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Research Article

Quadrature Based Energy Efficient Hierarchical Routing Protocol for Heterogeneous Wireless Sensor Networks

Deeksha Verma†* and Satbir Singh†

†Department of Electronics Technology, Guru Nanak Dev University RC, Gurdaspur, Punjab, India

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Abstract

A very rapid advancing wireless sensor networks (WSN) and latest hierarchical protocol used in this environment leads to give the network stability, throughput and less energy consumption which leads to make the network more reliable and energy stable, have led to many new protocols specifically designed for sensor networks where energy conservation is prime aim, mostly attention given to routing protocols they might differ depending on the application and network architecture. In this most advanced environment there are so many energy conservation protocols being used for the sake of reliability and many more factors. So from the very beginning of the WSN some conventional protocols are getting used by making the advancement in them by adding some of new functions or updating the conventional protocols. So, by considering the base protocol i.e. LEACH which is usually works in the homogeneous network only, where all sensor motes have same energy levels. In this paper there is an area which is divided into the regions and these regions are further divided and used to count the cluster heads in each region and on the basis of that parameters are calculated like dead nodes, alive nodes, cluster heads, residual energy, network lifetime which all are calculated up to some finite rounds. The best possible value is taken in this case to give the optimum output of each parameter in same aspect.

Keywords: *Leach, heterogeneous, homogeneous, quadrature, residual energy, cluster head*

1. Introduction

The concept of sensor networks which has been made viable by the convergence of advanced micro sensor motes wireless networks and then firstly the sensing tasks and the potential sensor networks applications are explored at a great level and the review of the factors are used to influence the design of the sensor networks which is provided and communication architecture is outlined then algorithms and protocols on each layer are developed [K.Akkaya and M.Younis *et al*, 2005] then algorithms and protocols on each layer are developed [K.Akkaya and M.Younis *et al*, 2005]. There is advancement in the existing environment to perform well with more reliability and good factors of the networks as well. Routing is not so simple task in WSNs it is very challenging due to the inherent characteristics that distinguishes these networks from other wireless firstly, due to the large area covered with the sensor motes, so it's not an easy to build a scheme for deployment of large sensor motes because they also will have high overhead of ID maintenance secondly, when compared with the other communication in their networks sensed data flow from the multiple users to the base station thirdly, these sensor motes are tightly energy, processing and storage constraint so there is a need of energy management lastly, theses motes are generally stationary except some other mobile nodes. So all these factors shows greatly why routing is not an easy task but as the advancement happening nowadays there is need to focus only how to enhance network lifetime and with the minimum usage of energy[L. Qing, Q. Zhu, and M. Wang *et al*,2006].

In the hierarchical routing protocols are best known in regard with the energy efficiency and by using the method of clustering technology it greatly minimizes the energy consumed in collecting and disseminating data[K.Akkaya and M.Younis *et al*, 2005]. There is also concept of re-clustering method when sink node generates emergency to restore network coverage.

So, here in this paper there is conventional protocol LEACH[W. Heinzelman, A. Chandrakasan, and H. Balakrishnan *et al*,2000] is taken as base protocol which is quite common protocol for energy conservation but at the time of now there is much more advancement happened in this conventional protocol on the basis of clustering method i.e. how

*Corresponding author **Deeksha Verma** is a M Tech Scholar and **Satbir Singh** is working as Assistant Professor

many cluster heads are present in each round, which is famous for getting used in the homogeneous environment but as we all know that homogeneous environment is kind of ideal case which do not exists practically so by considering this case we simulated the LEACH[W. Heinzelman, A. Chandrakasan, and H. Balakrishnan *et al*,2000] conventional protocol quadrature form in heterogeneous environment.

2. Related Work

Based upon the optimal factor the clustering head method is chosen in homogeneous environment the technique is termed as the (LEACH) Low Energy Adaptive Cluster Hierarchy when load distributed among motes. On energy distribution basis the network is divided into homogeneous and heterogeneous and further the protocols are restricted to the particular environment. LEACH, Power Efficient Gathering In Sensor Information System (PEGASIS) [S. Lindsey and C. Raghavendra *et al*, 2002], Hybrid Energy Efficient Distributed clustering (HEED) [O. Younis and S. Fahmy *et al*, 2004] are homogeneous environment protocol while Stable Election Protocol (SEP) [G. Smaragdakis, I. Matta, and A. Bestavros *et al*, 2004] and Distributed Energy Efficient Clustering (DEEC)[L. Qing, Q. Zhu, and M. Wang *et al*,2006] used in heterogeneous environment. Q-LEACH is a protocol which describes the network performance which should be very efficient in this work some features like network stability, network lifetime and throughput for optimized performance of WSNs. For the sake of better performance of network the area is divided into four quadrants and motes distribution is also even in this case as it is the case of the homogeneous environment [B. Manzoor, N. Javaid, O. Rehman, M. Akbar, Q. Nadeem, A. Iqbal, M. Ishfaq *et al*, 2013].

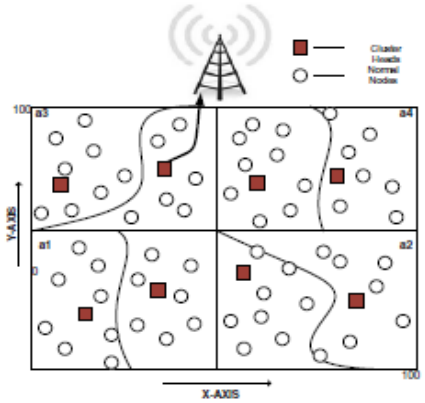


Fig 1 Network Topology

This figure shows that how load is distributed among sensor motes, it is the idea of the efficient clustering for better coverage of area. Here motes are divided equally. The overall area is represented as below:

$$A=a_1+a_2+a_3+a_4 \quad (1)$$

$$a_{n=} A(x_m,y_m)$$

where n=4 and m=100. Hence, overall field is distributed as follows:

$$\lim_{\substack{xm=0:50\\ym=0:50}} an+\lim_{\substack{xm=51:100\\ym=0:50}} an+\lim_{\substack{xm=0:50\\ym=51:100}} an+\lim_{\substack{xm=51:100\\ym=51:100}} an \quad (2)$$

By dividing the area into four quadrants each area have a definite cluster head in particular region which are stationary having optimum positions. Transmission load of other sensing nodes are reduced to a great extent. Quadrature is the upgraded version of conventional LEACH which use to drain more energy leads to degrades the network performance but here in this case the area divided into the sub sectors which shows this is more deterministic in nature as compared to the conventional protocol, nodes are well distributed in the sub sector so that it leads to have less energy drainage. In each sector for optimized clustering randomized clustering method is used. In every round nodes decide to become cluster head (CH) depends on the probability (P) and threshold T(n). In the starting step when CH is developed the value of probability is P=0.05[B. Manzoor, N. Javaid, O. Rehman, M. Akbar, Q. Nadeem, A. Iqbal, M. Ishfaq *et al*,2013].

There are two phases

i) Setup phase
ii) Node association phase

The setup phase decides the CH selection method. How CH selection occurs each node have a chances to become they used to choose random value between 0 and 1. If the value is less than the threshold T (n) then the node, and when do not meet the condition that there are desired number of CH present it used to select that node as CH. Cluster selection depends on Received Signal Strength Indication (RSSI) of the advertisement [B. Manzoor, N. Javaid, O. Rehman, M. Akbar, Q. Nadeem, A. Iqbal, M. Ishfaq *et al*, 2013]. When clusters formed motes must tell CHs about their association. Now on the basis of information is given to the CH which are attached to the nodes time slots are assigned to them on the basis of TDMA and this is broadcasted to the motes. And secondly the Node Association phase performs how motes are associated with their CH and this phase is based on the RSSI. The motes which are not involved in this process are used to remain off in the favor of optimum energy utilization. When the data of all motes received at the CH it is compressed here and then forwarded to the BS and then starts the process of new CH formation. In this work they used localized coordination in each sectored area and here for the transmission and reception of data from motes to CHs and then to the BS same radio model is used. Initially all motes send their location information to the BS so it is the BS responsibility which logically divide the area on the basis of collected information. To avoid the congestion TDMA time slots.

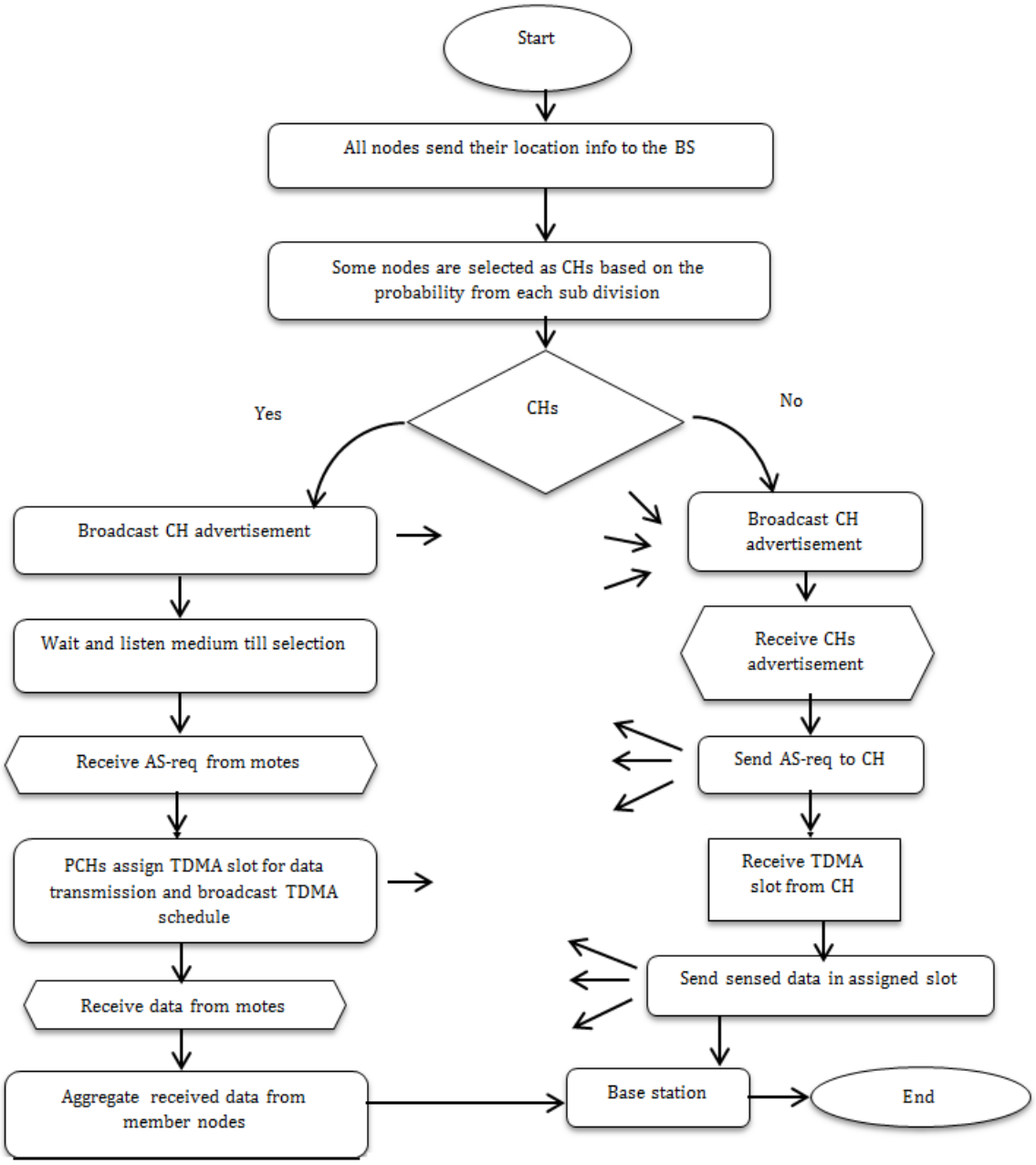


Fig 2 Working principle of Q Leach

This flow chart shows that the on the probability basis each cluster head is selected in sun divisions then again there are further conditions of being a CH or not and then broadcasts, waits and all this divided into time slots of the TDMA by receiving data then starts aggregates and ultimately in the end after every favorable perspective the data goes to the base station and then end of procedure after that the next procedure of making CH starts again if there is any problem arises regarding the CH then re clustering can also be done.

3. Proposed Work

In this proposed work there is only some parameters are added in the Q-LEACH which is added to this related work and as we know that the LEACH the conventional protocol is used in the homogeneous environment but here in the proposed the work is done in the heterogeneous environment by adding some new parameters in the related work which gives optimum output with same value of K (number of rounds) or can say that packet length is same in both cases. It is distributed and self-organized network where sensor motes will locally carry out sensing, processing and transmitting operations in an autonomous and unattended manner energy based clustering algorithm for WSNs. In this proposed work an introduction of an energy efficient heterogeneous clustered scheme based on the weighted election probability of each node to become CHs according to the criteria of residual energy. Re-clustering protocol are also presents and the next CH is selected on the basis of residual energy of each node and the average

energy of each cluster. It proposed distributed clustering algorithm where CH are elected which follows the three way text exchange between each sensor and its neighbors. The energy consumption and optimal cluster number first order radio model

E_{elec} - Energy dissipate to run radio deviation
E_{fs} - free space model of transmitter amplifier
E_{mp} - multipath model of transmitter amplifier
L - packet length
d_o - distance threshold

$$d_o=\sqrt{Efs/Emp} \quad (3)$$

Nodes division in quadrature

NN=[1 n/4;((n/4)+1) (n/2);((n/2)+1) (n-(n/4));((n-

(n/4))+1) n]; (4)

$$E_{tx}(l,d) = \{IEelec + l \in fsd^2, d < do \quad (5)$$
$$\{IEelec + l \in mpd^4. d \geq do$$

$$E_{rx}(l) = lE_{elec} \quad (6)$$

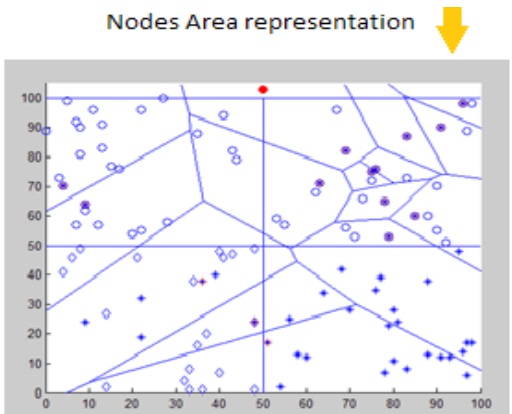
$$E_{cluster} = E_{ch} + (N/K-1) \quad (7)$$

$$E_{member} = lE_{elec}(N/K-1)+E_{tx}+(lE_{elec}+l\in f_sR\text{^}2/2K) N/K \quad (8)$$

$$E_{total} = KE_{cluster}=KE_{CH}+NE_{member} \quad (9)$$

$$K_{opt}=R/d\text{^}2 \sqrt{N \in fs/2 \in mp} \quad (10)$$

These are the basic formulas used in the proposed work used to find the required optimum simulations. The neighbor node of the sink node will directly connect to it, when initial energy levels assigned to the nodes on that basis CH is selected and each CH advertise its ID and residual energy level. If a CH found that the message of advertisement from any other cluster have higher energy level is reported by others as CH it is mainly on the basis of residual energy levels and the distance from the BS. So basically the difference is that in heterogeneous environment CH is chosen on the basis of the residual energy, motes are left with the maximum residual energy and have less distance are going to become the CH. So in this case residual energy is calculated and number of CHs in each round.



This is the network area is divided into four quadrants and on each round these are further dynamic sub divisions are present in the heterogeneous environment as all motes have different energy levels here and each sub divided area have their defined CHs[B. Manzoor, N. Javaid, O. Rehman, M. Akbar, Q. Nadeem, A. Iqbal, M. Ishfaq et al, 2013].

4. Results and Discussion

Simulations results show that the different parameters are taken on the optimum value to get the desired results and obtained from MATLAB software.

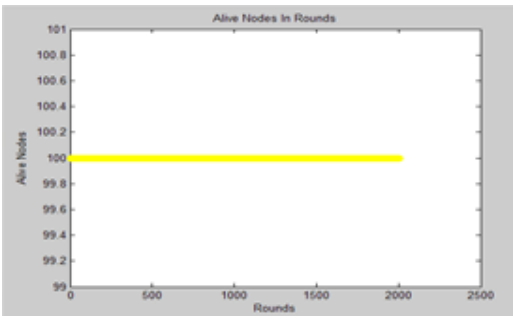


Fig 2 Alive nodes

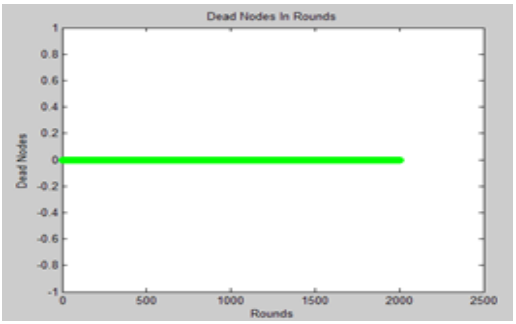


Fig 3 Dead nodes

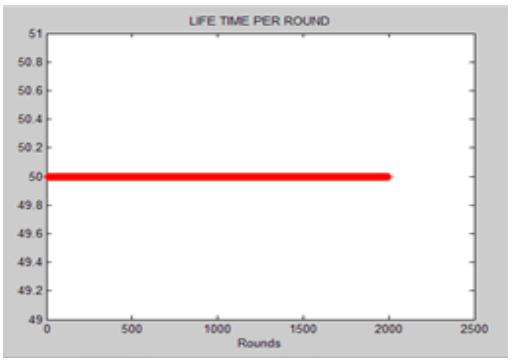


Fig 4 Lifetime of motes

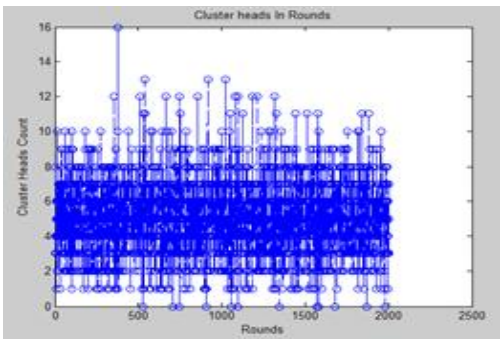


Fig 5 CHs count

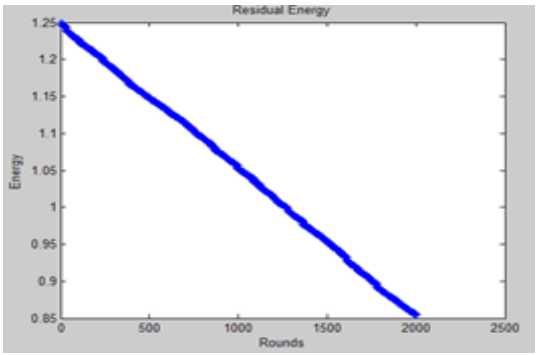


Fig 6 Residual energy

These are the simulations result of the proposed work shows five results but here two parameters are different from the related work the residual energy on the basis of that this protocol used to made capable of getting used in the heterogeneous environment and the number no CHs formed in the defined packet length or can say that definite rounds which is on x-axis up to the value of 2000 it gives optimum value or favorable case and other parameters are same but in the heterogeneous environment like dead and alive nodes are giving the best possible values.

Conclusion

As it is clearly visible here that the values of packet length is up to 2000 the network is how much stable depends on the dead and alive nodes in this simulation the dead and alive nodes are kind of giving ideal values there are zero constantly dead nodes and alive nodes are 100 best possible constant over the packet length. The lifetime of the network per rounds is constant over packet length. The cluster head selection process per round is simulated and in the last the residual energy decreasing as number of rounds increasing this concept is able to make the use of this protocol in heterogeneous environment. So, best possible values are obtained in each simulation.

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