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Tabu Search and Tree Based Energy Efficient Protocols for Wireless Sensor Networks

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Abstract— The quick growth in network transmission equipments have enable further period digital services like video-conferencing, on-line games and distance education to grow to be the traditional web tasks. WSNs has become major space of analysis in process theory attributable to its big selection of applications. however attributable to restricted battery power the energy consumption has become major limitations of WSNs protocols. although several protocols has been planned thus far to boost the energy potency more however still a lot of sweetening is done. GSTEB has shown quite important results over the on the market WSNs protocols. however it's neglected several problems. so as to beat the constraints of the sooner work a brand new improved technique is planned during this analysis work. The planned technique has the power to beat the constraints of the GSTEB routing protocol by mistreatment clump and TABU search. The comparison are drawn among the present and planned techniques. The comparisons has clearly shown that the planned technique outperforms over the on the market techniques.

Keywords— GSTEB, PASCCC, WIRELESS SENSOR NETWORK ,TABU SEARCH

I. INTRODUCTION

A wireless device network (WSN) includes of a whole bunch to many thousand low-power multi-functional device nodes, doing add an unattended setting, and having sensing, computation and communication capabilities. the elemental aspects of a node definitely ar a device unit, AN ADC (Analog to Digital Converter), (Central processing unit), AN heat unit along side a communication unit. device nodes ar micro-electro-mechanical systems (MEMS) that make enumerable reaction to a modification of some healthiness like temperature and pressure. device sense or live the physical knowledge with the world to become monitored. The repetitive ANalog signal perceived through the sensors is digitized by an digitiser and delivered to controllers for more process. device nodes ar of smaller size, use very low energy, ar operated in high meter densities, that change it to be freelance and accommodative towards setting.

The spatial density of device nodes among the sphere may well be the maximum amount as twenty nodes/ m^3. As wireless device nodes ar usually smaller electronic gadgets they might solely be ready having a restricted power supply. every device node carries a precise a part of exposure for the aim it's going to and properly report the particular amount that it should be perceptive. Some reasons for power consumption in sensors are: (a) signal sampling and conversion of physical signals to electrical ones; (b) signal acquisition, and (c) analog-to-digital conversion.

II. A GENERAL SELF-ORGANIZED TREE-BASED ENERGY-BALANCE ROUTING PROTOCOL

General Self-Organized Tree-Based Energy-Balance Routing Protocol (GSTEB) builds a routing tree employing a method wherever for each single spherical, base station (BS) assigns a root node and broadcasts this choice to each device nodes. Then, every node selects its parent by taking into thought solely itself and its neighbours data, so creating GSTEB a strong protocol. Simulation results reveal that GSTEB embrace a far better performance than different protocols in reconciliation energy consumption, so prolong the period of WSN.

It considers a condition wherever within the network collects data at regular intervals from a topography wherever every node regularly senses the environment and sends the info back to BS. normally there area unit 2 definitions for network life span:

a) The time from the begin of the network method to the death of initial node inside the network.
b) The time from the begin of the network method to the death of last node inside the network.

Two extreme cases in knowledge fusion are:

Case(1): the info among any device nodes may be utterly amalgamated. every node transmits the identical volume {of knowledge|of knowledge|of information} in spite of what proportion data it receives from its kids.

Case (2) the info can't be amalgamated. The length of message transmitted by each relay node is that the total of its own detected knowledge and received knowledge from its kids.

The chief arrange of GSTEB is to attain a extended network era for various applications.In each spherical ,BS assigns a root node and broadcasts its ID and its coordinates to each device nodes. at the moment the network computes the trail either through sending the trail data from BS to device nodes or by having constant tree organization being dynamically

and severally designed by each node. For each cases, GSTEB will modify the foundation and reconstitute the routing tree with very little delay and tiny energy consumption.

A. Operation of GSTEB

The operation of GSTEB is split into

a) Initial section,
b) Tree Constructing section,
c) Self-Organized information aggregation and transmittal section, and
d) info Exchanging section.

a) Initial section

In Initial section ,the network parameters area unit initialized. Initial section is splited into 3 steps.

Step 1: once Initial section starts ,BS broadcasts a packet to each of the nodes to apprise them of outset, the length of your time slot and also the quantity of nodes N. As all the nodes acquire the packet, they're going to calculate their individual energy-level (EL).

Step 2: each node sends its packet during a circle with a precise radius throughout its own interval when Step one.For illustration, among the i interval ,the node whose ID is i'll send away its packet. This packet contains a introduction and also the info as an example coordinates and EL of node i.Every alternative node during this period of time can observe the channel, and if a number of them area unit the neighbours of node i ,they can receive this packet and record the data of node i in memory storage.

Step 3: each node sends a packet that consists of all its neighbours' info throughout its own period of time when Step a pair of is over. then its neighbours will acquire this packet and record the data in memory storage.

b) Tree Constructing section

In each spherical, GSTEB performs the varied steps to create a routing tree:

Step 1: Bachelor of Science assigns a node as root and broadcasts root ID and root coordinates to each detector nodes.

Step 2: each node tries to choose a parent in its neighbours exploitation EL.

Step 3: Since all nodes chooses the parent as of its neighbors and every node records its neighbors' neighbors' info in Table II, all node will acknowledge all its neighbors' parent nodes by computing, and it will furthermore recognize all its kid nodes. If a node has no kid node, it defines itself as a leaf node, from that the info transmittal starts.

c) Self-Organized information aggregation and transmittal section

After the routing tree is built, each detector node collects info to provide a DATA_PKT that needs to be transmitted to Bachelor of Science.

d) Information Exchanging section

For Case1, as a result of each node needs to form and transmit a DATA_PKT in each spherical, it should exhaust its energy and expire. The vanishing of any detector node will influence the topography.Therefore the nodes that area unit planning to die ought to apprise others.

For Case2, Bachelor of Science will gather the initial EL and coordinates info of each detector nodes in 1st section. for each spherical, Bachelor of Science builds the routing tree and also the agenda of the network by exploitation the EL and coordinates info. Once the routing tree is made, the energy expenditure of each detector node during this spherical may be calculated by Bachelor of Science ,thus the data needed for conniving the topology for succeeding spherical may be known prior to.

B. Benefits of GSTEB

Following ar the varied advantages of GSTEB protocol:

1) The chief advantage of GSTEB is that it balance the network load.
2) GSTEB achieves a improved performance in energy saving, since each node has extra opportunities to pick out the adjacent neighbor because the parent.
3) The energy for building the routing tree is deeply condensed.
4) within the GSTEB , once the foundation node is electoral, all alternative nodes calculate and find their own oldsters by themselves in equivalent with no any info swap ,so the energy utilization is neglected.
5) GSTEB achieves a extended network lifetime for various applications.
6) GSTEB encompasses a improved performance than alternative protocols in leveling energy utilization, so prolonging the lifetime of WSN.

III. PRIORITY-BASED APPLICATION-SPECIFIC CONGESTION CONTROL CLUSTERING PROTOCOL

Wireless detector networks comprise resource-starved detector nodes, that area unit deployed to sense the surroundings, gather knowledge, and transmit it to a base station (BS) for additional process. Cluster-based hierarchical-routing protocols area unit accustomed expeditiously utilize the restricted energy of the nodes by organizing them into clusters. solely cluster head (CH) nodes area unit eligible for gathering knowledge in every cluster and transmittal it to a Bachelor of Science. Unbalanced clusters lead to network congestion, thereby inflicting delay, packet loss, and degradation of Quality of Service (QoS) metrics. during this study, we tend to propose a priority-based application-specific congestion management clump (PASCCC) protocol, that integrates the quality and nonuniformity of the nodes to sight congestion during a network. PASCCC decreases the duty cycle of every node by maintaining threshold levels for varied

applications. The transmitter of a detector node is triggered once the reading of a particular captured event exceeds a particular intensity level. Time-critical packets area unit prioritized throughout congestion so as to keep up their timeliness necessities. In our projected approach, CHs guarantee coverage fidelity by prioritizing the packets of distant nodes over those of near nodes. a unique queue programing mechanism is projected for CHs to attain coverage fidelity, that ensures that the additional resources consumed by distant nodes area unit used effectively. The effectiveness of PASCCC was evaluated supported comparisons with existing clump protocols. The experimental results incontestable that PASCCC achieved higher performance in terms of the network period of time, energy consumption, knowledge transmission, and different QoS metrics compared with existing approaches.

cluster-based routing protocol is given. To the foremost really effective of data, PASCCC is that the initial protocol of its kind to contemplate quality, nonuniformity, and congestion detection and mitigation utilizing a bunch hierarchy. several studies have addressed congestion detection and mitigation, however they are either generic or specifically related to the transport layer. Following assumptions with reference to the PASCCC area unit made:-

1. Nodes area unit deployed indiscriminately within the field with another variety of energy values.
2. Nodes area unit designed for adjusting their transmission capability to possess the power to achieve a very distant CH on prime of a particular spherical.
3. The positioning of a Bachelor of Science is not fastened and it'd be either at intervals or far from detector field.
4. Nodes area unit designed for moving throughout the sector to hide vacant areas utilizing the random waypoint quality model with AN rate of interest V, wherever the goodness of V ranges between Vmin and Vmax. Hence, complete coverage of the detector field is secured.

In PASCCC, the nodes area unit designed for moving over the sector if necessary to possess the power to hide vacant regions. quality ensures complete coverage and property in the slightest degree times. Hence, it isn't as doubtless that a generated event goes unreported. In PASCCC, 100 percent of the nodes area unit advanced. These nodes have higher energy in distinction to traditional nodes, thereby developing a heterogeneous quantity of nodes within the network. PASCCC is certainly AN application-specific protocol. In scheme, 2 application parameters area unit thought victimization PASCCC: temperature and humidness. PASCCC acts as a reactive protocol for temperature observance and as a proactive protocol for humidness. In reactive routing protocols, the nodes react like a shot to unforeseen and forceful changes within the values of detected events, and they are appropriate for time-critical applications. In proactive routing protocols, the nodes activate their transmitters, sense environmental surroundings, and report captured knowledge sporadically to the Bachelor of Science. These protocols area unit deserve applications that require periodic knowledge transmission.

IV. TABU SREACH

Tabu Search may be a meta-heuristic that guides a neighbourhood heuristic search procedure to explore the answer house on the far side local optimality. one in every of the most elements of Tabu Search is its use of adaptative memory, that creates a additional versatile search behavior. Memory-based ways ar so the hallmark of tabu search approaches, based on an exploration for "integrating principles," by that different sorts of memory a befittingly combined with effective ways for exploiting them. a completely unique finding is that such principles ar typically sufficiently potent to yield effective downside finding behavior in their title, with negligible reliance on memory. Over a good vary of downside settings, however, strategic use of memory will create dramatic variations within the ability to resolve issues. Pure and hybrid Tabu Search approaches have set new records to find higher solutions to issues in production coming up with and programming, resource allocation, network style, routing, monetary analysis, telecommunications, portfolio coming up with, offer chain management, agent-based modeling, business method style, prognostication, machine learning, data processing, biocomputation, molecular style, forest management and resource coming up with, among several different areas.

The TS technique is apace turning into the strategy of alternative for coming up with answer procedures for exhausting combinatorial optimisation issues. A comprehensive examination of this system will be found within the book by Glover and lagune (1997). Widespread successes in sensible applications of optimisation have spurred a ascension of the strategy as a way of distinguishing very prime quality solutions with efficiency. TS strategies have conjointly been accustomed produce hybrid procedures with different heuristic and algorithmic strategies, to supply improved solutions to issues

A. Solving the problem by local search

One of the foremost winning strategies of assaultive massive scale onerous combinatorial improvement problems is native search (Ahuja et al. 2002; Michiels et al. 2007). each native search technique relies on the construct of an area perform, that's a mapping N, that for every resolution X assigns a set of solutions N(X) that may be reached in one move ranging from X. The set N(X) is named a neighbourhood of X. a neighborhood search rule starts from a possible resolution X0 and performs a sequence of moves, that include selecting an answer

$$Xi+1 \in N(Xi).$$

By specifying methodology of selecting an answer from the neighbourhood and a stopping criterion we tend to obtain a selected form of the native search algorithms such as: unvarying improvement,simulated hardening, threshold acceptance or tabu search.

Tabu search rule .

Ensure: The neighborhood N(T).

1: N(T)←∅
2: for all ∈ E \ T do
3: verify the set of edges that area unit on the trail from i to j in T
4: for all f ∈ do
5: Add T ∪ \ f to N(T)
6: end for
7: end for
8: come N(T)

our main goal is to construct a quick tabu search rule for computing solutions of fine quality for giant instances of the minmax regret minimum spanning tree downside. the quality works on the tabu search technique and a few of its applications to onerous combinatorial improvement issues will be found in Glover (1989, 1990), Glover and lake (1997).

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V. RESULTS AND DISCUSSION

To study the GSTEB ,PASCCC routing protocol in wireless sensor network To proposed and implement TABU SEARCH GENERAL SELF ORGANIZED ENERGY BALANCE ROUTING PROTOCOL for selection of cluster head. To comparative analysis of proposed TBGSTEB(TABU SEARCH general self organized energy balance routing protocol) with general self organized energy balance routing protocol(GSTEB) and PASCCC by using parameters. Stable period , network lifetime , half node dead time , packet sent to base station , packet sent to cluster head, residual energy

B. Experimental Set-Up

In order to implement the proposed design and implementation has been done. Table 5.1 has shown a variety of constants and variables required to simulate this work. These parameters are standard values used as benchmark for WSNs.
TABLE 1

Parameter	Value
Area(x,y)	100,100
Base station(x,y)	100,100
Nodes(n)	3000
Probability(p)	0.1
Initial Energy(Eo)	0.1
transmiter_energy	50nJ/bit
receiver_energy	50nJ/bit
Free space(amplifier)	10nj/bit/m2
Multipath(amplifier)	0.0013pJ/bit/m4
a(energy factor b/w normal and advance nodes)	1
Maximum lifetime	3000
Message size	4000 bits
Effective Data aggregation	5nJ/bit/signal

C. Experiment Results

ON APPLYING CLUSTERING , PASCCC AND TBGSTEB FOLLOWING RESULTS WILL BE ACHIEVED.

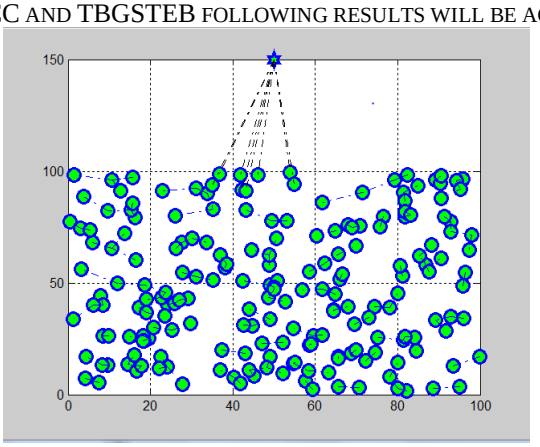

FIG.1: WHEN ALL THE SENSOR NODES ARE ALIVE

Fig1 is showing the active environment of ABC based GSTEB. Blue around is representing the base station. Blue around are representing the normal sensor nodes. Black dots line are representing how data communicate to the base station. The black dotted lines shows the commutation between the member nodes and cluster head.

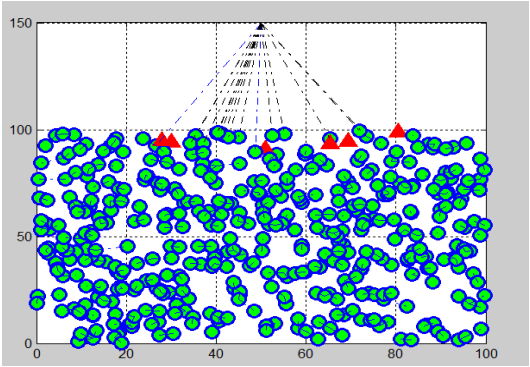

FIG2: WHEN FIRST NODE IS DEAD

FIG2 showing the environment of ABC based GSTEB in which one node is dead. Dead node is represented by red triangle. Blue around are representing the normal sensor nodes. Black dotted lines are representing how data communicate to the base station. Blue lines are showing the Communication between member nodes to cluster head.

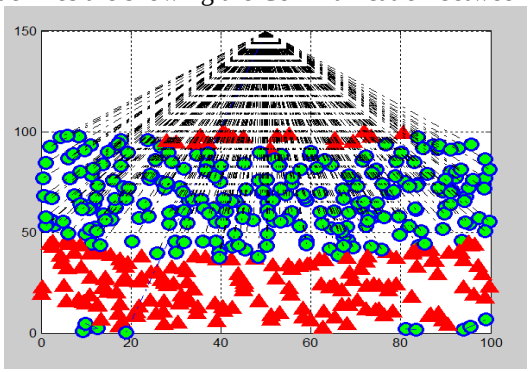

FIG. 3: WHEN HALF NODES ARE DEAD

FIG3 is showing the environment of ABC based GSTEB in which half nodes are dead. Dead nodes are represented by red triangle. Black spot is representing the base station. Blue around are representing the normal sensor nodes. Black dotted lines are representing how data communicate to the base station. Blue dotted lines are showing the Communication between member nodes to cluster head.

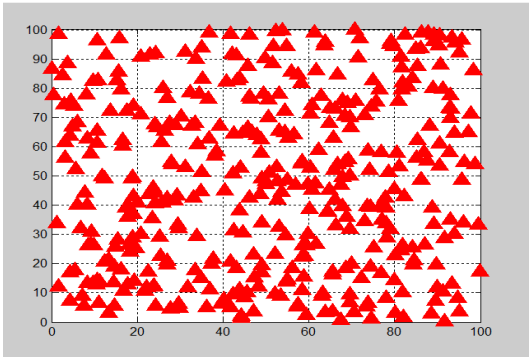

FIG. 4: WHEN ALL NODES ARE DEAD

FIG4 is showing the environment of ABC based GSTEB in which all nodes are dead. Dead nodes are represented by red trinagle

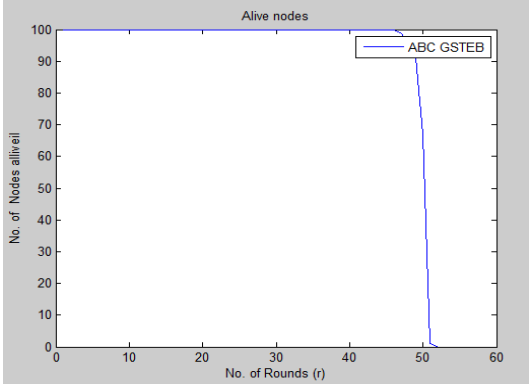

FIG 5: ALIVE NODES

Fig. 5 showing alive nodes. X-axis is representing alive number of nodes. Y-axis is representing the number of rounds.

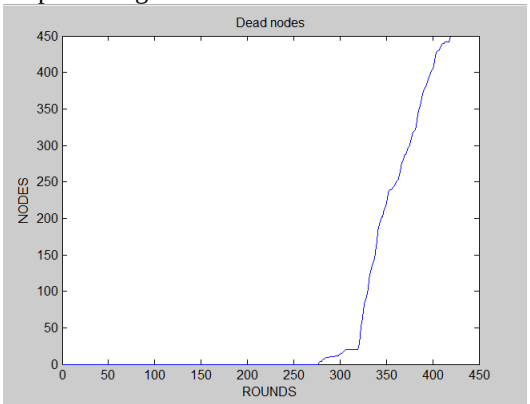

FIG.6 DEAD NODES

Fig.6 showing dead node nodes. X-axis is representing dead number of nodes. Y-axis is representing the number of rounds.

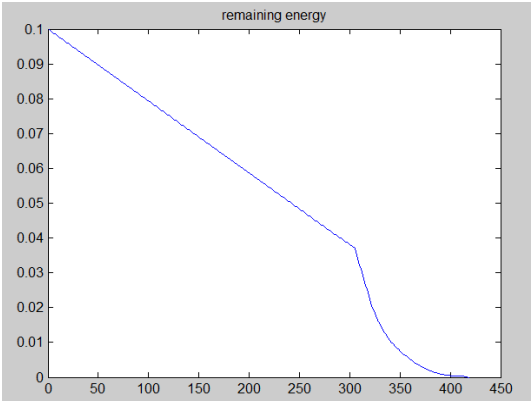

FIG.7: REMAINING ENERGY

FIG7.showing the remaining energy. X-axis is representing the number of rounds. Y-axis is representing the energy in joules.

Gsteb, pascc routing protocol in wireless sensor network. To proposed and implement tabu search general self organized energy balance routing protocol for selection of cluster head.to comparative analysis of proposed tbgsteb(tabu search general self organized energy balance routing protocol) with general self organized energy balance routing protocol(gsteb) and pascc by using parameters.stable period , network lifetime , half node dead time , packet sent to base station , packet sent to cluster head, residual energy

D. RESULT IN TABULAR

TABLE.1 FIRST NODE DEAD

NUMBER OF NODE	GSTEB	PASCCC	TBGSTEB
150	207	122	440
200	200	108	439
250	198	110	445
300	197	84	451
350	198	98	449
400	199	108	456
450	200	107	455
500	198	99	459
550	199	101	458

Table 1 has shown the comparison among GSTEB, PASCCC and TBGSTEB with respect first node dead time. It has been clearly shown that the number of rounds for first node dead in case of the TBGSTEB are quite more than the GSTEB&PASCCC.

TABLE .2 HALF NODE DEAD

NUMBER OF NODE	GSTEB	PASCCC	TBGSTEB
150	360	344	445

200	351	322	452
250	327	325	455
300	298	338	459
350	296	342	461
400	282	356	462
450	270	354	464
500	276	346	463
550	277	340	464

Table.2 has shown the comparison among GSTEB, PASCCC and TBGSTEB with respect half nodes dead time. It has been clearly shown that the number of rounds for half nodes dead in case of the TBGSTEB are quite more than the GSTEB&PASCCC.

TABLE.3 ALL DEAD NODE

NUMBER OF NODE	GSTEB	PASCCC	TBGSTEB
150	389	431	454
200	376	427	463
250	358	433	472
300	350	439	471
350	345	439	473
400	348	441	484
450	347	442	487
500	339	448	481
550	338	444	491

Table 3 has shown the comparison among GSTEB,PASCCCand proposed TBGSTEB with respect all node dead time. It has been clearly shown that the number of rounds for All node dead in case of the proposed TBGSTEB are quite more than the GSTEB &PASCCC.

TABLE.4 PACKET SEND TO CLUSTER HEAD

NUMBER OF NODE	GSTEB	PASCCC	TBGSTEB
150	46.6600	179.2000	445.9200
200	45.7500	174.1450	452.8500
250	45.8800	172.6800	457.9240
300	57.5667	174.6033	460.3167
350	52.8629	175.7286	462.4314
400	54.6950	176.0600	463.4050
450	54.7533	177.6889	464.9844
500	55.8690	176.9200	465.7780
550	54.4618	176.8345	466.8655

Table.4 has shown the comparison among GSTEB,PASCCC and TBGSTEB with respect packets sent to BS. It has been clearly shown that the number packets sent to cluster head in case of the TBGSTEB are quite more than the GSTEB &PASCCC.

TABLE .5 PACKET SEND TO BASE SATATION

NUMBER OF NODE	GSTEB	PASCCC	TBGSTEB
150	46.6600	13.5667	85.4333
200	45.7500	10.3300	54.2750
250	45.8800	8.3760	53.3280
300	57.5667	7.0133	68.4287
350	52.8629	6.0429	65.3571
400	54.6950	5.3500	64.3575
450	54.7533	4.7822	61.8111
500	55.8690	4.3220	60.9460
550	54.4618	3.8764	59.5345

Table.5 has shown the comparison among GSTEB,PASCCC and TBGSTEB with respect packets sent to BS. It has been clearly shown that the number packets sent to base station in case of the TBGSTEB are quite more than the GSTEB &PASCCC.

TABLE 6 RESIDUAL ENERGY

NUMBER OF NODE	GSTEB	PASCCC	TBGSTEB
150	0.1426	0.1109	0.1490
200	0.1053	0.0807	0.1133
250	0.0822	0.0648	0.0916
300	0.0649	0.0549	0.0767
350	0.0554	0.0471	0.0660
400	0.0476	0.0423	0.0516
450	0.0412	0.0378	0.0517
500	0.0374	0.0339	0.0465
550	0.0342	0.0309	0.0424

Table.6 has shown the comparison among GSTEB, PASCCC and TBGSTEB with respect residual energy. It has been clearly shown that the residual energy in case of the TBGSTEB is quite more than the GSTEB &PASCCC.

a). First Node Dead Time (Stable Period Evaluation)

The comparison among GSTEB,PASCCC and TBGSTEB with respect first node dead time. It has been clearly shown that the number of rounds for first node dead in case of the proposed are quite more than the GSTEB and PASCCC. It has clearly verified that the TBGSTEB is comparatively better than the both protocols.

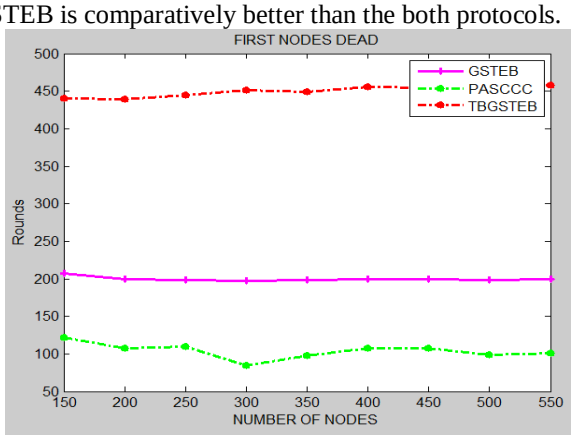

Fig a First Node Dead

b). Half Node Dead Time

The comparison among GSTEB,PASCCC and TBGSTEB with respect half nodes dead time. It has been clearly shown that the number of rounds for half nodes dead in case of the TBGSTEB are quite more than the GSTEB and PASCCC. It has clearly verified that the TBGSTEB is comparatively better than the available protocols

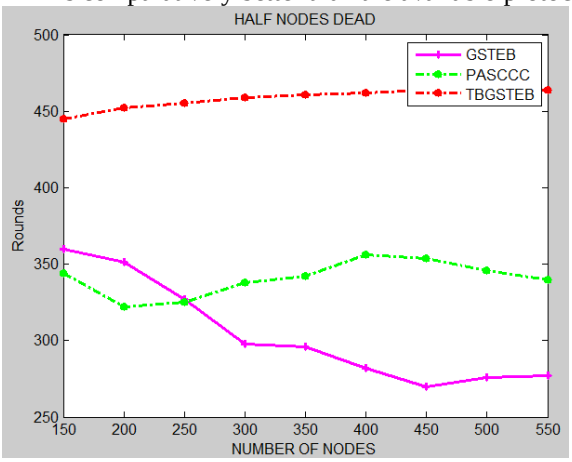

Fig.b Half Node Dead

c). All Dead Node Time I.E. Network Lifetime

The comparison among GSTEB,PASCCC and TBGSTEB with respect all dead node time. It has been clearly shown that the number of rounds for all dead node in case of the TBGSTEB are quite more than the GSTEB and PASCCC. It has clearly verified that the TBGSTEB is comparatively better than the available protocols.

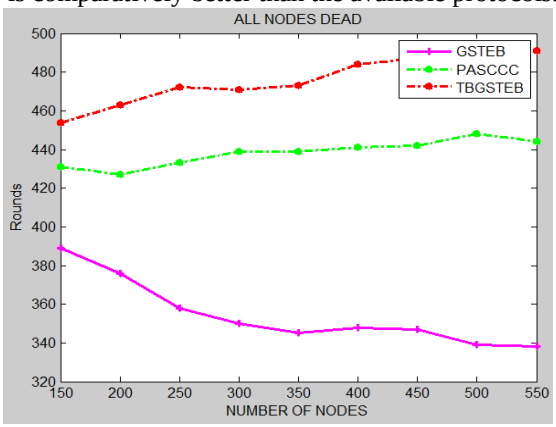

Fig c All dead node

d) Packets Sent To Base Station (Throughput)

The comparison among GSTEB,PASCCC and TBGSTEB with respect to number of packets transferred between the base stations to cluster head as well as between cluster head to member nodes in each round. It has been clearly shown that the packets with in case of the TBGSTEB are quite more than the GSTEB and PASCCC. It has clearly confirmed that the TBGSTEB is comparatively better than the available protocols.

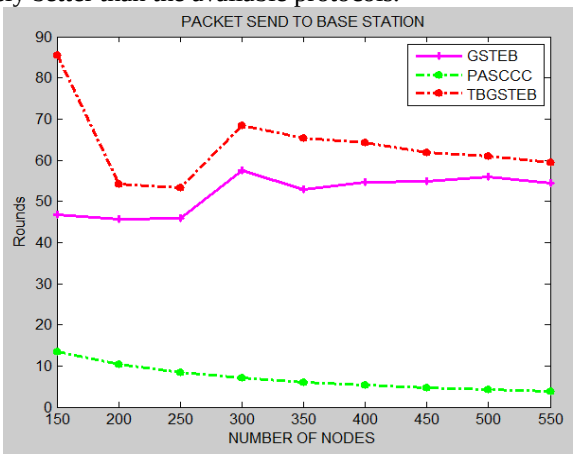

Fig d Packet sent to base station

e). Packets Sent To Cluster Head

The comparison among GSTEB,PASCCC and TBGSTEB with respect to number of packets transferred between the cluster head to base station as well as between base station to member nodes in each round. It has been clearly shown that the packets with in case of the TBGSTEB are quite more than the GSTEB and PASCCC. It has clearly conformed that the TBGSTEB is comparatively better than the available protocols

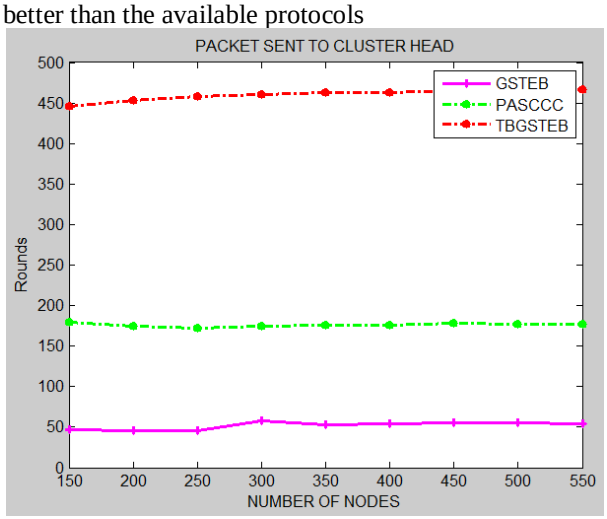

Fig e. Packet sent to cluster head

f). Remaining Energy (Residual Energy)

The comparison among GSTEB, PASCCC and TBGSTEB with respect to average remaining energy i.e. remaining energy. It has been clearly shown that the residual energy in case of the TBGSTEB are quite more than the GSTEB,PASCCC. It has clearly confirmed that TBGSTEB is comparatively better than the existing protocol.

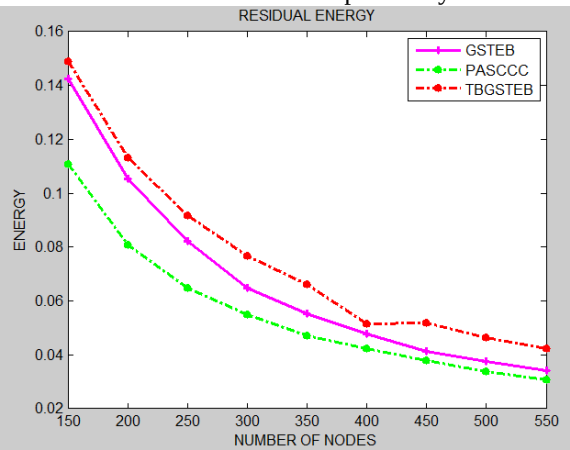

Fig f. residual energy

V. CONCLUSIONS

Many protocols has been proposed so far to improve the energy efficiency further but still much enhancement can be done. GSTEB has shown quite significant results over the available WSNs protocols. But it has neglected many issues. In order to overcome the constraints of the earlier work a new improved technique is proposed in this research work. The proposed technique has the ability to overcome the limitations of the GSTEB routing protocol by using clustering and TABU search. The proposed technique is designed and implemented in the MATLAB tool with the help of data analysis toolbox. Experiments has clearly shown that the proposed technique outperforms over the available methods. However this work has not consider the use of 3D WSNs, therefore in future work we willl extend the proposed technique for 3D WSNs environment.

REFERENCES

[1] Tang, ShaoJie, et al. "DAWN: energy efficient data aggregation in WSN with mobile sinks." Quality of Service (IWQoS), 2010 18th International Workshop on. IEEE, 2010.

[2] Xibei, Jia, Zhang Huazhong, and Zhang Jingchen. "Research of data aggregation routing protocol in wsn data-related applications." Computer Science and Information Technology (ICCSIT), 2010 3rd IEEE International Conference on. Vol. 1. IEEE, 2010.

[3] Bista, Rabindra, Kim Hee-Dae, and Jae-Woo Chang. "A new private data aggregation scheme for wireless sensor networks." Computer and Information Technology (CIT), 2010 IEEE 10th International Conference on. IEEE, 2010.

[4] Xiao, Haitao, et al. "The health monitoring system based on distributed data aggregation for WSN used in bridge diagnosis." SICE Annual Conference 2010, Proceedings of. IEEE, 2010.

[5] Zanjani, Motahareh Bahrami, Reza Monsefi, and Arash Boustani. "Energy efficient/highly secure data aggregation method using tree-structured orthogonal codes for Wireless Sensor Networks." Software Technology and Engineering (ICSTE), 2010 2nd International Conference on. Vol. 2. IEEE, 2010.

[6] Hasenfratz, David, et al. "Analysis, comparison, and optimization of routing protocols for energy harvesting wireless sensor networks." Sensor Networks, Ubiquitous, and Trustworthy Computing (SUTC), 2010 IEEE International Conference on. IEEE, 2010.

[7] Raju, G. T., et al. "Wireless sensor network lifetime optimization." Advances in Recent Technologies in Communication and Computing (ARTCom 2011), 3rd International Conference on. IET, 2011.

[8] Zhu, Liehuang, and Meng Li. "An energy efficient and integrity-preserving aggregation protocol in wireless sensor networks." Performance Computing and Communications Conference (IPCCC), 2011 IEEE 30th International. IEEE, 2011.

[9] Nie, Pin, and Bo Li. "A cluster-based data aggregation architecture in WSN for structural health monitoring." Wireless Communications and Mobile Computing Conference (IWCMC), 2011 7th International. IEEE, 2011.

[10] Chu, Hung-Chi, et al. "Design and implementation an energy-aware routing mechanism for solar wireless sensor networks." High Performance Computing and Communications (HPCC), 2011 IEEE 13th International Conference on. IEEE, 2011.

[11] Mathapati, Basavaraj S., Siddarama R. Patil, and V. D. Mytri. "Energy Efficient Reliable Data Aggregation Technique for Wireless Sensor Networks."Computing Sciences (ICCS), 2012 International Conference on. IEEE, 2012.

[12] Tamilselvan, G. M., and S. Kiruthika. "An energy efficient data aggregation based medium access control protocol using centre at nearest source approach for sensor networks in a lattice topology." Computing, Communication and Applications (ICCCA), 2012 International Conference on. IEEE, 2012.

[13] Eu, Zhi Ang, and Hwee-Pink Tan. "Adaptive opportunistic routing protocol for energy harvesting wireless sensor networks." Communications (ICC), 2012 IEEE International Conference on. IEEE, 2012.

[14] Mantri, Dnyaneshwar, Neeli Rashmi Prasad, and Ramjee Prasad. "BHCDA: Bandwidth efficient heterogeneity aware cluster based data aggregation for Wireless Sensor Network." Advances in Computing, Communications and Informatics (ICACCI), 2013 International Conference on. IEEE, 2013.

[15] Said, Adel Mounir Sareh, et al. "Dynamic aggregation protocol for wireless sensor networks." Advanced Information Networking and Applications (AINA), 2013 IEEE 27th International Conference on. IEEE, 2013.

[16] Wu, Yin, and Wenbo Liu. "Routing protocol based on genetic algorithm for energy harvesting-wireless sensor networks." IET Wireless Sensor Systems3.2 (2013): 112-118.

[17] Mantri, Dnyaneshwar, Neeli R. Prasad, and Ramjee Prasad. "Grouping of clusters for efficient data aggregation (GCEDA) in wireless sensor network."Advance Computing Conference (IACC), 2013 IEEE 3rd International. IEEE, 2013.

[18] Hooman Ghaffarzadeh and Ali Doustmohammadi , "Two-phase data traffic optimization of wireless sensor networks for prolonging network lifetime", 2013.

[19] Han, Zhao, Jie Wu, Jie Zhang, Liefeng Liu, and Kaiyun Tian. "A General Self-Organized Tree-Based Energy-Balance Routing Protocol for Wireless Sensor Network." (2014): 1-1.

