Journal of Engineering and Applied Sciences 11 (12): 2628-2634, 2016
ISSN: 1816-949X

Increasing the Life Time of Wireless Sensor Networks by Applying Dual-Cluster Head and Angular Clustering in Mobile Base Mode

Abbas Ezoji
Department of Computer Science and Engineering,
Islamic Azad University, North Tehran Branch, Tehran, Iran

Abstract: Clustering is considered as one of the life increasing approaches in wireless sensor networks. The size of cluster head, cluster number and cluster selection is of the most important factors in clustering. Increment in cluster size leads to distance enhancementand early discharging. The decrement of cluster size leads to increase in overhead of controller data transport. Unsuitable selection of cluster heads results in increase of distance to cluster members and other clusters heads. In this research, we investigate the increase in life time of angular clustering by using dual-head cluster in wireless sensor networks in mobile sink mode. The selection of cluster head in this approach is a function of remained energy, mean distance to members and the gap between current cluster head and the previous one and also the distance it has with current sink. In this method, new cluster head is not substituted by previous cluster head until performance of the current cluster head is not less than optimum limit. Also once the optimal mean energy of the neighbor clusters of the current sink reaches to the threshold; it is the time to displacement of the sink to another position. The results show that this proposed approach leads to life increment.

Key words: Wireless sensor network, angular clustering, dual-head cluster, mobile sink, instant functionality time of cluster head, received clusters

INTRODUCTION

Wireless sensor network (Abbasi and Younis, 2007) includes hundreds or thousands of nodes by limited energy. Since, the life of each sensor is depended on its battery life amount, energy issues can be considered as basic challenges. Clustering is proposed as an approach to increase the life time in wireless sensor networks. In clustering (Singh *et al*., 2010), the environment of wireless sensor network is divided to parts called cluster. Nodes in each cluster receive data from the environment and send it to cluster head. The cluster head, after receiving data, integrates them. After integration, the data transfers via single step or multi step route to main station.

The size of cluster, the number of cluster head in each cluster and selecting cluster head and also the proper selection of multi hop route to the current base are considered as important factors in clustering. The increase in number of cluster head, itself causes the overload of control information and routing issues. Reduction in the number of cluster heads leads to increase in input load of cluster head and early discharge of cluster head. Early discharge of cluster head causes the faster replace of cluster head. Early replacing leads to increment in control information transformation and followed by energy waste (Abbasi and Younis, 2007).

The position of cluster head is considered as an important issue in clustering. According to energy model, consumable energy has direct relation with distance square. Inappropriate selection of cluster head will cause increasing distance and more energy consumption. The selection of cluster head is a function of the number of cluster members, the gap between cluster members, mean distance to cluster head, distance to main station and remaining energy.

The Leach protocol is one of the most popular protocols in the field of clustering. Each node makes decisions for the current session. Whether the cluster head to be selected? This decision making is according to the percent of required cluster head amount (p) and running time. Each node selects a digit between 0-1 randomly. If the digit is less than the threshold T (n), it will be chosen as a cluster head for next running time. The amount of threshold T (n) can be obtained by relation (1) as the following:

$$T(x) = \begin{cases} \dfrac{p}{1-P\left[\text{rmod}\left(\dfrac{1}{p}\right)\right]}, & \text{if } n \in G \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

To reduce the cluster head load, the dual cluster head method (Ruihua *et al*. 2011; Ebadi *et al*., 2010) is introduced. In these ways, the main dual cluster head and secondary cluster head are applied to collect data from cluster members and sending data from lower cluster heads, respectively. Ebadi *et al*. (2010) the selection of cluster head is based on remaining energy, the proportion of member's number in the radius of the neighborhood and received signal strength. The disadvantage of this approach is neglecting the dimension of distance and continuous replacing of cluster head. Yi and Deng (2010) the criterion is selecting the remaining energy of cluster head and the density of node. The advantage of this method is to selecting the auxiliary cluster head is based on node density. The disadvantage of this method is to replace the cluster head constantly and neglecting the distance dimension. Xuegong (2010) the choice of cluster head based on remaining energy, node distance to main station and the number of algorithm implementation. The disadvantage of this method is the imbalance of distance between members and cluster head.

In this study by applying angular clustering with selecting two cluster head in each cluster in mobile sink mode we increase the life time in wireless sensor network. The function of cluster head selection is dependent on remaining energy, the mean distance to cluster members and the distance of node to inner layer cluster head with appropriate coefficients.

MATERIALS AND METHODS

Energy consumption model: Consuming energy in wireless sensor networks include 3 parts as data sending, receiving and processing. The model of energy is given in Eq. 2:

$$\begin{cases} P_T(K) = E_{elec} \times K + E_{amp} \times d^{\gamma} \times K \\ P_R(K) = E_{elec} \times k \\ P_{cpu}(K) = E_{cpu} \times k \end{cases} \quad (2)$$

Where, P_T, P_R, P_{cpu}, indicate sent, received and processing consuming energy of k bits of data, respectively. E_{elec}, E_{amp}, E_{cpu}, respectively represent energy consuming (nJ/bit) per sending one bit in radio radius, required energy to send with radius more than E_{elec} and required energy to process per each bit. According to Eq. 2 the total consuming energy of k bits is such the following:

$$P_{total} = P_{send} + P_{recieve} + P_{process} = k(2E_{elec} + E_{cpu} + E_{amp} \times d^{\gamma}) \quad (3)$$

In the Eq. 3, we will see that energy consumption has direct relation with data length. If the sent data length is lower, we will use less energy. If the transmission distance is less than threshold, the energy consumption will have relation with d^2. If the transmission distance is more than threshold, it has relation with d^4. Therefore, the less transmission distance, the more decrease in energy consumption.

Clustering model: In the clustering algorithms, the cluster head acts as central controller. By gathering data from cluster members and sending data via multi step route, the energy consumption in the cluster head, compared to the other nodes has more significance. To maintain communication link between cluster heads close to the main station, it is better to have less cluster member near to the main station.

Suppose that n nodes in V distinct environments with angle θ with uniform density ρ are distributed. V is divided to m loops named V_1, V_2, ..., V_m. Each loop indicates a cluster. The distance of two nodes in the center of clusters is for one step transmitting of the cluster out as d_1, d_2, ..., d_m. The pattern of clustering model is shown in Fig. 1. To facilitate the tasks, the layer near to main station is named as inner layer and the last layer is named outer layer.

In Fig. 1, the cluster C_1 is created by nodes embedded in loop V_1, C_2 by nodes placed in loop V_2 and so on. n_1, n_2, ..., n_m indicates the number of distributed nodes in clusters V_1, V_2, ..., V_m. If A_i is the size of loop V_1, and 1 = i = m, we can calculate the number of nodes in each cluster just as Eq. 4:

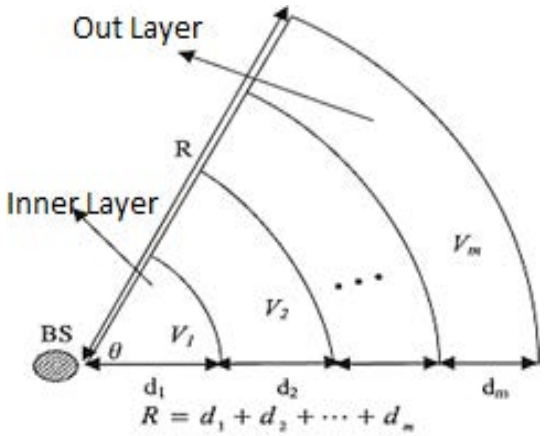

Fig. 1: The clustering model

$$n_i = \rho A_i = \frac{\rho\theta}{2}\left[\left(\sum_{j=1}^{j=i} d_j\right)^2 - \left(\sum_{l=1}^{l=i-1} d_l\right)^2\right] = \frac{\rho\theta}{2}\left(d_i^2 + 2d_i\sum_{l=1}^{l=i} d_l\right) \quad (4)$$

The number of nodes in V_{i+1} can be calculated as (Eq. 5):

$$n_{i+1} = \rho A_{i+1} = \frac{\rho\theta}{2}\left(d_{i+1}^2 + 2d_{i+1}\sum_{l=1}^{l=i} d_l\right) \quad (5)$$

According to above mentioned to maintain the network communications, the number of nodes in clusters V_i and V_{i+1} should follow the following condition:

$$n_{i+1} \geq n_i \quad (6)$$

According to Eq. 6, various amounts of d_i and d_{i+1} can be extracted. Thus, to facilitate the calculations, d_{1_hop} is considered as distance of one step (1 hop) in multi steps communications by considering $d_{1\_hop} = d_1 = d_2 = \ldots = d_m$. With this assumption, the greater than or equal relation is changed to greater than relation.

In each cluster, the cluster head receives data from members. After Aggregation of data, sends it toward inner layer or the main station. If the numbers of nodes a = near the main station are high, it will lead to early discharge of cluster heads close to main station. If the size of the cluster is very small, the number of nodes in the cluster will be very low. These nodes are being applied to transmit data from layers. The small size of cluster leads to early discharge of cluster head. So, the angular clustering for controlling the cluster size is required.

In some of the clustering algorithms, the cluster head is changed dynamically and successively. Successive substitution of cluster head due to frequent sending of controlling message causes to energy loss. If the cluster head continue its performance until the threshold, it will prevent waste of energy significantly. In Fig. 1, C_m is bigger than other cluster heads. We consider f_i) i = 1, 2, …, m) as continuous working time of cluster head. If f_1, f_2, f_3, the communication of clusters will be maintained. According to above, d_{1_hop}, θ and f_i are effective parameters on energy consumption and network life time.

Obtaining the optimum d_{1_hop}: Let's suppose we have n nodes between origin and destination with constant distance of d_{1_hop} like Fig. 2.

The whole require energy to transmit the message between the origin and destination on multi-hop link is just as Eq. 7:

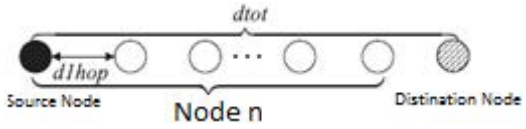

Fig. 2: Linear model of distance with equal hop

$$P \approx K \times \text{ceil}\left(\frac{d_{tot}}{d_{1hop}}\right) \times (2E_{elec} + E_{cpu} + E_{amp} \times d_{1hop}^{\gamma}) \quad (7)$$

ceil (A) implies the biggest integer of A. According to Eq. 7, the optimum distance of one-hop one and multi destination will be defined as relation (Eq. 8):

$$d_{opt} = \sqrt[\gamma]{\frac{\left(2E_{elec} + E_{cpu}\right)}{E_{amp}\left(\gamma - 1\right)}} \quad (8)$$

Relation (Eq. 8) indicates that d_{opt} depends on E_{elec}, E_{cpu}, E_{amp} and θ. The network topology and node distribution does not have any effect on d_{opt}.

Obtaining the optimum angle: The cluster angle is directly affected by the number of cluster head. Let's suppose that N_c indicates the number of cluster head, so we have:

$$\begin{cases} \frac{N_C}{m} = \text{ceil}\left(\frac{2\pi}{\theta}\right) \\ m = \text{ceil}\left(\frac{R}{d_{1hop}}\right) \end{cases} \quad (9)$$

M and θ represent the number of layers and the angle of cluster, respectively. According (Eq. 9), N_c is indicated as following:

$$N_C = \text{ceil}\left(\frac{2\pi}{\theta}\frac{R}{d_{1hop}}\right) \quad (10)$$

In clustering algorithms, general nodes, send sensed data to the cluster head. Therefore the required energy in each run is:

$$E_{normalnode} = k\left(E_{elec} + E_{amp} d_1^2\right)$$

D_1 is the distance to cluster head. The distribution of nodes in network is uniform and has density of $\rho(x, y) = R^2/N_C$. The distance between node and cluster head can be calculated as the following:

$$d_{1hop}^2 = \frac{R^2}{2\pi N_C} \quad (11)$$

If $\gamma = 2$ and $d_{1hop} = d_{opt}$ the total energy consumption in one run time will be calculated upon relation (Eq. 12):

$$P = \left[N\left(E_{elec} + E_{cpu}\right) - E_{amp}\frac{R^2}{2\pi} + E_{amp}\frac{NR^2}{2\pi N_c} + N_c\left(3E_{elec} + E_{cpu}\right)\right] \quad (12)$$

Equations 8 and 10, the optimum angle is calculated by derivative of total consumption of energy into angle:

$$\theta_{opt} = \sqrt{\frac{8\pi^3\left(3E_{elec} + E_{cpu}\right)}{N\left(2E_{elec} + E_{cpu}\right)}} \quad (13)$$

R does not affect on cluster angle. The angle is affected by physical parameters and the number of nodes. By taking the second derivative of the total energy consumption we will have:

$$\frac{\partial^2 P_{total}}{\partial\theta^2} = \frac{1}{\theta^3}\frac{4\pi R^2}{d_{opt}}\left(3E_{elec} + E_{cpu}\right) \quad (14)$$

The (Eq. 14) shows that the total energy consumption has inverse relation with cube of angle. If $\theta = \theta_{opt}$, we will have the least energy consumption. If $\theta = \theta_{opt}$, the energy consumption will be decreased.

The optimum time of cluster head replacement: In LEACH, the cluster head is substituting dynamically and successively. This successive substitution leads to energy waste. If the cluster head is not changed until reaching the threshold, the energy consumption and updating rate decrease.

Let's assume that d is the mean distance from cluster heads or main station and the d_2 is the average distance from cluster head to members. When each node in cluster V_m is considered as cluster head, the life time of the cluster will be calculated as the following:

$$T \approx \frac{n_m \times E_{ini}}{\left\{\left(2n_m - 1\right)\left(E_{elec} + E_{cpu}\right) + E_{amp}\left[d_0^2 + \left(n_m - 1\right)d_2^2\right]\right\}k} \quad (15)$$

To equalize the energy consumption, the work time of the cluster head should be equal. So the average optimum working time of each node will be as the following:

$$f_0 \approx \frac{E_{ini}}{\left\{\left(2n_m - 1\right)\left(E_{elec} + E_{cpu}\right) + E_{amp}\left[d_0^2 + \left(n_m - 1\right)d_2^2\right]\right\}k} \quad (16)$$

If the cluster head does not change successively until the energy discharge, the work time of the cluster head in V_m will be considered as the (Eq. 19):

$$f_m \approx \frac{E_{ini}}{\left[n_m\left(E_{elec} + E_{cpu}\right) + E_{amp} \times d_o^2\right] \times k} \quad (17)$$

According to relations (Eq. 16 and 17) and by assuming the ($n_m > 1$), we will have: $f_m > f_o$. If the working time of the first cluster head is f_m, by assuming the remaining energy of the cluster head which should be the least amount, it is the first node that its energy is discharged. So, the life time is approximately about f_m.

Providing the clustering method in mobile sink mode: In this article it is tried to select the next position of the sink such that the amount of energy in the neighboring clusters bethe greatest ones, therefore, the following relation is calculated while selecting new location of sink for each cluster, provided each cluster has greater amount will be chosen as the sink's new position.

This process has 3 phases which the first two phases just implement at the beginning of the cluster formation and the third phase is implemented in each change in the location of the sink.

The first phase (creating the clusters and selection of the sink's new location): The locations of sinks in this research are predefined points, so if the cluster is chosen as the location of sink, that point is introduced as central sink. To find the central X and Y points in each cluster we use relations (Eq. 18 and 19):

$$X = \left(Layer \times 1\right)Cos\left(\frac{\left(2j-1\right)\theta}{2}\right) \quad (18)$$

$$Y = \left(Layer \times 1\right)Sin\left(\frac{\left(2j-1\right)\theta}{2}\right) \quad (19)$$

$$1 = \left(\frac{R}{Layer_{tot}}\right) - \left(\frac{R}{2Layer_{tot}}\right) \quad (20)$$

$$Layer_{tot} = \left(\frac{R}{d_{1\text{-}hop}}\right) \quad (21)$$

Where:

$Layer_{tot}$ = The number of network's layer
R = Radius of network
J = The number of current cluster as 1 = j = sector and sector is the number of sectors that is sector = [360/θ]
θ = The angle of clustering

To determine the cluster nodes in this section, according to the location of each cluster's sink and considering this point that the (Eq. 12) should be established, clusters are created with its member's nodes.

$$\sqrt{\Delta x^2+\Delta y^2} \le \left(\frac{d_{1\text{-hop}}}{2}\right) \quad (22)$$

$$\Delta x = |x_n - x_s|, \Delta y = |y_n - y_s|$$

Second phases (creating the routing table): Since one of the most important advance challenges is absolutely dynamic routing toward the new location of the sink and also because the subject of optimal routing is out of the scope of this study, so it is just tried to apply a single algorithm and this topic is studied in other study.

The third phase (selection of sink location, introducing the received clusters to each cluster and selecting the cluster head in each cluster head): As it stands, this phase consisting of 3 parts.

Selecting the location of sink: After the routes between clusters were defined that is R_{ij} by relation 31-4, each cluster that has more S_j will be used as the place of sink selection:

$$S_j = \sum_{i \ne j} \frac{E_i}{R_{ij}} \quad (23)$$

Where:

E_i = The total energy of sensors exists in ith cluster

R_{ij} = The cost of route from Ith cluster to Jth cluster that it is here equal to the number of clusters in route between ith cluster and j

Introducing the receiving clusters (pre-cluster) to each cluster: After the cluster is selected as sink location, it announces to its neighbors, therefore Pre-cluster is as sink for its neighbors and after that every neighbors announce their announcement to other neighbors except sink cluster to be their pre-cluster and this is continued until the end of network and finally all the clusters except sink cluster will have specific pre-cluster, so it is clear that each cluster should sends its data to which one of the clusters in order to reach to the sink.

Selecting the cluster head in each cluster: Criterion for cluster head selection each cluster is calculated as relation (Eq. 24):

$$C_j = \propto E_j + \left(\frac{\beta}{(1/N)\left(\sum_{i<>j}\sqrt{\Delta x_{ij}^2+\Delta y_{ij}^2}\right)}\right) + \left(\frac{\gamma}{\sqrt{\Delta x_{js}^2+\Delta y_{js}^2}}\right) \quad (24)$$

$$\alpha+\beta+\gamma = 1 \quad (25)$$

Where:

E_j = The remained energy in current node

N = Total nodes exist in current cluster

$\Delta x_{ij}^2+\Delta y_{ij}^2$ = The distance of ith node to jth node that are members of same cluster

$(1/N)\left(\sum_{i<>j}\sqrt{\Delta x_{ij}^2+\Delta y_{ij}^2}\right)$ = The average distance of current node to other nodes in its own cluster

$\sqrt{\Delta x_{ij}^2+\Delta y_{ij}^2}$ = The distance of current node to the location of sink in its current pre-cluster

The selection of cluster head in one cluster head method: According to this fact that the criteria for distance and energy of both of them for each node is equal so itis suggested that: $\propto = \beta = \gamma$.

Selection of cluster heads in dual-cluster head method: In order to select the first cluster head in dual-cluster that gathers current cluster's data it should calculate β and $\propto$ with more value than γ and this process for the second cluster head is vice versa. Therefore, it is recommended that in dual-cluster head method, for each node, the value of C1 is calculated with this proviso that $\gamma \le \beta = \alpha$ and for C2, $\gamma \le -\beta = \alpha$ and for selecting the first cluster head, the greatest amount of C1 and the second one, the greatest amount of C2 would be the criteria.

Selection of cluster heads in triple-cluster head: In this method, given that just the first cluster head in applied for transferring data between two clusters and also the other dual-cluster heads are almost gather just half of the cluster's data, so it is recommended to select the first cluster head, the greatest amount of C1 with the proviso of $\gamma \ge \alpha \gg \beta$ and for selecting other dual-cluster head, two big amount for C2 are calculated by $\alpha > \beta \gg \gamma$.

The third phase should always repeat completely after every change in sink's location and the time of this change should be the moment in which the average amount of the first cluster heads of neighbor clusters is in the threshold amount:

$$(E_{send} * d_{Maxc})$$

Where:

E_{send} = Data sending energy between two neighbor clusters

D_{max} = The biggest route in existing routing matix

RESULTS AND DISCUSSION

In this study, we have tried to provide an analysis of this suggested method and comparing in different status, by applying commercial programming tools named Vs2013 to simulation, SqlServer2012 data base to every moment storage of simulated information in Log-making mode NoSql and also using SSRS tool to provide online statistical reports and diagrams during the simulation implementation.

It is necessary to note that almost all the conducted researches in engineering context use laboratory instruments such Mathlab as default to simulate that naturally it is required great survey and much more time to transfer it toward practical industry. The reason of applying above mentioned commercial instrument for simulation is developing the practical sample of this method and submitting it to the industry.

As it can be deduced from above studies, the effective parameters in this method are: the way of cluster head selection (one-cluster head, dual-cluster head and triple-cluster head), the number of sensors, the radius of sensors area, the primary energy of sensors, the amount of energy in data transferring from one sensor to other one in a cluster (nodes consist a cluster that their maximum distance between each other is d1-hop, so the greatest amount of this energy is the energy of data transfer for d1-hop), the amount of data transfer between dual-cluster head in neighbor clusters(this energy is different for each nodes in one cluster), the angle of θ between sectors, coefficients of γ, β, α, threshold energy in order to change the cluster heads in each cluster and threshold energy to change the location of main station.

In the case of threshold energy parameter in order to change the main station switching, it is necessary to explain that it is one of the most important effective parameters in making this method more optimal which here is the lowest amount of energy in all nodes dynamically at every moment, this means that if there was a node in each one of the neighbor clusters of the main station that its amount was less than the lowest amount of nodes energy in the whole network, the main station should be selected as relation (Eq. 23). It is also likely that even though the station should be changed but also according to this relation, the best candidate for station selection is again the previous station.

Simulation 1: The constant parameters according to Table 1-3 and variable parameters including the type of cluster heads selection.

Table 1: Constant effective parameters

The name of constant parameter	Amount
The number of nodes	200
Radius	20 m
Primary energy	5 J
$\alpha = \beta = \gamma$	1/3
Threshold of cluster head replacement	1 J
Threshold of station replacement	The lowest energy of network's sensor that should not be less than threshold of cluster head replacement

Table 2: The number of rounds until the first discharge of network sensor

The type of cluster head selection algorithm	Round until the first discharge of network sensor
One-cluster head	25
Dual-cluster head	50
Triple-cluster head	50

Table 3: The replacement of cluster head and the station in each algorithm

The number of rounds during the last replacement	Number of replacement	Type of replacement	The type of algorithm
24	6	Station	One-cluster head
24	6	Cluster head	
23	3	Station	Dual-cluster head
48	314	Cluster head	
29	5	Station	Triple-cluster head
49	814	Cluster head	

Table 4: Effective constant parameters

The name of constant parameter	Amount
Number of nodes	200
Radius	20 m
Primary energy	5 J
Threshold of cluster head replacement	1 J
Threshold of station replacement	The lowest energy of network sensors that should not be less than threshold of cluster head replacement

Table 5: The number of rounds to the first discharge of network sensor

The type of cluster head selection algorithm	Number of rounds to the first discharge of network sensor
One-cluster head	25
Dual-cluster head	50
Triple-cluster head	51

Table 6: Replacement of cluster head and station in each algorithm

Number of replacement during the last replacement	Number of replacement	Type of replacement	Type of algorithm
24	12	Station	One-cluster head
24	12	Cluster head	
49	11	Station	Dual-cluster head
49	628	Cluster head	
49	15	station	Triple-cluster head
49	1725	Cluster head	

Simulation 2: The constant parameters according to Table 4-6 and variable parameters of β, α and γ value in one-cluster head, dual-cluster head and triple-cluster head algorithms. In this simulation according to relations of 3 it is tried to have the following:

- One-cluster head: $\gamma = \beta = \alpha = 0.333$
- Dual-cluster head: $\beta = \alpha = 0.4$ and $\gamma = 0.2$
- Triple-cluster head: $\alpha = 0.05$, $\beta = 0.35$, $\gamma = 0.6$

By comparing the simulation 1 with constant values of β, α and γ with simulation 2 with variable values, it can be concluded that considering the amount of these coefficients according to the relation of β, α and γ in previous section will has great influence on the management of cluster heads replacement in order to optimize the process.

CONCLUSION

In this study, we study the increased longevity in wireless network sensors by using angular clustering and dual-cluster head in each cluster. The size of one-hop has no relation with topology and distribution of network node. The angle of the cluster is influenced by node physical parameters and the number of nodes. The function of cluster head selection is depended on the remaining energy, the average distance to cluster members and the distance of the node to the auxiliary cluster head of inner layer with appropriate coefficients. The results indicate that this proposed method leads to the increase in longevity.

The results also present that if the life time is the first energy discharge, the amount of ∝ in single cluster head, dual-cluster head and triple cluster head is 0.4, 0.4 and 0.6, respectively. If the life time is the discharge of 50% energy, ∝ is 0.6, 0.2 and 0.8, respectively. In the triple mode, because of equalizing the distance to members, it leads to higher stability and longevity. By applying the triple-cluster head the delay of data sending is decreased. If there is a heterogeneous network, on average, single cluster head, dual-cluster head and triple cluster head methods have improved the remained energy about 12%, 12.7 and 44.93%, respectively. If the longevity is the energy discharge of the first nodeby increasing the number of nodes, the single-cluster head and dual-cluster head methods do not have proper application. The triple-cluster head method is stable with increase in the number of nodes. By increasing the nodes, if the longevity is 50% of energy discharge, all the 3 methods are stable and lead to increase in longevity. By increasing the size of network, the longevity will be decreased due to distance increase. By increasing the size of network, single cluster head, dual-cluster head and triple cluster head methods maintain their longevity increasing nature.

The most important challenge we deal in this method is the appropriate routing algorithm. Here, we have tried to consider the smallest routes with optimal algorithm in order to create routing table. But what is perhaps more important and is not included in this article is the selection of routes with least shared paths to reaching the clusters to each other.

REFERENCES

Abbasi, A.A. and M. Younis, 2007. A survey on clustering algorithms for wireless sensor networks. Comput. Commun., 30: 2826-2841.

Ebadi, S., M. Ghasembaglou, A.H. Navin and M.K. Mirnia, 2010. Energy balancing in wireless sensor networks with selecting two cluster-heads in hierarchical clustering. Proceedings of the 2010 International Conference on Computational Intelligence and Communication Networks (CICN), November 26-28, 2010, IEEE, New York, USA., ISBN:978-1-4244-8653-3, pp: 230-233.

Ruihua, Z., J. Zhiping, L. Xin and H. Dongxue, 2011. Double cluster-heads clustering algorithm for wireless sensor networks using PSO. Proceedings of the 6th IEEE Conference on Industrial Electronics and Applications, June 21-23, 2011, Beijing, pp: 763-766.

Singh, S.K., M.P. Singh and D.K. Singh, 2010. Energy efficient homogenous clustering algorithm for wireless sensor networks. Int. J. Wireless Mobile Networks, 2: 49-61.

Xuegong, Q., 2010. A control algorithm based on double cluster-head for heterogeneous wireless sensor network. Proceedings of the 2010 2nd International Conference on Industrial and Information Systems (IIS), July 10-11, 2010, IEEE, New Yor, USA., ISBN:978-1-4244-7860-6, pp: 541-544.

Yi, X. and L. Deng, 2010. A double heads static cluster algorithm for wireless sensor networks. Proceedings of the 2010 International Conference on Environmental Science and Information Application Technology (ESIAT), Vol. 2, July 17-18, 2010, IEEE, New York, USA., ISBN:978-1-4244-7387-8, pp: 635-638.