Comparative Analysis of Energy Efficient Clustering Protocol in Wireless Sensor Networks

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Abstract—The clustering based protocols are the best for the heterogeneous wireless sensor networks because they perform the work on divide and conquer rule. In this study, the mainly focus is on the cluster head selection using tabu search in energy efficient clustering protocol. Due to limited energy in sensor nodes, the networkis not stable. For this, many protocols has been proposed so far to improve the energy efficiency .This paper presents the comparative analysis of REAC-IN protocol with Tabu based REAC-IN protocol in terms of alive nodes, energy variance and data received to the sink in bytes. The simulation results show that tabu based REAC-IN protocol performs better instead of REAC-IN protocol

Keywords- *REAC-IN,WIRELESS SENSOR NETWORK ,TABU SEARCH*

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I. INTRODUCTION

Wireless sensor networks (WSN) is formed by collection of sensor nodes, which are small energy constrained devices. Due to the limitation of small energy in nodes, the energy efficiency is considered to be a very important factor in wireless sensor network. Wireless Sensor network is consists of small distributed sensor nodes offering the reliable monitoring in several environments such as battlefield monitoring, disaster management, wildlife monitoring and civil applications. The wsn is also able to deploy the unchained sensors in areas without using any infrastructure for sound, pressure, pollutants or target tracking. The sensor nodes process data and send it to base station called as sink.

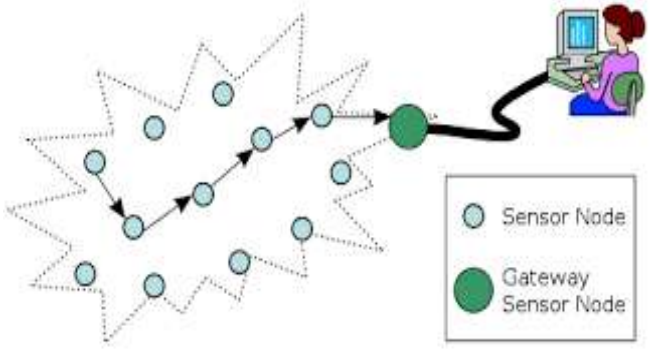

Fig 1. Wireless sensor network

For communication of data between nodes and sink many routing technologies are used such as single hop [1,2] and multi hop data transmission. But due to limited battery life of nodes these techniques were not so much effective due to early death of some nodes. These techniques were failed to achieve the network stability periods. A WSN contains a wide array of nodes which can be tightly or arbitrarily deployed in a location by which they have interest. There is Base Stations [13] (BS) situated to sensing area. The bottom station having major function in WSN as sink send queries to nodes while nodes sense the asked queries and send the sensed information in a joint way reverse to Base station. Base station also serves as an entrance for outer surface system i.e. Internet. And so the number of information and send only relevant data to customer via internet is performed by Base station. Because it is known nodes have little batteries which are hard to change or recharge. So to check out such structural design (having a lot less transfer and concentrated communication space) to improve power saving. You will find positive structural design like flat-network architecture and hierarchical network [15] architecture.

II. CLUSTERING TECHNIQUES

2.1 Clustering

In order to reduce power utilization, clustering [6,7,8] is used. In clustering, the sensor nodes select a cluster head and the nodes which fit in to the cluster send their information to the cluster head and data is aggregated at the cluster head [4] and then transmitted to the base station. A sensor in each cluster selected as a CH (Cluster Head), is responsible for transmission schedule, gathering information and fusing data and transmits back to the sink. Clustering algorithm [10,11,12] is used for the longer lifetime. All the algorithms and processing of data is done at the cluster head. One of many earliest works proposing this process in WSNs is LEACH[5] (Low Energy Adaptive Clustering Hierarchy), DEEC[3] (Design of a distributed energy-efficient clustering), EDACH (Energy-Driven Adaptive Clustering Hierarchy) and EEUC (An Energy-Efficient Unequal Clustering Mechanism) proposed with the objective of minimizing energy usage, while extending network life time.

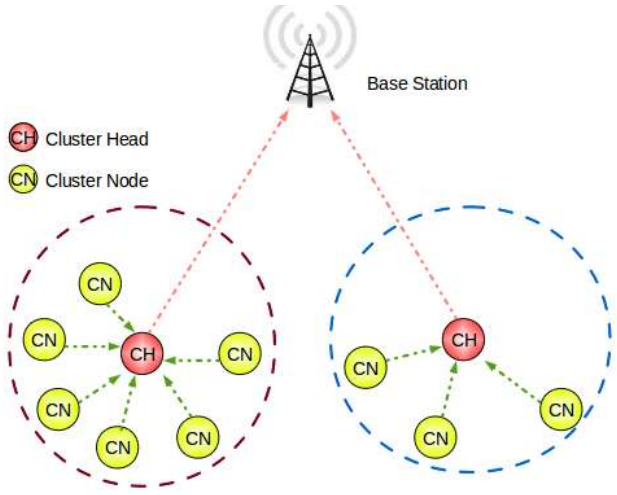

Fig 2. Cluster Formation

2.2 Clustering Objectives

Clustering is the main issue while using in the wireless sensor networks. The three main objectives of clustering are following.

- Maximizing network Life-time
- Fault-tolerance
- Fill handling

2.3 Communication in clustering

There are two types of communication in clustering techniques. These are inter-cluster communication and intra-cluster communication.

Inter-cluster communication:- In the inter-cluster communication, the communication is between one cluster head to another cluster head, or we can say, the inter cluster communication is between the one and another clusters.

Intra-cluster communication:- In the intra –cluster communication, the communication is within the clusters.

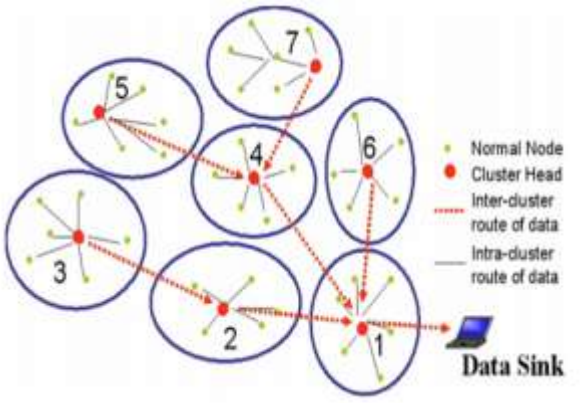

Fig 3.Communication in clustering.

III. REAC-IN

REAC-IN (Regional Energy aware Clustering with isolated nodes) tells how the each node consumes the energy in a uniform manner by rotating the cluster head throughout the all nodes. The selection process of cluster head in REAC-IN protocol is based on the factor weight. Weight is based on the threshold using in the residual energy of each node and regional average energy of all sensors in each cluster to distribute cluster heads, where LEACH selects the CH using the threshold value by considering the predefined probability only. REAC-IN protocol adapting the rotating epoch of single node to its energy and shows the problem of node isolation. The clustering algorithm which is used is not perfect which causes the problem of isolation. The isolated nodes communicate with the base station by taking extra amount of energy. The regional average energy and the distance among the sensors and the base station is used to determine whether the isolated node sent its data to a cluster head in the previous round or to the base station.

Isolated Nodes

Every sensor nodes have its energy to sense the surroundings and the sensed data is transferred to the sink. Due to improperly doing the design of clustering algorithm makes the creation of isolated nodes. The problem of energy consumption in isolated nodes become obvious, if the distance between them is far. For prolonging the network lifetime, the regional average energy of all sensors and distance between sensors and sink were analyzed to determine whether the isolated node send its data to cluster head or to the sink.

IV. TABU

Tabusearch [8, 9] are often thought-about as a generalization of repetitive enhancements like militia. TS relies on ideas that may be employed in each computer science and improvement fields. TS was much better by several researchers. TS apply to boundaries to direct the search for diverse regions. These restrictions are in respect to memory structures that may be thought of as intelligent qualifications. Intelligence wants adaptive memory and responsive exploration .As an example, whereas climb a stack one remember (adaptive memory) attribute of methods s/he has traveled and makes strategic choices (responsive exploration) on the thanks to reach your peak or descent. TS conjointly uses approachable investigation as a result of a nasty strategic call could offer a lot of data than an honest random one to come back up with quality solutions. TS has memory property that distinguishes it from different search styles. it'sadaptative memory that's conjointly completely different from rigid memory employed by branch and sure methods. Four type of Memory dimensions found in Tabu search like its quality, its recency, frequency and influence. TS force a move to a neighbor with least value deterioration.

4.1 Algorithm ofTabu search

Step 1 : Initialization
a) Select a starting solution $\boldsymbol{y^{now}}$ € y.
b) $\boldsymbol{y^{best}}$ =$\boldsymbol{y^{now}}$, best_cost= c($\boldsymbol{y^{besst}}$).

c) Set the history record H empty.

Step 2: Choice and termination
Determine candidate_N (y^{now}) as a subset of N(H,y^{now}).
Select y^{next} from candidate_N (y^{now}) to minimize c(H,y).
Terminate by a chosen iteration cut-off rule.

Step 3: Update
Re-set y^{now}= y^{next}.
If c(y^{now})< best_cost, perform step 1 (b).
Update the history record H.
Return to step 2.

4.2 Advantages of the Algorithm
1) Tabu allows non-improving solutions also.
2) Used for both discrete and continuous solutions.
3) Tabu solves the complex problems like quadratic assignments and scheduling.

4.3 Disadvantages of the algorithm
1) In tabu Search, so many parameters has to be defined.
2) Iteration could be very large.
3) Not found the global optimum.

V. EXPERIMENTAL SET-UP

To implement the proposed design and implementation has been done. Table 5.1 has shown the some constants and variables which is used for experimental set up. Here, the parameters are standard values used as benchmark for WSNs.

Table 1. EXPERIMENTAL SETUP

Parameter	Value
Area(x,y)	200,200
Base station(x,y)	100,100
Nodes(n)	200
Probability(p)	0.1
Initial Energy(Eo)	2
Transmiter_energy	50nJ/bit
Receiver_energy	50nJ/bit
Free space(amplifier)	10nj/bit/m2
Multipath(amplifier)	0.0013pJ/bit/m4

Simulation Results
This section describes the simulation evaluation of the REAC-IN protocol and tabu REAC-IN using the MATLAB simulator. The parameter which used in the simulation environment [10] are described in the table. The base station is present in the center of the network region. In this scenario, the cluster head selection is done by the tabu search and following results are obtained.

EXPERIMENT RESULTS

On applying the clustering technique, the following results will be achieved.

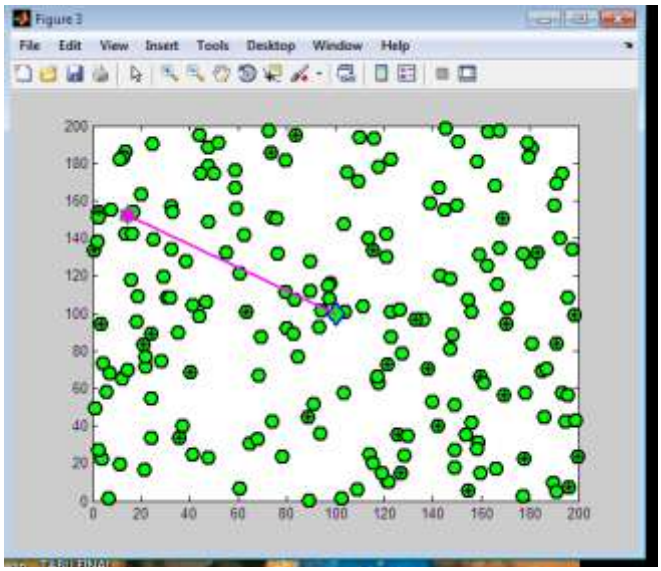

Figure.5.1.1: when all the sensor nodes are alive

Fig.5.1.1 is showing the active environment of Tabu based REAC-IN. Blue diamond shape node is representing the base station. Blue nodes represent the normal sensor nodes.

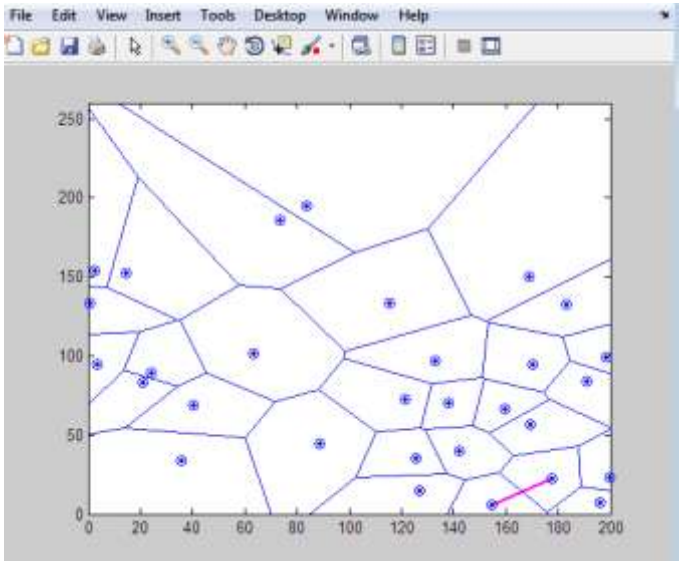

Figure.5.1.2: Selection of cluster heads

This Figure represents the scenario of cluster heads, how the clustering is done by using the suitable clustering algorithm. Red dotted line represents the data communication.

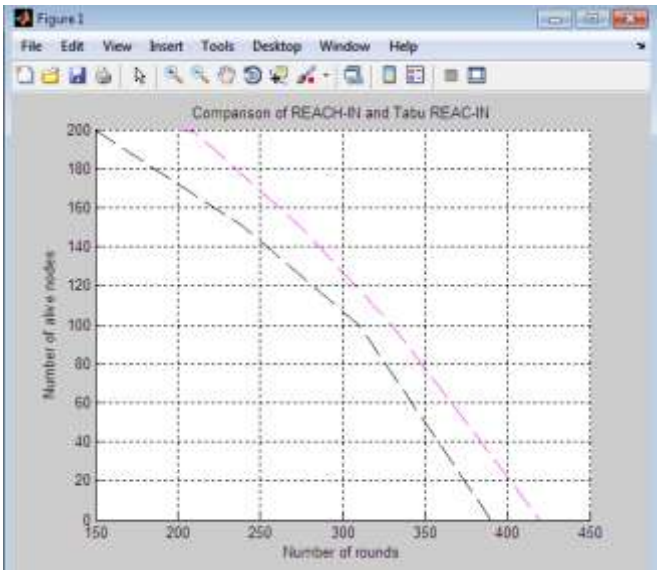

Figure 5.1.3: Alive Nodes

Fig.5.1.3 is showing alive nodes. X-axis is representing the rounds and Y-axis is representing the number of nodes alive .The black dotted line represents the performance of REAC-IN protocol, while the Red dotted line represents the Tabu based REAC-IN protocol. From the figure, we observe that the number of alive nodes are more in case of Tabu REAC-IN protocol.

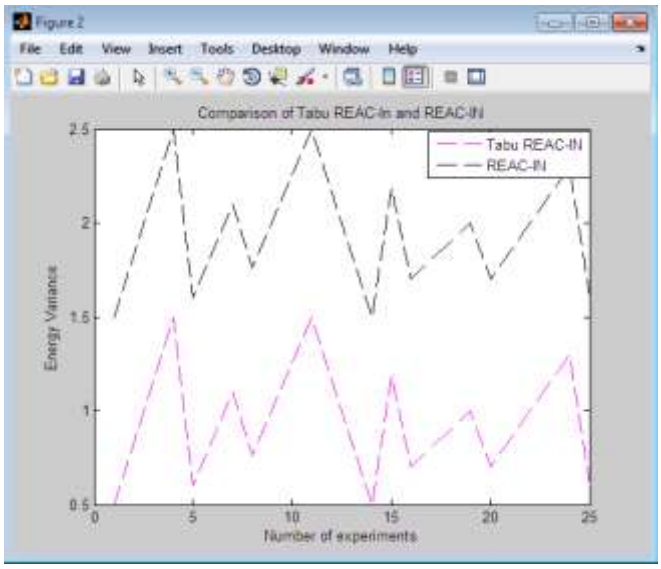

Figure.5.1.4 Energy Variance

Fig.5.1.4 is showing the energy variance. X-axis is representingthe number of experiments and Y-axis is representing the energy variance. From this figure, we observe that the energy variance is less in Tabu search based protocol while more in REAC-IN protocol because the selection of CH using the tabu search consumes the less energy.

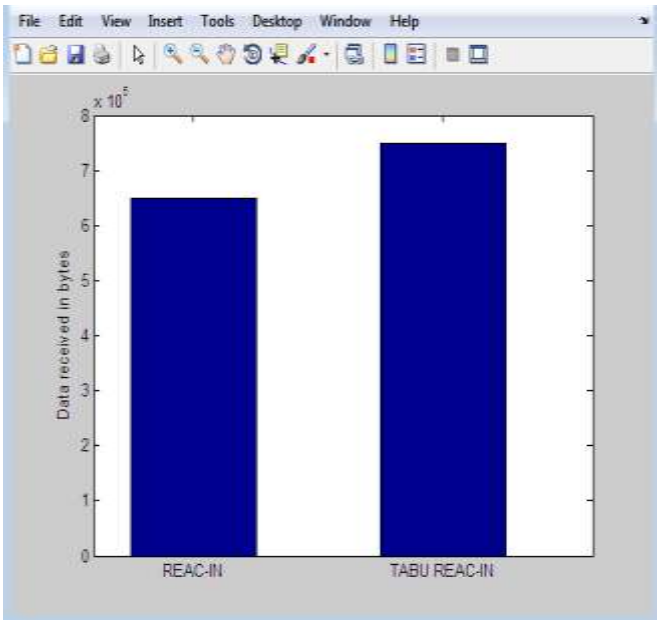

Figure.5.1.5: Number of data received at the sink

Fig.5.1.5 is showing the data received at the sink. X-axis is representingthe name of the protocols and Y-axis is representing the amount of data received in bytes.

CONCLUSION AND FUTURE SCOPE

To improve the energy efficiency, many protocols has been proposed. Tabu REAC-IN has shown quite significant results in WSNs environment. The proposed technique improves the cluster head selection process and makes the network more stable and efficient and have a long lifetime. This technique is designed in the data analysis toolbox used in the MATLAB tool. This work has not used for the 3D WSNs; therefore we will extend the proposed technique for 3D WSNs environment in future work.

REFERENCES

[1] Kumar, Dilip, Trilok C. Aseri, and R. B. Patel. "EEHC: Energy efficient heterogeneous clustered scheme for wireless sensor networks." Computer Communications 32.4 (2009): pp. 662-667.

[2] Gautam, Navin, and Jae-Young Pyun. "Distance aware intelligent clustering protocol for wireless sensor networks." Communications and Networks, Journal of 12, Volume no. 2 ,2010 pp. 122-129.

[3] Saini, Parul, and Ajay K. Sharma. "E-DEEC-enhanced distributed energy efficient clustering scheme for heterogeneous WSN." Parallel Distributed and Grid Computing (PDGC), 2010 1st International Conference on. IEEE, 2010.

[4] Wang, Xu, LiyanQian, Jianjun Wu, and Tian Liu. "An energy and distance based clustering protocol for wireless sensor networks." In Novel Algorithms and Techniques in Telecommunications and Networking, pp. 409-412. Springer Netherlands, 2010.

[5] Xunbo, Li, Li Na, Chen Liang, Shen Yan, Wang Zhenlin, and Zhu Zhibin. "An improved LEACH for clustering protocols in wireless sensor networks." In Measuring Technology and

Mechatronics Automation (ICMTMA), 2010 International Conference on, vol. 1, pp. 496-499. IEEE, 2010.

[6] Shilpa et al." Energy balanced QOS based cluster head selection strategy for WSN", Egyptian Informatics journal(Elsevier), 2014, pp.189–199.

[7] Isha, Varsha, "Study on Co-operative Communication for Energy Efficient Routing in Wireless Sensor Network", International Journal of Science and Research (IJSR), https://www.ijsr.net/archive/v5i8/v5i8.php, Volume 5 Issue 8, August 2016, 297 – 300.

[8] Harshdeep,Varsha. "Tabu Search and Tree Based Energy Efficient Protocols for Wireless Sensor Networks". International Journal of Advanced Research in Computer Science and Software Engineering (IJARCSSE) ISSN: 2277-128X, Impact Factor: 2.5, Vol-5, Issue-9, Page no 923-933, September2015.

[9] Harshdeep,Varsha. "Tabu Search Based General Self-Organized Tree-Based Energy-Balance Routing Protocol (GSTEB) for Wireless SensorNetworks". International Journal of Engineering and Advanced Technology(IJEAT) ISSN: 2249-8958, Impact Factor: 1.121,Vol-5, Issue-1, Page no 66-72, October2015.

[10] J.Leu et al., "Energy efficient clustering scheme for prolonging the lifetime of wireless sensor network with isolated nodes", IEEE, Vol. 19, no. 2, feb 2015.