_1, c_2, c_k,......... c_k}

Step 2: Obtain the clusters. According the Equation (5) to obtain the k clusters : C_k={$C_1, C_2 \ldots C_k$},

$$\|x_i - c_h\| < \|x_i - c_h\|$$
$$(\forall j: 1 \le j \le k)..................(2)$$

In Equation (2), $\|x_i - c_h\|$ is the Euclidean distance between x_i and c_hFrom Equation (2) we can find every sensor node will be assigned the cluster which has the least distance form cluster centre.

Step 3: Adjust the cluster centre and the clusters according the follow equation:

$$C_i = (\sum_{i=1}^{n} x_i)/n \quad 1 \le j \le k \ldots\ldots (3)$$

Step 4: If the iteration time reaches the max value T or the obtained cluster centre c={c_1, c_2, c_k,......... c_k} has not changed for three iterations, then the algorism end and output the clusters C_k={$C_1, C_2 \ldots C_k$}, else go to the step 2.

When the algorithm is ended, the cluster is formed, but the cluster centre may not corresponding to the sensor node position, so we need to according the Euclidean distance assign the some sensor node:

$$\|x_i - c_h\| < \forall j \|x_i - c_h\| \; (1 \le i, j \le n)$$
$$.....(4)$$

In Equation (4), $c_h (1 \le h \le k)$ one of the cluster centre from the set c, so the cluster centre is assigned to x_i and then x_i is the really sensor node position.

B. Cluster Tree Construction Phase

In this phase, using information delivered to cluster node in the former phase. In a routing tree structure, for every cluster node a path to its cluster head is identified. Cluster head knows position of all nodes located in its cluster. Tree formation is Explained briefly in following steps:

- In tree constructing phase we will create a FP tree in order to show simulations of the cluster in wireless sensor networks.
- After creating tree data transmition takes place from sensor nodes to base station.
- Then we apply greedy algorithm first to find shortest path between cluster heads and non cluster heads nodes in tree so that data can send from source to destination without loss the packets in network.

C. Load Balancing In Cluster Tree Topology

After the tree construction, the load balancing process is initiated. The WSN routing tree is rooted in the base station. The load of child sensor nodes adds to the load of each upstream parent in the tree.

Therefore, the sensor nodes close to the base station will be heavily loaded. So in order to balance the load among different branches of tree Analytical Hierarchy Process (AHP) [15] methodology is applied and it is for analytical Hierarchy weight decision load is properly balanced among different branches of the tree, To measure how well the load is balanced across different branches of a routing tree, the following factors are considered and calculated. The weight calculation of various parameters:

Suppose there are n servers available and m requests in no particular order that need to be processed concurrently at the same time, and m is usually much larger than n. First, construct the judgment matrix of pair wise comparisons. In order to get the weight of the above indices.

Step 1: Calculate the product of the matrix elements in each row:

$$M_i = \prod_{j=1}^{n} B(i,j) (j = 1,2, \ldots\ldots n)$$

Step 2: Compute

$$\sqrt[n]{M_i} : \overline{W_i} = \sqrt[n]{M_i} \text{ (i=1,2,........n)}$$

Step 3: normalize the vector of

$$W_i = [W_1, W_2, ... W_n] : \overline{W_i} = \sum W_i (i = 1,2, .. n)$$

*Step 4:*calculate max eign vector values

$$lamda\ max = \sum \quad (AW)i/nW_i$$

Step 5: then the consistency test is checked

In this way load is evenly balanced across the different branches of tree in order to avoid energy misbalancing across the network. After Balancing load across network.

Here residual energy[39] is also evaluated for each and every node. The energy calculation is done using

$$E_i = \lceil \text{residual}_{\text{energy(i)}} / \alpha \rceil$$

Where E(i) is an projected energy value rather than a actual one and i is the ID of each node. α is a constant which is the minimum energy unit and can be changed based on requirements.

D. Self-Organized Data Collecting and Transmitting Phase

After the routing tree is constructed, each sensor node collects information to generate a DATA_PKT which needed to be transmitted to BS.

Previous discussions, show that there may be many leaf nodes sharing one parent node in one time slot.

If all the leaf nodes try to transmit their data at the same time, then data messages sent to the same parent node may interfere with each other. By applying Frequency Division Multiple Access (FDMA) or Code Division Multiple Access (CDMA), the schedule generated under competition is able to avoid collisions. However, the accompanying massive control packets will cause a large amount of energy to be wasted. By using the control of BS, the energy waste can be reduced and thus the process may be much simpler. At the beginning of each round, the

operation is also divided into several time slots. In the time slot, the node whose ID is i turns on its radio and receives the message from BS. BS uses the same approach to construct the routing tree in each round, and then BS tells sensor nodes when to send or receive the data. In each TDMA time slot, the nodes work in turns defined by BS. When BS receives all the data, the network will start the next
Phase.

E. Information Exchanging Phase

Once the routing tree is constructed, the energy consumption of each sensor node in this round can be calculated by BS, thus the information needed for calculating the topology for the next round can be known in advance. However, because WSN may be deployed in an unfriendly environment, the actual EL of each sensor node may be different from the EL calculated by BS. To cope with this problem, each sensor node calculates its EL and detects its actual residual energy in each round. EL is defined as EL1 and the actual EL as EL2. When the two ELs of a sensor node are different, the sensor node generates an error flag and packs the information of actual residual energy into DATA_PKT, which needs to be sent to BS. When this DATA_PKT is received, BS will get the actual residual energy of this sensor node and use it to calculate the topology in the next round.

Simulations and Discussions:

In this section, we present the simulation results as the performance evaluation of our proposed k-GSTEB algorithm. We used NetBeans for our simulations. We have run a number of experiments with different values of these parameters to determine the optimal set for our network size. Tables 1 indicates the WSN parameters that are used during simulations.

Table 1: Simulation Parameters

Max No. Of Clusters	10
Max no. Of nodes/cluster	5
Packet size	80 bytes
Simulation times	10,20,30,50,100 seconds
Transmission Range	12 metre
Area Size	50×50
Mac	IEEE 802.15.4

The details of simulation parameters are as follows: In an area of 50x50 $meter^2$ sensor field, maximum 15 cluster are possible into sensor area and minimum 1 cluster and maximum 5 nodes per cluster are possible and these sensors are randomly deployed. Sensors nodes have a transmission range of 12 meters. Number of executions are two. The maximum Rate adjustment value is 75% and is also assumed that there is no interference from other nodes. The lifetime of a wireless sensor network is constrained by the limited energy supply and processing capabilities of their nodes. To enhance the life time of the sensor network it is very important to have high energy efficiency at all the processing nodes.

Performance metrics: The performance of proposed protocol is compared with the GSTEB protocol. The performance is evaluated basically, According to the following metrics.

i) *Network Response Time:* It is the duration of time during which data transmission from source to destination or base station takes place. It is measured in milliseconds.

ii) *Packets received at Base Station:* It is the numbers of packets received at base the destinations or base station. It is usually measured in bits per seconds.

iii) *Total Energy consumption:* It is the total amount of energy exhausted by the nodes in network while receiving and transmitting data and working. It is usually measured in pjoules or joules.

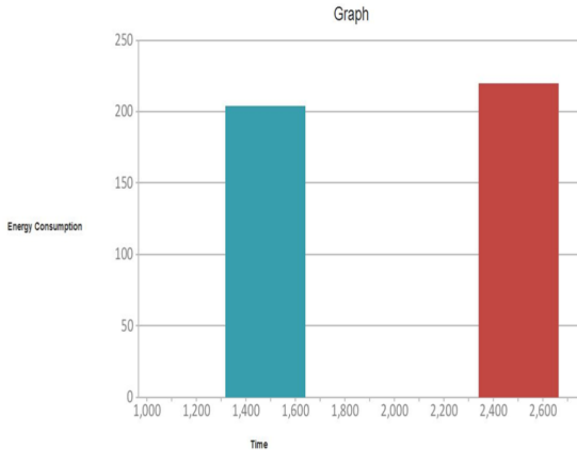

Figure 4: Energy Consumption Comparison of k-GSTEB and GSTEB Routing Protocols

In figure 4 blue bar is representing K-GSTEB protocol and red is representing GSTEB protocol. The graphical representation of Energy Consumption is shown in the figure 4. The graph shows that our proposed k-GSTEB routing protocol performs better than the GSTEB routing protocol in terms of Energy Consumption values. As we have observed that our proposed k-GSTEB consumes less energy due to control of massive transmission of data packets from base station to sensor nodes in network,

vi) End to End Delay: It refers to the time taken for a packet to be transmitted from source to destination or base station.

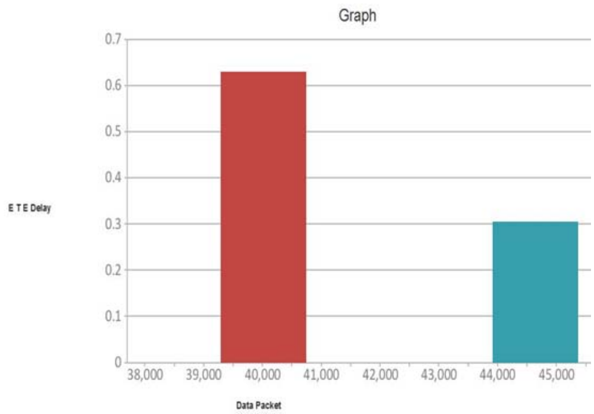

Figure 5: End to End Delay Comparison of k-GSTEB and GSTEB Routing Protocols

In figure 5 blue bar is representing K-GSTEB protocol and red is representing GSTEB protocol.
The graph shows that our proposed k-GSTEB routing protocol performs better than the GSTEB routing protocol by minimizing end to end delay while organising sensor nodes in network and data transmission from source to destinations. As we have observed that in our proposed k-GSTEB base station only interacts with cluster heads while data transmission and other non cluster heads nodes are locally managed by their own cluster heads. This leads to reduction in end to end delay during data transmission from source to destination.

v) Throughput: It is the number of packets received by destinations or base stations from the source in a given time. It is usually measured in bits per second.

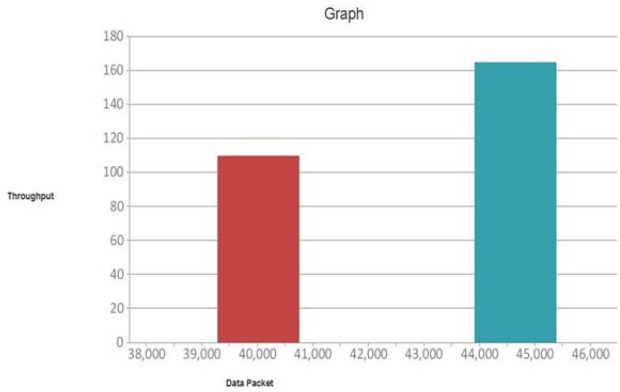

Figure 6: Throughput Comparison of k-GSTEB and GSTEB Routing Protocols

In figure 6 blue bar is representing K-GSTEB protocol and red is representing GSTEB protocol.
The graphical representation of throughput comparison is shown in the figure 6.The graph shows that our proposed k-GSTEB routing protocol performs better than the GSTEB routing protocol in terms of throughput values. K- GSTEB gives high throughput values by consuming less energy and by minimizing data packet drop ratio.

CONCLUSION AND FUTURE WORKS

A wireless sensor network is a group of small sensor nodes which communicate through radio interface. These sensor nodes are composed of sensing, computation, communication and power as four basic working units. There are various types of restrictions on Wireless sensor networks, but limited energy, communication capability, storage and bandwidth are the main resource constraints. When we try to reduce energy consumption it leads to energy imbalance and leads to partition network which will degrade network performance and thus reduce network performance. So our concern should not focus only on reducing energy consumption but should focus to balance energy consumption throughout the network. This will leads to improve network performance and life time. In order to reduce energy consumption and balance load among various sensor nodes in the network we are applying k-means clustering algorithm and AHP scheduling algorithm to propose a new k-means based GSTEB which is showing better results than existing routing protocols such as GSTEB etc.
In future work to be carried out under the current research work included is for the enhancement of the proposed scheme by introducing new mechanisms to improve the performance parameters such as packet drop ratio, energy consumption, end to end delay, load balance etc. We can also consider some other security parameters for further more enhancements. We can also extend this research work by applying genetic algorithm to organise nodes into clusters to improve the efficiency of the GSTEB.

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