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A Novel Analytical Approach to Clustering Based GSTEB for Mobile Sink

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***Abstract*:**
Although GSTEB has given away relatively considerable outcome in wireless sensor network(s) but still it has not given the idea of three major objectives: mostly, current research has not been considered the consequence of the movable sink, can proffer stage wise clustering to supplementary improve the outcomes, the pretty upshot of the reactivity has been ignored too since GSTEB has seen as proactive one. To triumph over the restriction of the former exertion, a new-fangled superior technique is projected in this research. The proposed technique has cross over these restrictions. This proposed protocol with mobile sink evaluates the effectiveness of the propose GSTEB for mobile sink based environment. Also, evaluates the effect of network range and nodes scalability on the proposed GSTEB according to the specific parameters: stability phase, network lifespan, throughput, standard residual energy. Simulation results conclude the better outcomes given by the proposed protocol. Future scope is also given.

Keywords: *GSTEB, protocol, WSNs, mobile sink*

1. Introduction

In last few years, researchers have been magnetized by a unique class of improvised networks popularly known as *Wireless Sensor Networks* or WSN. Today, major proportion of active research in computer science and telecommunication is the region of WSN. Three foremost things WSN do - i*)* sense the data ii) aggregate the data iii) route the data to the gateway or base station or sink. The whole WSN is actually build of huge amount of small energy tiny wireless devices popularly known as sensor nodes, path connecting edges and base station or sink. Particular distinctiveness of WSN is the restricted power as well as bandwidth assets, elevated compactness of nodule exploitation, cheap and unpredictable sensor nodes (prone to failure) that responsible for the size and costs of the sensor nodes. These sensor nodes communicate and aggregate the data which is further send to the sink as required. Target sensor node is node which is to be responsible to send the required data for a specific region. By satellite communication, sink send all the information to the client who make use of the internet. Real time applications such as smart city center networks, Smart Grid-net and power Control Sensor Network, Wireless Sensor Network for fitness analysis, wireless road applications, wireless smoke sensors. The data start off from unlike sensor nodes amassed mutually in the sink node for the duration of transmission. [2] The very basic objective of the data congregation in wireless sensor network (WSNs) is to gain important information from the working location. Clustering is a successful topology approach and data congregation protocol in wireless sensor networks. [3] Clustering lessens the direct transmissions to the base station by in network data aggregation, as well as diminishes the power utilization by dropping the transmitting distance. Hierarchical (clustering) protocols can assist in dropping functional power utilization. Above all, Clustering is constructive for applications which have need of scalability to hundreds or thousands of nodes. The performance of the clustering proposal is biased by the process of cluster-leader (that aggregate the data) appointment and the dimension or the numeral clusters.
Tree- based topology is one more method used for very fewer nodes except hierarchical clustering offers a healthier congregation for large number of nodes [1]. The cluster-based wireless sensor networks are branded as the mainly energy competent and nearly all long- live category of sensor networks. In a clustered network, the message-passing procedure is alienated into intra and inter-cluster announcement. The intra-cluster message-passing procedure begins with the nodes contained by a cluster to the leader but the inter-cluster communication travels since the top towards data hub (base station nodule).

Multi-hope [6] routing achieves key benefits:

a. Along with multiple paths, the broadcast load maintains the equilibrium and the nodes consume fair energy. This makes the network more energy efficient and protracts the network duration.
b. Due to multipath, chances of data redundancy add to broadcast and amplify the reliability

Due to densely deployed nodes, redundant data might be reduced from multiple nodes that can be combined to reduce transmission.

2. Recent Aggregation Protocol

So far research has been done with data aggregation protocols, following are some of the relevant protocols:

2.1. DAWN (Data Aggregation in WSNs with Mobile Sink)

This technique shows how to best plan the (compiled) packet routing and travel group of portable base station to gather the data in wireless sensor networks to capitalize on the network duration. For this, an arrangement policy is given for the immobile sensor network; propose numeral movement policies for portable sinks to lessen the power utilization along with dissimilar data gathering necessities. The information from all the sensors wishes to be gathered at each instant of time, and then sent to the base station. Here, data compilation involves determines a likely most favorable permissible stream network and Interference-free Link Scheduling. The data assembling arrangement given by DAWN (Data Aggregation in WSNs with mobile sink) algorithms compared with that acquired from a chain based hierarchical protocol [7]. In each experiment, the network lifetime is measured. To guess the eminence of estimation, calculate OPT for these data gathering problems. The time-span underneath the arrangement of DAWN is for all time notably superior to Random Waypoint arrangement

2.2. TEEN (Threshold Sensitive Energy Efficient Sensor Network Protocol)

TEEN targeted on reactive networks and the initial protocol developed in favor of reactive networks. In this method, whenever cluster change time arises, as well as the features, the cluster-head transmit toward its components. The nodes always sense their surroundings constantly. Initially, constraint from the feature set reaches its hard threshold value, then the node toggles the source and send the sensed data. A value of this data is stored in a domestic variable, known as the sensed value (SV). The nodes then after that spread data in the existing cluster time have to follows defined conditions [11].The chief negative aspect of this plan is when threshold is not attained, the nodes do not exchange a few words at all, and after that the client do not obtain a few data from the network even if each and every node dies. Consequently, this plan is not good for which client wants to acquire data on an ordinary basis. One more likely trouble is that a realistic execution must make sure for no collisions in the cluster. It is suitable for time decisive applications like intrusion detection, explosion detection and moreover pretty well-organized in terms of energy expenditure as well as instant response. Also, it gives consent to the user in the direction of manage the energy expenditure and accurateness appropriate to the application.

2.3. Proactive Network Protocol

Proactive network is one of the nomenclatures of sensor networks. Due to irregular data broadcasting, these networks utilize energy frequently. Also, these networks give a clear picture of the related factors at standard gaps. So, Proactive networks have been proved well-matched for those applications that mandate irregular data examining. Proactive network protocols are grounded on the performance and objective applications in sensor networks protocols. The focal point in proactive protocol is an escalating duration of network, throughput and to decline the energy expenditure. On every varied instant of cluster, once the cluster heads are decided, the cluster head broadcasts these two factors: detail time i.e. time gap between consecutive details thrown by a node and attribute i.e. package of materialistic factors which is the area of client concern to acquire data. On every $D_{T,}$ the component of the cluster sense or intellect the factors illustrated in the attributes and sense the data to cluster-head. The CH aggregates that data and throws either to sink or to the upper level of CH, if in case may be. This guarantees about the absolute illustration of the whole network's region. *LEACH [12]* is a good approximation of proactive protocol with some slight differences. It is known as the hierarchical clustering pseudo-code. Performance of LEACH is fine in homogeneous environment. However, on the other hand, in heterogeneous environment the performance goes down. Instance applications are:

- To examine equipments, for fault detection and analysis.
- To bring together data of heat alteration outline for specific region

2.4. Reactive Network Protocol

In reactive networks all nodes react instantaneously to unexpected as well as extreme variations in the sensed values. It is known to be appropriate to time crucial applications. These networks are application reliant and intellect the surroundings periodically but broadcast the data just when cluster-value arrives to absolute value of the attribute. As data broadcasting utilizes lot of power usually as compared to sensing the data so, the reactive networks are able to diminish or exploit throughput to their respective applications. It has been found that if the broadcastings are not high then the network duration would maximize just because cluster-value could not get on the absolute value. Though the cluster-value gets on the absolute value again and again, then broadcasting would be maximizes and node would rapidly expire. In addition to the attribute when each varied instant of cluster, the CH transmit to its components: hard threshold i.e. an absolute value of the attribute away from which the sensing node has to turn on its transmitted and send the details to the CH and soft threshold i.e. little modification in the attribute in which turn on the transmitted

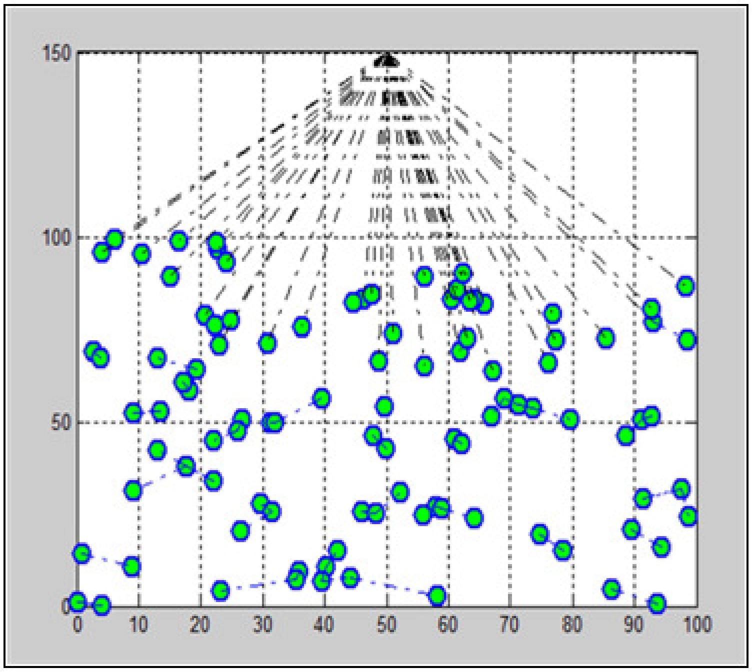

Figure 1: Existing GSTEB protocol with static sink

And then broadcast. In reactive networks the nodes intellect the atmosphere frequently. Initially, when attributes factors arrive up to hard threshold value the node turn on its transmitter and throws the sensed data. The chief negative aspect of this method is if the threshold does not arrive, node would never communicate, user would never obtain any data and will never know about the death of all nodes. Hence this method is proven to be well- suited for the daily required data by user. Realistic accomplishment must guarantee for will no fender-bender in the cluster. To avoid these issues, TDMA scheduling will present a delay in the time critical data and CDMA used to avoid this problem. *Ant-chain [13]* is a proficient algorithm used a reactive routing protocol along with the aim of optimistic power and diminishing delay and has been proved better algorithm than LEACH [] and PEGAIS[] based on power proficiency.

Reactive networks [15] is paramount apt for time-critical appliances such as

- Invasion exposure.
- Ambient cloud.
- Detonation discovery
- DDoS (Distributed Denial-of-Service attacks) monitoring.
- Flood-Guard detection and distributed mitigation system.

Threshold energy sensitive energy efficient protocol is known as the opening protocol aimed for reactive networks.

2.5. Existing Protocol

GSTEB (General Self-Organized Tree-based Energy Balance routing protocols) [2] as shown in Figure 1 where network gathers information from time to time since a territory where every node frequently senses the location and throws the data return to Base station. The major ambition of GSTEB is to attain a lasting network life span for dissimilar applications. GSTEB can amend the root and recreate the routing tree with modest impediment and small power expenditure. Because GSTEB is a self-organized protocol, it only put away a little extent of energy in every round to transform the topography for balancing the energy consumption [5]. Entirely, leaf nodes can broadcast data in the similar TDMA time slot due to the short transmitting delay[2]. A little minor transformation is made to build the presentation of GSTEB alike with the purpose of PEDAP. So GSTEB is approximately the best result as the data composed by sensors cannot be amalgamated, GSTEB presents one more easily way to corresponding the network consignment. In actuality, it is not easy to share out the load uniformly on each and every node in that kind of case. However, GSTEB needs base station to calculate the topography that increases in energy waste as well as elongated impediment and are tolerable when compared among the power utilization and the time impediment for data broadcasting. Simulation fallouts have shown that GSTEB extend the network lifetime more than 100% compared with HEED. Thus a better balanced load is attained compared with the protocols such as LEACH, HEED, PEGASIS, PEDAP, TBC [2]. This protocol in which network gathers information from time to time since a territory where every node frequently senses the location and throws the data return to Base station. It is a proactive protocol as discussed in previous protocols.

Although GSTEB has given away relatively considerable outcome in wireless sensor network(s) but still it has not given the idea of three major objectives: -

- Mostly, current research has not been considered the consequence of the movable sink

- Can proffer stage wise clustering to supplementary improve the outcomes
- Pretty upshot of the reactivity has been ignored too since GSTEB has seen as proactive one**.**

3. Proposed Protocol

To triumph over the constraints of the earlier exertion a new-fangled superior procedure is projected in this research effort. The proposed technique utilizes the clustering and mobility thus has the capability to beat the restrictions of the GSTE Brouting protocol. Subsequent section contains the algorithmic designed for the proposed technique and methodology as well.

*Algorithm***:** Begin GSTEB (x, y, N, E_o)

1. Deploy sensor node
   For i = 1:N
      WSN (i).xd = rand;
      WSN (i).yd = rand;
      WSN (i).E=E_o;
   End

2. Deploy sink
   WSN (N+1).xd = 50/150;
   WSN (N+1).yd = 50/150;

3. While (r<=MAXTIME)
3.1. For I = i:N
   Check dead nodes
   If WSN (i).E<=0
      Dead= dead+1;
   End
3.2. Find direct/ indirect nodes
   If WSN (i).distance <= d_o
      WSN (i).D = 1;
   Else
   WSN (i).D = 0;
   End
3.3. Apply data aggregation
   If (WSN (i).D == 0) && (WSN (i).I > 0)
3.3.1. Find nearest node having WSN.D=1 and communicate data with it
3.3.2. Evaluate and update consumed energy

$$W(I).E = W(I).E \begin{cases} E_{Tx}(1,d) = I\,E_{elec} + l_{Emp}\,d^4, & d>=d_o \\ E_{Tx}(1,d) = I\,E_{elec} + l_{Efs}\,d^2, & d>=d_o \end{cases}$$

Where $d_o = \sqrt{\frac{E_{fs}}{E_{mp}}}$ and d is evaluated distance

3.4. Apply TDMA
   If (WSN (i).D == 1) && (WSN (i).I > 0)
3.4.1. Evaluate distance

$$d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

3.4.2. communicate data
3.4.3. Evaluate and update energy consumption

$$W(I).E = W(I).E \begin{cases} E_{Tx}(1,d) = I\,E_{elec} + l_{Emp}\,d^4, & d>=d_o \\ E_{Tx}(1,d) = I\,E_{elec} + l_{Efs}\,d^2, & d>=d_o \end{cases}$$

Where $d_o = \sqrt{\frac{E_{fs}}{E_{mp}}}$ and d is evaluated distance

End 3.4

3.5. Check lifetime
If dead == N
Print network lifetime
break;
end
4. Return network lifetime
Given optimal algorithm presents *x* and *y* as area where *N* is the number of nodes and Eo is the initial energy. Initially deploying sensor nodes on randomly selected x and y area. Then sink is deployed on a defined area of 50/150 in which 50 considered as internal value for the selected area where as 150 is the external region away from boundary of the selected area. Number of rounds represents by *r* during which numeral dead nodes are checked and do is the minimum distance to find direct as well as indirect nodes.

3.1. The Concept of Mobile Sink
The concept of movement of base station has been vicinity of interest in the research society because of its mobility properties. As the name let you know that base station moves in sensor's proximity, data relays to the mobile [16] base station to drop that to the destination or data processing core later on. Majority of the current studies believed sink as static in wireless sensor networks where the whole sensed data from the sensors are relayed to it through many relays known as multi-hop transmission. [8] Consequently, the most adjacent sensor to the sink will be the peak of the power expenditure as they have to transmit data to supplementary isolated sensors. When sensor exhausts their power, sink disconnect from the other network while the remaining sensors still work with adequate residual energy. This technique balances the power expenditure with the sensor in a more efficient manner. So, mobile sink navigate the examining areas and halt at some sites for sensed data collection. According to Luo and Hubaun [10], sensor must deploy consistently in circle region by evaluating the network lifetime. Both of them concluded that mobility of base station with the external factors of circle provide prolonged network lifespan. Unlike to *static* sink which deployed the center of the circle. Wang [14] has been proposed a flow based routing protocol which seems to be attractive theoretically.

4. Implementation and Results
The simulation implementation has been shown that the improved GSTEB set of rules for wireless sensor networks including movable base station is more efficient in terms of energy balancing and network lifetime. Because GSTEB is a self-organized protocol, it merely utilizes a little extent of power in every round to alter the topography for balancing the energy consumption. Using the methodology of the proposed protocol, implementation has been done as follows:

- Figure 2Clustering based protocol provides the base station with number of cluster heads communicating with sensor nodes to collect the required data. According to the situation any node can be cluster head, gather data and transmit to the base station. Here, rhombus shaped represents the base station, blue node represents the cluster heads and other green node represents the sensor nodes. This procedure extremely lessens power expenditure and in that way augmenting the network duration
- Figure 3 gives the view of random locations of the base station. In static sink technique, the most adjacent sensor to the sink will be the peak of the power expenditure as they have to transmit data to supplementary isolated sensors. When sensor exhausts their power, sink disconnect from the other network while the remaining sensors still work with adequate residual energy. To alleviate this *static* base station locality issue, the mobile sink is chosen to balance the power expenditure with the sensor in a more efficient manner.

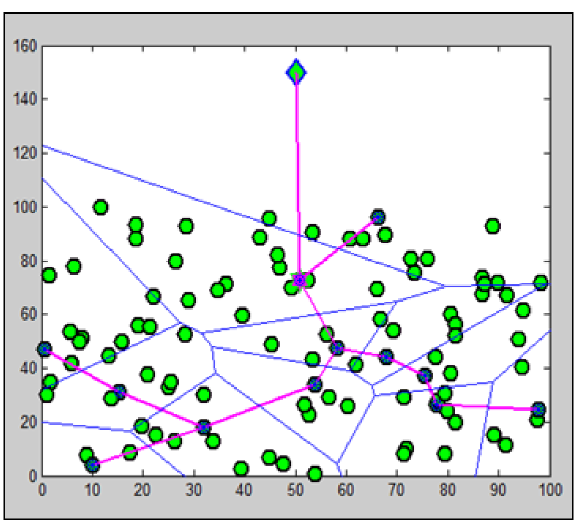

Figure 2: proposed clustering based GSTEB routing protocol

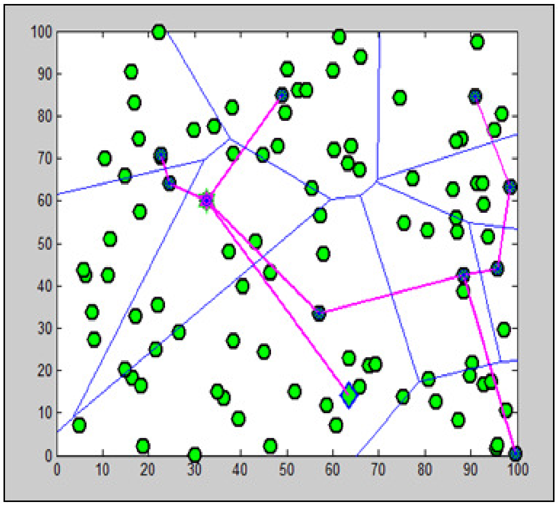

Figure 3: arbitrary position of sink in improved GSTEB

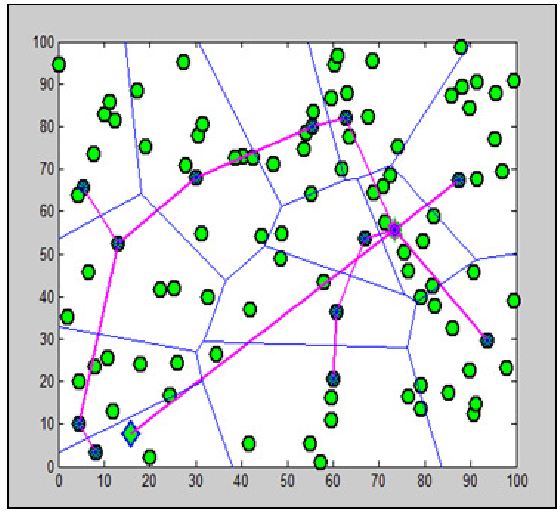

Figure 4: Changed sink position in improved GSTEB

- Figure 4 shows the location that has been changed from the last location. So, mobile sink navigate the examining areas and halt at some sites for sensed data collection. Sink mobility already proved as blessing rather than bothering issues of the network which involves the duration of network, scalability, throughput etc.

4.1. Quantitative Analysis

- The quantitative analysis for the proposed method as well as the earlier protocol based upon the characteristics as initial lifeless nodule or first dead node, shown in the table 1.

ENERGY	EARLIER GSTEB	CLUSTER BASED	MOBILE SINK
0.01	19	55	59
0.02	36	119	117
0.03	54	168	119
0.04	72	232	180
0.05	91	301	243
0.06	108	366	340
0.07	131	424	421
0.08	144	46	497
0.09	164	525	564
0.10	183	621	632
0.11	201	637	642
0.12	215	720	701
0.13	251	773	801
0.14	251	838	841
0.15	272	893	921

Table 1: First Deadnode

ENERGY	EARLIER GSTEB	CLUSTER BASED	MOBILE SINK
0.01	51	6	67
0.02	99	18	135
0.03	146	19	204
0.04	198	260	272
0.05	248	327	337
0.06	298	394	406
0.07	348	454	473
0.08	397	19	541
0.09	446	591	610
0.10	495	638	678
0.11	546	701	740
0.12	366	777	812
0.13	642	843	870
0.14	696	905	946
0.15	741	969	1013

Table 2: Half Dead Node

- Table 2 represents the results of earlier GSTEB, clustering based and GSTEB with mobile sink of partly lifeless nodule or half dead node at energy levels from 0.01 to 0.15.
- Table 4 represents quite different results of number of packets used (throughput) in earlier GSTEB, clustering based and GSTEB with mobile sink at different energy levels.
- Table 3 represents the execution results of earlier GSTEB, clustering based and GSTEB with mobile sink at different energy levels. For instance, from 0.01 to 0.15 energy level shows the continuous difference of 50 in earlier work while significant differences of the proposed method which gives far better results.

ENERGY	EARLIER GSTEB	CLUSTER BASED	MOBILE SINK
0.01	50	68	70
0.02	100	141	146
0.03	150	200	213
0.04	200	264	273
0.05	250	331	343
0.06	300	404	412
0.07	350	459	492
0.08	400	527	553
0.09	450	595	619
0.10	500	644	681
0.11	550	717	770
0.12	600	782	817
0.13	650	847	887
0.14	700	911	949
0.15	750	979	1021

Table 3: Network Lifespan

ENERGY	EARLIER GSTEB	CLUSTER BASED	MOBILE SINK
0.01	50	35.5000	35.7571
0.02	99	71	74.7808
0.03	23.2717	100.5000	108.0329
0.04	23.6613	132.5303	137
0.05	23.1081	166.0483	172.4023
0.06	27.6684	202.7228	206.6359
0.07	25.8169	230.1874	246.7378
0.08	26.4797	264.0266	227.4702
0.09	25.3970	298.0134	350.2003
0.10	25.5401	322.7174	341.1322
0.11	25.2735	359	385.9416
0.12	24.8525	391.5384	409.0881
0.13	26.8268	424	529.2717
0.14	25.9688	456.0274	475.0619
0.15	25.1974	490.2288	511.0196

Table 4: Throughput

4.2. Qualitative Simulation Results

The qualitative results represent the performance graphs of earlier GSTEB protocol and the proposed GSTEB routing protocol. Network lifetime is defined as the time on the system initiates till initial node becomes lifeless.

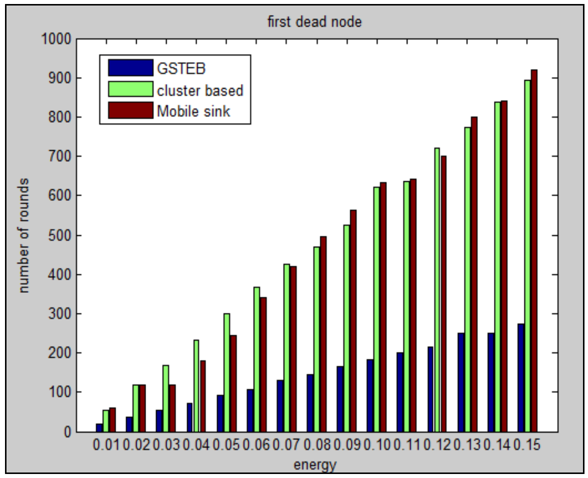

Figure 5: Comparative first deadnode energy graph

The performance graph shown in Figure 5 visually clarifies the routine of initial lifeless or first dead node differs between previously adopted technique where energy utilize in merely less than 300 rounds and the projected protocol that shows the same energy expenditure in more than 900 rounds.

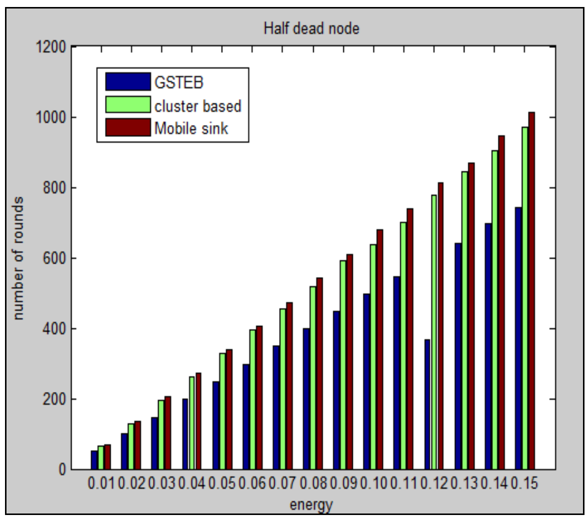

Figure 6: Comparative half dead node energy graph

In case of half dead node, shown in Figure 6, stands for energy expenditure in 700 rounds with certain decrease at some energy level for previously adopted technique but the same energy expenditure in 1000 rounds with gradual increase

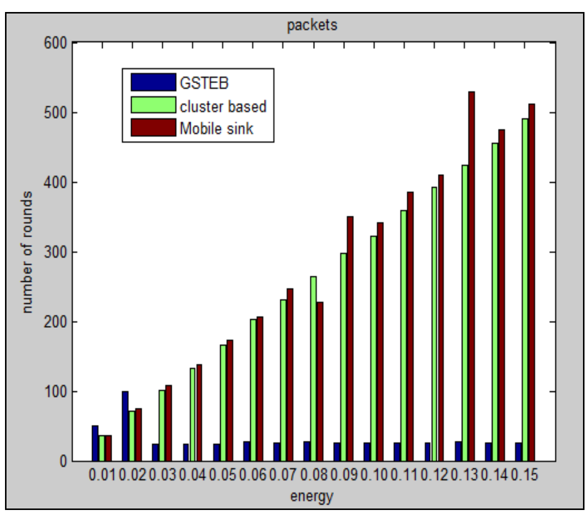

Figure 7: Comparative packets used energy graph

The remarkable plot for packets, which are used to send to the base station, hold the gradual increased energy consumption in more than 500 rounds for clustered GSTEB but the same consumption however declined just for average of 50 rounds as shown in Figure 7.

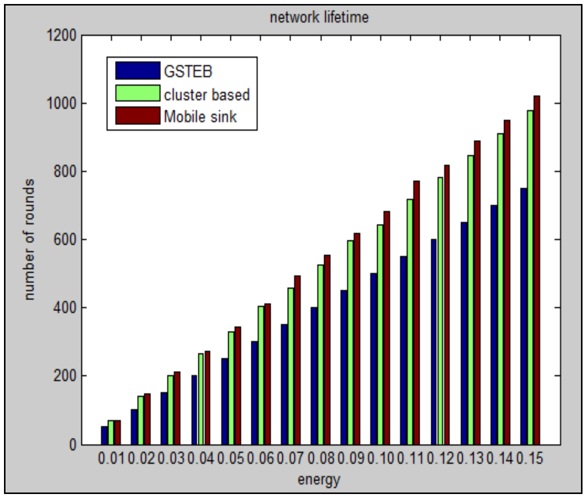

Figure 8: Comparative network lifetime energy graph

Therefore, Figure 8 gives obviously further lifespan to the network from an improved qualitative outcome than earlier technique. Thus, Simulation analysis with mobile sink, unlike to static sink as shown in Figure 1, shows the pretty good outcomes along with massive distinction in performances comparatively for both old technique and clustered GSTEB.

5. Conclusion and Future Scope

From the given proposed method, execution results conclude: Clustering based GSTEB routing protocol to add to the results further. Evaluates the effectiveness of the propose GSTEB for mobile sink based environment. Evaluate the effects of network range and node scalability on the proposed GSTEB. The comparison is also being drawn among the GSTEB, proposed GSTEB and Mobile sink based proposed GSTEB according to the specific considerations which are time of primary dead node i.e. Stability phase, time of last dead node i.e. Network lifespan, time of half dead node, throughput, average left over energy.

As a future scope, dual mobile sink can be applied to further improve the proposed protocol to get more network lifetime and lessen the energy expenditure as well as work in more realistic environment.

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