Clustering for Reduction of Energy Consumption in Wireless Sensor Networks by AHP Method

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Received: 11/Sep/2017 Revised: 22/Feb/2018 Accepted: 19/May/2018

Abstract

Due to the type of applications, wireless sensor nodes must always be energy efficient and small. Hence, some studies have been done in order to reduce energy consumption. One of the most important operations of wireless sensor networks is data collection. Due to the energy limitation of nodes, energy efficiency must be considered as an important objective in the design of sensor networks. In this study, we present a method in which nodes, in the first phase, find their position by using the position of the base station and two assumed nodes out of the environment where their geographical locations are known. In the second phase, we determine the cluster heads based on the criteria such as the remaining energy, the distance (the distance from the cluster head and the distance from the base station), the number of neighbors (the one-step neighbors and the two-step neighbors) and the centrality by using the multi- criteria decision making method. The proposed method in the NS2 environment is implemented and its effect is evaluated as well as compared with the NEECP E-LEACH protocols. Simulation results show that the proposed method improves the energy consumption, the network life span, the average packet delivery and the average delay.

Keywords: Clustering; Energy; Location; Base Station; Sensor Networks.

1. Introduction

The most important reason for the emergence and development of wireless sensor networks has been the continuous monitoring of contexts that are difficult or impossible to achieve by human beings [1]. In order to carry out the duties for a long time, these networks should be autonomous without the involvement of individuals. Such a network, according to its application, collects information about various events from its operating context and reports these information to the base station during initial processing, for instances, applications such as industry [4], crisis management [35,5], health [2,6] and military [3]. Each sensor node has a limited energy supply and in most applications, it is not possible to replace energy sources. Therefore, sensor node life is heavily dependent on the energy stored in its battery. Hence, extending the life span of such network is one of the most important issues [7,8].

Moreover one of the important issues of energy consumption in wireless sensor network is clustering. In the clustering method, the network is divided into a number of independent sets referred to as sets of clusters. So each cluster has a number of sensor nodes and cluster heads. The cluster nodes send their data to their cluster head node. The cluster head node aggregates the data and sends it to the base station. Therefore, clustering in sensor networks has some advantages such as supporting data aggregation, facilitating data collection, organizing an appropriate structure for scalable routing, and disseminating data efficiently over a network.

Research has proved that cluster head selected on single criterion doesn't have energy efficiency. Hence, an ideal cluster head is the one which is selected on multiple criteria. Solution of using multiple criteria can be solved via Multiple Criteria Decision Making (MCDM) technique. MCDM methods are used to solve the decision- making problem in engineering and sciences, with multiple attributes. MCDM techniques compare and rank multiple alternatives based on degree of desirability of their respective attributes. There are different types of MCDM approach. In this paper, it is used AHP (Analytic hierarchy process) method [32]. The AHP is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then. It is used

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around the world in a wide variety of decision making situations, in fields such as government, business, industry, healthcare, shipbuilding and education [33].

In this paper, sensor nodes find their position by using the position of the base station and two other virtual points. Then by considering criteria such as remaining energy, the distance (distance from the cluster and distance from the base station), the number of neighbors (the one-step neighbors and the two-step neighbors) and the centrality, cluster heads are selected by using AHP method.

The rest of the paper is organized as follows: Section 2 reviews the related work. In Section 3, nodes, in the first phase, obtain their geographical position. In the second phase, cluster heads are selected by using AHP method. Section 4 analyzes experiments concerning existing nodes. Finally, in Section 5, we summarize discussion and conclude.

2. Review of the Related Literatures

Most of the clustering algorithms [9-12] have been established for WSNs according to heuristic methods. LEACH [9] as one of the popular distributed clustering algorithm where the sensor nodes designate LEACH offers substantial energy saving and extends the period of the network in comparison with the static clustering and minimum transmission energy. However, the chief difficulty of this algorithm is that there is a probability to choose a cluster head with very low energy, which may expire quickly and therefore reduces the performance of the network. Consequently, the amount of algorithms has been established to advance LEACH protocol, PEGASIS [13] and HEED [14] are prevalent among them. PEGASIS classifies the nodes into the chain in an attempt to make opportunity for each node to convey and obtain the data only from its neighbor nodes. In each turn, an arbitrarily designated node from the chain as a cluster head is chosen. PEGASIS is more efficient than LEACH; nevertheless, it is unbalanced for huge networks. Furthermore the delay is expressively high. Recently, many algorithms [15-19] have been established for data gathering structures for prolonging the lifetime of WSNs. Loscri et al. [20], have suggested TL-LEACH protocol presenting a novel level of hierarchy. It advances the network period over LEACH, however, with an extra overhead for selecting subordinate cluster heads and also non-cluster head nodes allocate to the cluster heads according to distance only, which may cause severe energy imbalance to the network. Xiaoyan et al. [22], have argued that M-LEACH algorithm is comparable with LEACH and only difference is that it forward to cluster head node in next hop rather than sending the data directly to the base station and thus it keeps energy in comparison with LEACH and TL-LEACH. However, in multi-hop data transfer between cluster heads, it does not regard the significant metrics like energy, node degree etc. Yassein et al. [21] discussed that V-LEACH protocol improves the LEACH protocol where some cluster heads referred as vice cluster heads are designated along with the chief cluster heads and once the main cluster heads die, the vice cluster heads play as a cluster heads. It is revealed that it acts better than unique LEACH. However, sensor nodes require additional processing energy for choosing cluster heads. Also, it doesn't mind of development of clusters, which may cause severe energy incompetence of the WSN. In [23], the researchers have argued that E-LEACH protocol, which is similar to LEACH protocol, but in the selection of cluster heads, remaining energy of the cluster heads was taken into consideration, which can spread the life of the network by saving the low energy of cluster heads. Means, it may not selects the cluster head with low energy. Bari et al. [24], have argued the least distance clustering (LDC) for enhancing the lifetime of WSNs. The value of their method is that it performs faster, due to the assigning of non- cluster head nodes to the nearest cluster head. The chief difficulty of LDC is the unsuitable creation of clusters. Nevertheless, it is problematic to discover the optimal clusters for large scale networks, since the computational difficulty differs exponentially. The studies [26-28], have planned energy well-organized cluster based routing arrangements for dependable networks and in [29] a framework for energy assessment in WSNs has proposed. A Novel Energy-Efficient Clustering Protocol (NEECP) is developed to improve the lifetime of sensor network. NEECP elects cluster heads in an influential manner and each cluster possesses various sensing range to balance the load on the cluster head. The protocol also uses the chain based data aggregation arrangements to spread the period of WSN. Furthermore, NEECP evades redundant data spreads that further advance the network lifetime. NEECP applies stochastic cluster head election procedure to select cluster heads [30].

3. Proposed Method

3.1 System Assumptions and Energy Model

Throughout the paper, assume that the following conditions hold:

- All nodes are constant and have resource constraints.
- The base station has no resource constraints.
- All nodes are located within one or more steps of the base station.
- All nodes have data to send at specific moments.
- The nodes are not equipped with a locator system.
- All of nodes that are located at the distance less than r meters from the base station, directly communicate with the base station (r is the radio radius of nodes).

Two nodes are located at the out of the environment where their geographic locations are known.

- There is not any guiding node in the network and all network nodes, using the proposed method of [43], can obtain their geographic location. The energy pattern as the same radio pattern in [31] is applied in this study. In this model, transmitter disperses energy to run the radio electronics and the power amplifier. The receiver dissipates energy to run the radio electronics. The energy consumption of the node depends on the amount of the data and distance to be sent. In this model, when the transmission distance d is less than the threshold distance d_0, the energy consumption of a node is relative to d^2, otherwise it is relative to d^4[31]. The whole energy consumption of each node in the network for conveying the k- bit data packet is given by the following equations.

$$E_{TX}(k,d) = E_{TX-elect}(k) + E_{TX-amp}(k,d) \quad (1)$$

$$= k\left(E_{elect} + E_{amp}d^{\alpha}\right) \quad (2)$$

$$= \begin{cases} k(E_{elec} + \varepsilon_{fs}d^2), & d < d_0 \\ k\left(E_{elec} + \varepsilon_{mp}d^4\right), & d \geq d_0 \end{cases} \quad (3)$$

Where the threshold distance d0 is:

$$d_0 = \sqrt{\frac{\varepsilon_{fs}}{\varepsilon_{mp}}} \quad (4)$$

Where $E_{elect}$is the energy that is required for the run of the radio, ε_{mp} and ε_{fs} are the energy required to run the transmitter amplifier contingent on the distance d. To receive a k-bit message, energy consumed is:

$$E_{Rx}(k,d) = E_{Rx-ele}(k) = k.E_{elec} \quad (5)$$

Data collected from neighboring nodes are redundant and extremely connected. Therefore data is combined at the cluster heads. Energy dissipated for combining m messages of k bits is

$$E_{DA}(k) = E_{agg}.k.m \quad (6)$$

3.2 The Process of Determining the Geographic Location of Nodes

- According to Figure 1, we assume that one-step neighbors of the base station are aware of geographic locations of the base station and two assumed nodes outside the environment where their geographic locations are known. By this information, such a node can obtain its geographic position after calculating the distance between itself and the base station and two nodes outside the environment. For calculate distance between two nodes, there are different ways to estimate the distance between sensor nodes in WSNs such as RSSI, TOA, TDOA, RTOF and etc. Recently Adler and et al. presented a solution to get a precise estimation of the distance between two nodes without the needs for special purpose chips or a redesign of already existent nodes. It is used radio runtime measurement to calculate the distance between nodes and then it is presented algorithms to refine the measurements [37].

By continuing this method, all nodes are able to find locations.

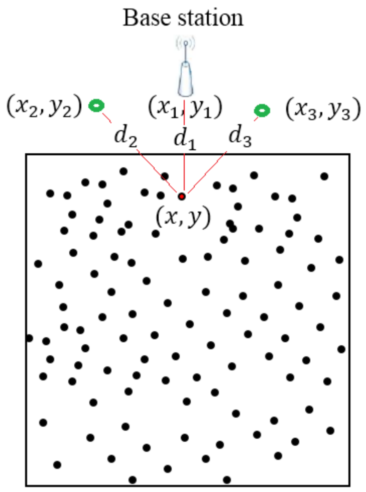

Fig. 1. Determining the geographical position of nodes

Now assume that (x, y) is the position of the unknown node which its distance from base station and two other known nodes with coordinates $(x_1, y_1), (x_2, y_2), (x_3, y_3)$ are d_1, d_2, d_3 respectively. In this case the following equations hold

$$(x - x_1)^2 + (y - y_1)^2 = d_1^2 \quad (7)$$

$$(x - x_2)^2 + (y - y_2)^2 = d_2^2 \quad (8)$$

$$(x - x_3)^2 + (y - y_3)^2 = d_3^2 \quad (9)$$

So

$$x^2 + y^2 - 2xx_1 - 2yy_1 = d_1^2 + x_1^2 + y_1^2 \quad (10)$$

$$x^2 + y^2 - 2xx_2 - 2yy_2 = d_2^2 + x_2^2 + y_2^2 \quad (11)$$

$$x^2 + y^2 - 2xx_3 - 2yy_3 = d_3^2 + x_3^2 + y_3^2 \quad (12)$$

Equation (12) implies that

$$x^2 + y^2 = 2xx_3 - 2yy_3 + d_3^2 + x_2^2 + y_2^2 \quad (13)$$

Considering above equation and Equations 7 and 8,

$$\begin{cases} 2x(x_1 - x_3) + 2y(y_1 - y_3) = d_3^2 - d_1^2 + x_1^2 + y_1^2 - x_3^2 - y_3^2 \\ 2x(x_2 - x_3) + 2y(y_2 - y_3) = d_3^2 - d_2^2 + x_2^2 + y_2^2 - x_3^2 - y_3^2 \end{cases} \quad (14)$$

Finally it will be obtained two equations which have the solutions because it is assumed that the three points of $(x_1, y_1), (x_2, y_2), (x_3, y_3)$ are not on the same line. Therefore the single-step neighbors of the base station obtain their geographical positions. Similarly two-step neighbors obtain their geographical positions using the geographical positions of single-step nodes. By continuing this way, after a while all nodes on the network receive their geographic location. The scheme of running the proposed method has been shown in Figure 2.

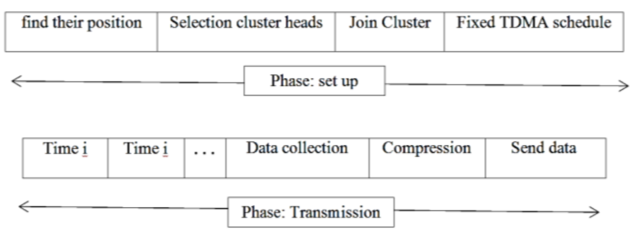

Fig. 2. The schemeof running the proposed method

3.3 Selecting Cluster Heads by AHP Method

Creating a hierarchical structure is one of criteria of service quality which aims to select optimally cluster heads based on the desired criteria. In the following, it is described the selection criteria for cluster heads with its reasons. In this section, the factors that are important in decision making are expressed as a hierarchical decision tree in the form of a decision tree, as shown in Figure 3.

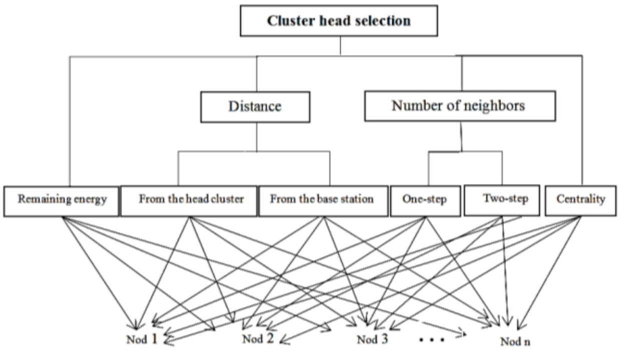

Fig. 3. Display of hierarchy to determine the cluster header

To determine cluster heads, Table 1 is utilized to converting linguistic expressions to numerical values.

Table 1. Numerical values of preferences in paired comparisons

Linguistic expression to determine preference	***numerical value***
Full Preference	9
Pretty strong	7
Strong preference	5
Little preference	3
The same preference	1
Preference between intervals	2,4,6,8

3.3.1 Criteria of Selection

- The distance from the base station: The more cluster head node is closer to the base station, the less the energy it uses to send the data packets. If the location coordinates of the node is (x_i, y_i) and the location coordinates of the base station is (x_j, y_j), then the distance of node from the base station is equal to:

$$d = \sqrt{((x_i - x_j)^2 + (y_i - y_j)^2} \tag{25}$$

- The distance from the cluster head: The closest node of cluster to the cluster head is the better candidate for cluster head. The distance of node from the cluster head is calculated similar to (25).
- The remaining energy of the node: Because the overhead of cluster head is larger than the other nodes, so the node should be selected as a cluster head that has enough energy, otherwise the nodes will be disconnected from the base station due to the node's death.

The number of neighbors: If r denotes the radio radius of each node, then the single- step neighbors of a node is the set of nodes that are located at a distance less than r meters from the node.

- The number of two-step neighbors: The two-step neighbors of the node are defined as the set of nodes which are located at the distance less than 2r meters from the node.
- Centrality: The mean distance of cluster nodes from a desired node is considered as centrality of that node. In fact reduction of centrality of the cluster head causes the energy consumption for intra-cluster communication (between nodes and cluster head).

If C is the set of cluster nodes, the centrality of the node x_0 is defined as follows:

$$\sum_{x_s \in C} \frac{|x_0 - x_s|}{|C|} \tag{26}$$

Where x_0 denotes the coordinate of the cluster node and x_s denotes the coordinate of the node within the cluster and $|C|$ is the number of nodes of C.

3.3.2 Determining the Paired Comparison Matrices

At this stage, the decision making matrix of the paired criteria is made. The ijth entry of the decision-making matrix, in fact, is the ratio of the preference of ith option to the jth option. If the values are quantitative, it is sufficient to divide the values. If the values are qualitative, Table 1 is utilized to convert qualitative values to quantitative ones.

After making decision matrix, it should be checked the consistency or inconsistency of matrix. In the decision matrix, if the following equality is satisfied for all i, j, k,

$$a_{ij} = a_{ik}.a_{kj} \tag{27}$$

Then it is said that the matrix is consistent, otherwise is not.

3.3.3 Calculating Weights of Options and Criteria

In the following, the assumption of inconsistency of decision matrix is used to calculate the weights of criteria which have a very decisive role in decision-making problems which is in the form of Table 2.

Table 2. The paired comparison matrix of criteria

	remaining energy	**distance**	**number of neighbors**	**centrality**
remaining energy	1	a	b	c
distance	$1/a$	1	$1/d$	$1/f$
Number of neighbors	$1/b$	d	1	e
centrality	$1/c$	f	$1/e$	1

So the decision matrix is as follows:

$$A = \begin{pmatrix} 1 & a & b & c \\ \frac{1}{a} & 1 & \frac{1}{d} & \frac{1}{f} \\ \frac{1}{b} & d & 1 & e \\ \frac{1}{c} & f & \frac{1}{e} & 1 \end{pmatrix}$$

We use the eigenvector method to calculate weights. We obtain roots of the characteristic polynomial of matrix A, which is equal to solutions of equation $\det(kI -$

$A) = 0$. Assuming that k_{max} is the largest eigenvalue of A, the eigenvector associated with it is obtained by solving the Equation (28) using the MATLAB software. In this way, we obtain the corresponding eigenvector.

$$(k_{max}\, I - A)W = 0 \text{ where } \sum_{i=1}^{4} w_i = 1 \quad (28)$$

Let corresponding eigenvector be (w_e, w_d, w_n, w_c). So the weights of criteria are obtained as follows:

The weight of the remaining energy = w_e

The weight of distance = w_d

The weight of the neighbor numbers = w_n

The weight of the centrality = w_c

For two criteria distance and the number of neighbors, below the paired comparison submatrices are made up.

Table 3. The paired comparison submatrices of distance

Distance	Distance from the head cluster	Distance from the base station
Distance from the head cluster	1	g
Distance from the base station	1/g	1

Table 4. The paired comparison submatrices of neighbors

The number of neighbors	One-step neighbors	Two-step neighbors
Two-step neighbors	**1**	**h**
Two-step neighbors	**1/h**	**1**

So the sub-matrices of the paired comparisons are as the following:

B_1 is the sub-matrix associated with the distance and

B_2 is the sub- matrix associated with the number of neighbors.

$$B_1 = \begin{bmatrix} 1 & g \\ \frac{1}{g} & 1 \end{bmatrix} \qquad B_2 = \begin{bmatrix} 1 & h \\ \frac{1}{h} & 1 \end{bmatrix}$$

Both matrices are compatible and the weights of each of the sub- criteria are as follows:

The weight of distance from cluster head = w_h

The weight of distance from base station = w_b

The weight of the number of single step neighbors = w_1

The weight of number of two-step neighbors = w_2

Now put:

$$E = \sum_{i=1}^{m} e_i \quad (29)$$

$$N = \sum_{i=1}^{m} n_i \quad (30)$$

$$M = \sum_{i=1}^{m} m_i \quad (31)$$

$$D = \sum_{i=1}^{m} \frac{1}{d_i} \quad (32)$$

$$D' = \sum_{i=1}^{m} \frac{1}{d'_i} \quad (33)$$

$$C = \sum_{i=1}^{m} c_i \quad (34)$$

Where

e_i: Remaining energy of ithnode

n_i: The number of one-step neighbors of i^{th} node in the cluster

m_i: The number of two-step neighbors of i^{th} node in the cluster

d_i: The distance of i^{th} node from the cluster head

d'_i: The distance of i^{th} node from the base station

c_i: The average distance of i^{th} node from all nodes of the cluster

For each node, calculate the following value, which is the final weight of the i^{th} node:

$$w_{\,node} = \frac{e_i}{E} w_e + \frac{1}{d_i D} w_d w_b + \frac{1}{d'_i D'} w_d w_h + \frac{n_i}{N} w_n w_1 + \frac{m_i}{M} w_n w_2 + \frac{c_i}{C} w_c \quad (35)$$

Finally the node that has the biggest weight is selected as new cluster head.

Therefore, in the present paper, it has been tried to combine different criteria for choosing optimal cluster heads. Then we tried to provide the possibility of changing cluster head role after each transmission. So that the consumption of cluster energy is distributed equally among all cluster members and so early death of cluster nodes is prevented. The base station chooses cluster heads based on the criteria such as number of single-step and two steps neighbors, remaining energy, the distance from the cluster head, the distance from the base station and centrality of each node. For this purpose, a target function has been proposed that should be calculated for all nodes of each cluster. The base station calculates the weight w_{node} for each node, a node that has the biggest weight is selected as new cluster head. Finally the base station creates a packet which contains the geographic location of the nodes selected as cluster heads and then sends it to all nodes, so each node knows its cluster head.

4. Simulation Environment

The NS2 simulator is one of the most popular open source network simulators. For network research, NS is used as a discrete event simulator. The NS2 simulator is the second version of NS-Simulator. NS is essentially based on the network simulator called REAL. The original version of NS was designed in 1989. it has evolved in recent years and has continued to the third version. NS2's second version is widely used in academic research and has many packages that have been developed by people who have no financial benefit. Simulation on the Red hat Linux operating system using the NS2 network simulator was done.

Table 5. Simulation parameters used for WSNs

Parameter	*Value*
Number of sensor nodes	100
Target area	100*100
Energy of sensor node	2j
Transmission Range	30 m
Data Aggregation Energy	50pj/bit/report
Data Packet Size	4000 bits
Hello Packet Size	200 bits
Transmitter Electronics ($E_{elect}T_x$)	50 nJ/bit
Receiver Electronics ($E_{elec}R_x$)	50 nJ/bit
Transmit Amplifier (E_{amp})	100 pJ/bit/m2
Packet length	400 b
Transmission Frequency Band	2.4 GHz
MAC Protocol	CSMA/CA
Distribution	normal

In the first scenario, the base station is located in position at 100*100. In the second scenario, the base station is located in the optimal position.

Table 6. Simulation Scenarios

Base station	location
Scenario 1	100*100
Scenario 2	50*50

Evaluation Criteria:

To evaluate the efficiency of the proposed method, four criteria have been used: the average of consumable energy, the number of live nodes, the mean of end-to end delay, the mean of packet delivery success which refers to ratio of the number of packets delivered (successfully) to the base station to the number of packets generated by the source node. The four criteria are evaluated in two scenarios. In the first scenario, the location of the base station is placed at 100 * 100, and in the second scenario, the base station is located at the optimal position. In both scenarios, the four mentioned criteria have been evaluated. To evaluate the performance, the proposed method is compared with the methods of E-LEACH and NEECP methods.

Energy consumption of network per round is shown in Figure 4. It is observed that our proposed method consumes less energy than previous ones. The energy of the E-LEACH method ends at 440, and in the NEECP method, energy ends at 560, but in the proposed method energy ends at 760. A major constituent of energy consumption is communication process. So the proper communication model is very much necessary for any energy efficient clustering protocol. This is the main reason of lower energy consumption in our proposed method is much less than E-LEACH and NEECP method.

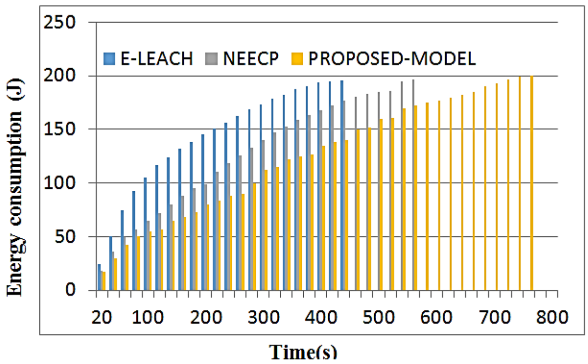

Fig. 4. Comparison of the amount of energy consumed in the first scenario.

Energy consumption of network per round in the second scenario is shown in Figure 5 It is observed that our proposed scheme consumes less energy than previous schemes. The energy of the E-LEACH protocol ends after 480 rounds, and in the NEECP method, energy ends after 600 rounds, but in the proposed method energy ends after 820 rounds. It follows that the proper location of the base station is effective on efficient energy consumption.

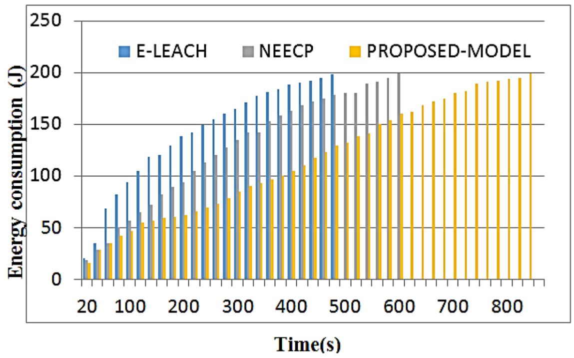

Fig. 5. Comparison of the amount of energy consumed in the second scenario.

In Figure 6, the lifetime of the network in the proposed method is compared with E-LEACH and NEECP protocols. In the E-LEACH algorithm, after 240 rounds, nodes start to dying vigorously, and after 380 rounds they are almost energized and the network lifetime ends. In the NEECP method, after 560 rounds, only 8 nodes are alive. While in the proposed method, network works with 32 live nodes after 560 rounds and the network lifetime ends after 680 rounds. The network lifetime of the proposed method is higher than the E-LEACH and NEECP methods. In the proposed method, the selection of the cluster heads due to the greater remained energy causes lower energy nodes not to participate in sending packets. So this is an important factor in increasing the lifetime of the network.

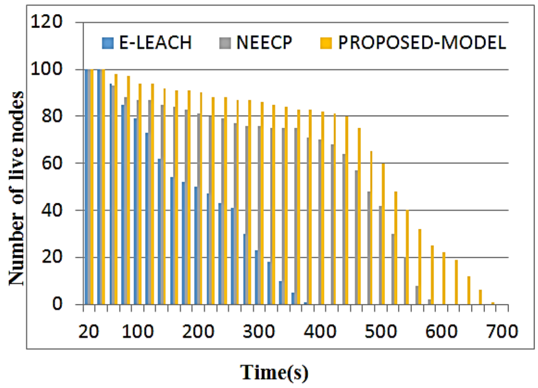

Fig. 6. Diagram of the number of live nodes (network lifetime) in the first scenario.

Figure 7 shows the network lifetime in the scenario that the base station is located optimally increases. In this figure, the lifetime of the network in the proposed method is compared with E-LEACH and NEECP methods. In the E-LEACH method, after 240 rounds, nodes start to dying vigorously, and after 380 rounds they are almost energized and the network life ends. In the NEECP method, after 560 rounds, only 24 nodes are alive. While in the proposed method, network works with 69 live nodes after 560 rounds and the network life ends after 740 rounds. The network lifetime of the proposed method is higher than the E-LEACH and NEECP methods because of optimally location of the base station. So the proper base station location is on efficient energy consumption.

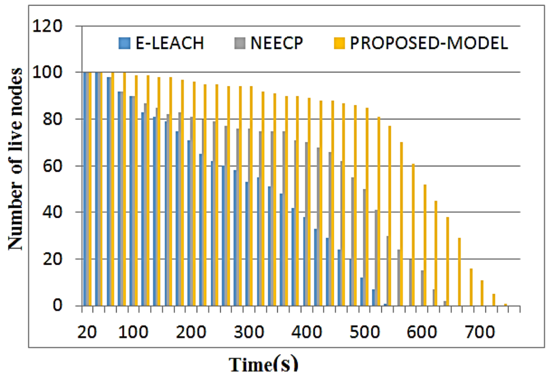

Fig. 7. the number of live nodes (network life span) in the second scenario.

Figure 8 shows that the proposed method minimizes end -to-end delay because of proper cluster heads selection and more density of nodes around the base station. Therefore, the delay is reduced compared to the NEECP and E-LEACH methods.

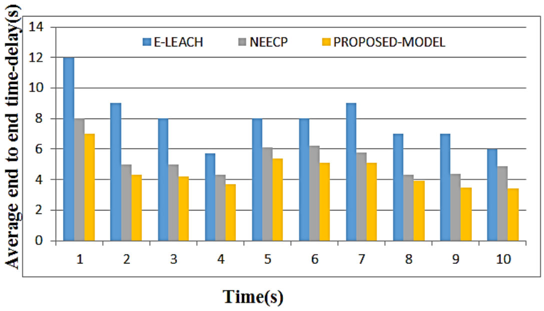

Fig. 8. The mean of end to end delay in the first scenario.

Figure 11 shows that the proposed method minimizes the end -to-end delay because the base station is located optimally and the nodes nearer to the base station need not firstly send the data to cluster head, they can directly communicate with the base station. Therefore, the delay is reduced compared to the NEECP and E-LEACH methods.

Figure 9 the first scenario, shows the percentage of accuracy of received packets which is yield by analyzing how many packets any node has sent, how many of them are actually received. As multi hop path is used for data communications, thus long distance communications is minimized so chance of data loss also is minimized.

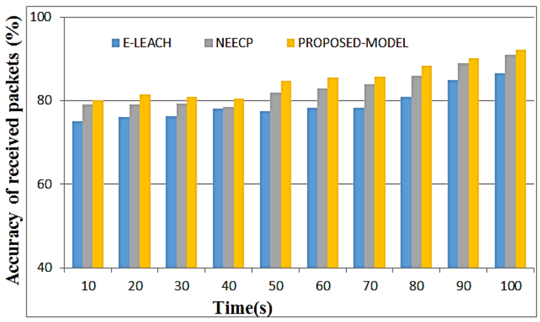

Fig. 9. Packets deliveries in the first scenario.

Figure 10 the second scenario in which the base station is located in optimal position shows the percentage of accuracy of received packets which is yield by analyzing how many packets any node has sent, how many of them are actually received. As multi hop path is used for data communication, thus long distance communications is minimized so chance of data loss also is minimized.

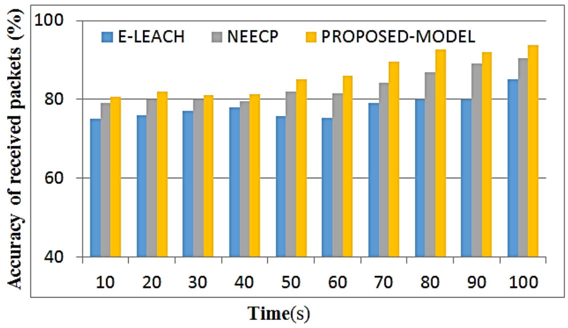

Fig. 10. Packets delivery in the second scenario.

5. Conclusion

In this study, we presented a method which has two phases. In the first phase, all sensor nodes obtain their geographical positions by using the location of the base station and two assumed nodes out of the environment where their geographic locations are known. In the second phase, the cluster heads are determined by the base station in such a way that the base station considered the remaining energy, the distance (the distance from the cluster and the distance from the base station), the number of neighbors (the one-step neighbors and the two-step neighbors) and the centrality as criteria for cluster heads selection by using AHP method. We simulated the proposed method by two scenarios. The first scenario assumed that the base station is located at position 100*100 and the second scenario assumed that it is located in 50*50. The proposed method has been compared to NEECP and E-LEACH methods in terms of energy consumption, life span, average delay and delivery. The simulation results showed that the proposed method had better performance because of choosing optimal cluster heads and base station location according to the density of nodes. One of the ways that can have a significant impact on reducing the energy consumption in WSN is determining the optimized location of the base station. Therefor the location of the base station has an important role in energy consumption of the network. So we will try to find a method for optimizing the location of the base station in the future.

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