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Fuzzy Clustering Based Routing in Wireless Body Area Networks to Increase the Life of Sensor Nodes

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Abstract: *Body area networks is one of the types of wireless area networks which has been created to optimize utilizing hospital resources and for earlier diagnosis of medical symptoms, and ultimately to reduce the cost of medical care. This network like most of the wireless networks is without infrastructure and the embedded sensor nodes in the body have limited energy. Hence, the early power completion of the wireless nodes based on the transmission of messages in the network can disrupt the entire network. In this study, a fuzzy clustering based routing is presented to overcome the mention challenge. In this method, the sensor nodes are allocated to the nearest cluster, based on their distance from the cluster head node, and exchange information with the cluster-head at the near distances, and the cluster-head node, due to its high initial energy, can transmit data to the remote server. In this study, due to the movement of the person and the position shift in the sensor nodes and the distances between the cluster-head nodes, sensor nodes belonging to the clusters are also updated and placed in their proper cluster and the transmission of sensory messages was done with its nearest cluster- head node. Simulation results show that the proposed method can be better than other existing methods in and equal condition.*

Keywords: *Fuzzy clustering, wireless body area networks, sensor nodes*

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1. INTRODUCTION

Monitoring patients at general hospitals, as well as nursing rooms or other health care facilities is very important in preventing the clinical deterioration of hospitalized patients. In most cases, vital or physiological signs (e.g., temperature, pulse and respiration rate, blood pressure and oximetry) are measured manually by professional nurses several times a day. This time-consuming work can be done for efficiency and reliability by using real-time monitoring systems. [1] Wireless Body Area Networks (WBANs) are one of special-purpose sensor networks that have been developed to monitor patients in healthcare centers. These networks include a number of sensors on the body surface, either inside the body tissues or on clothing, which all together allows receiving, process, and communicating data. In these networks, there is a base station that receives information from sensor nodes and sends it to remote centers.

This technology is one of the latest technologies in the field of diagnosis and management of health care. The sensors on this network are portable and very small. Typically, each ninety sensor has the ability to receive one or more of the vital signs and process these signals and store processed information and transmit data to other sensor nodes or a wireless Body area network server. Continuous monitoring of Wireless Body Area Network increases the possibility of early detection of emergency situations in patients at a high health risk and provides a wide range of health services for people with different degrees of perceptual, sensory and motion disability.

One of the most important issues in Wireless Sensor Networks is how to transfer information from nodes within the network to the base station and select the best possible route to transmit this information. Choosing the best route can be influenced by various factors such as energy consumption, response speed and latency rate, accuracy of data transfer, and so on [2].

Therefore, in this research, a fuzzy cluster base routing is presented in order to overcome the mentioned challenges. In this method, two cluster-head nodes with high-energy are considered at two points of the body, and other sensor nodes in the points of the body are also embedded in order to communicate with the nerve fibers. Sensor nodes are assigned to the nearest cluster, based on their distance from the cluster head node, to exchange information with the cluster head node, and the cluster-head node, regards to its high initial energy, transmits data to the remote server. Naturally, with the movement of the person and the displacement of sensor nodes embedded in different places, such as hands and feet, the distances between the cluster-head nodes and the other nodes can change. Hence, the distance between a specified node from a cluster head node may be farther and be closer to another cluster head node. As a result, it is necessary that sensor nodes belonging to the clusters upgrade and place in their proper cluster and transmit sensory messages to the nearest cluster-head node. The main innovation of this research is using fuzzy logic to calculate the distance between sensor nodes and cluster head nodes and ultimately assigning a sensor node to a cluster of nodes.

Given that the exchange of information in Body Sensor Networks is the main cause for energy utilization in body sensor networks, the information transmission by each node to remote servers causes waste of energy. Sending data to close distances to cluster-head nodes is an approach that has been foresaw in this routing protocol. The more the distance between the sensor node and the cluster head node is, the lower the power consumption of the sensor nodes and the life span of the body sensor network will increase. Hence, the major purpose of this study is reducing the energy utilization of sensor nodes and increasing the life extent of the sensor body. It is expected that energy utilization of sensor nodes improve compared to non-clustering methods.

Our contribution in this article is to improve the clustering of sensor nodes in WBAN. Fuzzy clustering is the approach taken in this research to improve energy consumption and increase network lifetime. Moving sensor nodes in the WBAN increases the distance compared to cluster-head nodes, which leads to increased communication costs and energy dissipation in sensor nodes. Hence, in this research, the fuzzy node membership of the sensor nodes to clusters is calculated and the node membership is updated based on this fuzzy function. Updating the nodal spacing with nodes of the cluster is reviewed periodically. The nodes belong to the closest cluster makes to send messages at close range, reduce communication costs, save energy and prolong network lifetime.

In the remainder of this article, the related work has been reviewed in Section 2. The proposed method for clustering based routing in wireless body area networks is presented in Section 3. Implementation and testing of the proposed model have been done in Section 4. The conclusion and future work of this article is provided in section 5.

2. RELATED WORKS

Over the past years, researchers have provided divers routing protocols based on clustering and different methods have been suggested to select one of the cluster nodes as a cluster head and send data to the base station or sink. The most common and prominent routing protocols are presented in the methods discussed in the next sub-sections in this section.

2.1.Hybrid Indirect Transmission (HIT)

The authors have introduced a data collection protocol named Hybrid Indirect Transmission (HIT) based on the hybrid architecture of one or more clusters that each cluster has multi-jump transmission potential. HIT utilizes parallel processing related to inside and between clusters that minimizes energy consumption as well as network latency or reaction time. Details about the HIT method are: At first, one or more cluster heads are chosen, and then these cluster heads allocate their state across the network to form one or more clusters. After cluster formation, upper and lower relationships are formed for every cluster. Knowing that there are multiple routes within each cluster from the sensor node to the cluster heads, each node can find its own blocked set immediately, which is a list of nodes that cannot establish any relation with the same node at the same time. Ultimately, after computing the time division multiple access (TDMA), the sensor nodes transmit sensor data to the cluster head and through the upper neighbors. Average energy depletion with the number of nodes ranges from 10 to 200 per round. When the number of nodes grows, average energy dissipation for HIT grows slower than LEACH and PEGASIS. The advantage of this protocol is when the number of nodes increases (Jess Collipper et al., 2004[8]).

2.2.Anybody algorithm

Anybody is a cluster-based data collecting protocol that is designed to reduce the direct paths of sensor nodes to distant stations. This method uses LEACH, in which the cluster selects in regular time intervals to maintain a balance in energy consumption, and cluster head aggregates the data and send them to the base station. In LEACH, it is thought that all nodes are within the range of the base station. Anybody performs this via using a cluster head selection method based on density and using these clusters to build the main network. The five steps in Anybody are: neighbor exploration, density computation, clusters formation, main column setup and path configuration. [9]

In the first step, single-hub neighbors are distinguished by sending a Hello1 message, and this is spotted during the first time frame, and double-hub neighbors are identified by sending Hello2 messages in the second time format. During the second step, each node computes its density based on two-hub neighboring data and shares the density information with neighbor nodes with sharing the Hello3 message. In the third step, each node sends a list of single-hub neighbor nodes to the neighbor node with the highest density, and uses a connection message for this end, and on the condition that it has the highest density, will send every message. The cluster head is chosen based on the highest local density and the nodes are grouped into clusters. During the fourth step, every cluster shows the nodes of the entry (Thomas Wattin et al., 2007).

2.3.SEA-BAN algorithm

The purpose of the routing algorithm called SEA-BAN is the following features [10]:

- Expanding the life span of the network by equally distributing energy and consuming amongst the body nodes.
- Local coordination to modify and adjust the cluster.
- Shifting from the cluster method to one of the two multi-hop methods or direct transmission depending on the energy level which is procurable to the body nodes in each cluster.
- The outcome of focused computations with lower computations by the pressure to independent nodes. (Hugo et al. 2013) Limited energy is a main inhibitor in WBSNs and in other WSN applications. In WSNs, orderly mechanisms of clusters for decreasing the number of direct connections of sensor nodes to the base station are considered to reduce energy consumption and reestablish the link quality, which is resulting in network lifetime Increase.

HIT performs better in reducing energy consumption compared to LEACH and PEGASIS, and works better in direct transmission to a small number of nodes as well. Each strap can possibly consume more energy in general. Moreover, HIT reduces network latency for data collection. The main benefit of AnyBody is that the number of clusters remains constant and sustained with

Table.1 methods comparison.

Methods	Decreasing delay	Reducing energy utilization	Increasing lifetime	Increasing delivery rates	Reducing dropped Messages
HIT	*	*	*	-	-
Anybody	*	*	*	*	-
SEA-BAN	-	*	*	*	*
Proposed Method	*	*	*	*	*

increasing the nodes number, while in LEACH, with increasing nodes, the number of clusters also grows (5% of nodes). These results are compared to the LEACH in a larger cluster scale of AnyBody and AnyBody also reduces the cost of cluster adjusting [6].

Table.1 compares the previous and proposed methods in terms of evaluation criteria in WBAN.

3. METHODOLOGY

The body sensor network has been introduced as the intelligent and advanced health monitoring system. It introduced advanced and integrated applications in the fields of medicine, fitness, sports, entertainment, military science and consumable electronics. In WBAN, because of the limited access to the energy source, the network lifetime is a noticeable challenge. Since 80% of the total energy consumption is consumed only because of communication at WBAN, routing protocols play a key role in optimizing energy consumption in such networks. Therefore, in this research, a fuzzy clustering routing protocol is proposed to reduce the energy consumption of sensor nodes in the network and increase the network lifetime. In this chapter, the K-means clustering method and the FCM fuzzy clustering method are presented, and then we will explain the details of the proposed method.

3.1.Clustering

Clustering is finding groups of data (objects) in which objects within a group are very similar and are different from objects within other groups. In other words, there is a great similarity inside the groups and a large difference between different groups [13].

3.2.K-means base algorithm

This technique is a prototype-base clustering technique. The clustering method based on the prototype is a kind of clustering in which the cluster is a set of objects in which each object is closer to its own prototype (more similar) that this cluster prototype is defined among other clusters; indeed each cluster is known by its prototype. For continuous data, the prototype is often the central point (median) of all data in the cluster. In the case of other data, in which the central point seems meaningless, the prototype is an average limit of data representing the data of that cluster.

The K-means clustering method is simple, and we begin to explain the base algorithm. In the beginning, we choose K as the first central point, where K is a user-defined parameter, which means that K is equal with the number of desirable clusters. Then each point is assigned to the nearest central point and each set of assigned points is assigned to a cluster. Euclidean Philosophy is used to allocate points from the equation (1).

$$\text{Euclidean distance} = \left(\sum_{i=1}^{n} |x_i - y_i|^2\right)^{1/2} \quad (1)$$

Then the central point of each cluster is updated by assigning each point to that cluster. Updating the cluster centers is done by finding a new central point using the new midpoints assigned to the cluster.

$$c_i = \frac{1}{m_i}\sum_{x\in c_i} \mathrm{x} \quad (2)$$

These allocated and updated steps continue as long as none of the central points in the clusters is changed, and with the assignment of each point, the same central points are returned, or all points belong to the clusters.

3.3.FCM algorithm

Many real-world issues need to be classified into flexible clusters. These clusters can be obtained based on fuzzy logic, such as FCM, and it has been proved that many types of fuzzy clustering algorithms compete with conventional clustering algorithms. The relative advantage of this method is that there are no sharp boundaries between the clusters, thus allowing each feature vector to belong to different categories by a certain degree of membership. The degree of membership in a feature vector in a cluster is usually considered as a function of its distance from the central points of the cluster or from other vectors representing the cluster center. Fuzzy Features K-means algorithm is sometimes referred to as the C-means fuzzy algorithm. The traditional clustering method produces partitions; in one partition, each pattern belongs to one and only one cluster. Fuzzy clustering extends the concept that the association of each pattern with each cluster is by using a membership function. Usually FCM applies to uncontrolled clustering issues. The basic structure of the FCM algorithm is discussed below [16].

The FCM algorithm is a clustering technique that allows a piece of data to be assigned to two or more clusters based on the membership function. This is based on minimizing the following objective function [16]:

$$J_m = \sum_{i-1}^{N}\sum_{j-1}^{C} u_{ij}^{m} \parallel x_i - c_j \parallel^2, 1 \le m \le \infty \quad (3)$$

Where m is any real number greater than 1, uij is the membership degree of xi in the j cluster, xi is the dimension of the ith measured data, cj is the dimension center of the d of the cluster, and ||*|| is any similar normal expression between any measured data value and center of the cluster. Fuzzy partitioning is done through a duplicate optimization of the objective function shown in (21), or by updating the uij membership degree and the cluster centers cj is done through the following equation [16]:

$$u_{ij} = \frac{1}{\sum_{k=1}^{c}[\parallel x_i - c_j \parallel / \parallel x_i - c_k \parallel]^{\frac{2}{m=1,\dots c_j}}} = \frac{\sum_{i=1}^{N} u_{ij}^{m} x_i}{\sum_{i=1}^{N} u_{ij}^{m}} \quad (4)$$

This repetition stops when:

$$max_{ij}\{\left|u_{ij}^{(k=1)} - u_{ij}^{(k)}\right|\} < \xi \quad (5)$$

where ξ is a final criterion between 0 and 1, while k is the repetition step. This method converges to the local minimum or a saddle point of jm [16].

In this algorithm, the data is subjected to a membership function within the range of each cluster, which represents the fuzzy behavior of the algorithm. To do this, the algorithm constructs a suitable matrix called U, whose elements are numbers between 0 and 1, and represent the degree of membership between the data and the cluster centers. In general, introducing fuzzy logic in the K-means clustering algorithm is FCM algorithm. FCM clustering techniques are based on fuzzy behavior and provide a natural method for producing a cluster in which membership weights are interpreted naturally (but not probable). The structure of this algorithm resembles the K-means algorithm and behaves in the same way [16].

3.4.Proposed Method

As we have mentioned, in this research, a routing method based on fuzzy clustering is presented in order to increase the life of the sensor nodes in the body sensor network. Fuzzy clustering calculates the membership probability of each node to each cluster, and assigns the node to the closest cluster, depending on the distance between nodes from the central points of each cluster.

In the present study, sensor nodes are part of a body sensor network, which initially involves two nodes of high-energy clusters at two points of the body, as well as other sensor nodes at points of the body in order to relate to the nerve fiber are embedded.

Sensor nodes have limited energy and are supplied through limited battery power. On the other hand, transferring messages between nodes will maximize the energy consumption of the nodes. Therefore, the closer the distance between the nodes and the transmission of messages occurs at short intervals, the energy consumed by the nodes will be reduced and will result in a later completion of the energy source and failure of the sensor node embedded in the body. Completion of early energy in a node can lead to a disruption of the entire functioning of the body sensor and cause irreparable consequences. Hence, the purpose of most of the routing methods in sensor networks is to reduce node power consumption and increase the lifetime of nodes and at higher levels increasing the network lifetime.

The process of selecting cluster head nodes is based on the following three factors:

- Nodes energy - The energy level of each node determined by the fuzzy energy variable,
- Node concentration - The number of nodes in the vicinity of the node, determined by the fuzzy concentration variable,
- Node centrality - A value that assigns a node based on how the center of the node is classified for a cluster, determined by the fuzzy centralization variable.

To find the center of the node, the base station selects each node and calculates the sum of the squares of the distances for the other nodes from the selected node. Since primary energy of the cluster head nodes in the proposed scenario is more than other nodes, effective factors in selecting the cluster head node are the amount of centrality and concentration of nodes around the cluster head nodes. The highest centrality and node concentration causes the least amount of energy required by other nodes to transmit data to the cluster head node.

The nodes in each cluster communicate with the cluster head node related to that cluster and exchanging data is done through the cluster node. An access point or base station is also intended for the exchange of information with the cluster heads in the network. Sensor nodes are assigned to the closest cluster, based on their distance from the cluster node, and exchange information with the cluster node. In the proposed method, the distance between the nodes and the cluster head node is calculated through the fuzzy membership function in the FCM algorithm which is described in the previous chapter. The output of the fuzzy membership function is between 0 and 1, which indicates the probability of assigning each node to each of the cluster head nodes. By assigning nodes to the closest cluster head, the transmission of sensed messages in the body sensor network will occur in the short distance between the node and the cluster head node. The sensor nodes transmit messages to the cluster node, and the cluster node, due to its high initial energy, transmits data to the remote server.

Naturally, by moving of the person and changing the position of sensor nodes embedded in different places, such as the hands and feet, the distances between the cluster head nodes and other nodes may change. Hence, the distance between a specified node from a cluster head node may become farther and it may be closer to another cluster node. As a result, sensor nodes belong to clusters must be upgraded and placed in their proper cluster and transmission of sensory messages is done to the nearest node of the cluster. The main innovation of this research is using fuzzy logic to calculate the distance between sensor nodes and cluster head nodes and ultimately assigning a sensor node to a cluster of nodes.

Given that the exchange of information in sensor networks is the main reason for energy consumption in sensor body networks, the transmission of information by each node to remote servers causes waste of energy. Sending data at distances close to cluster head nodes is an approach that has been thought through this routing protocol. The more the distance between the sensor node and the cluster head node is, the lower is the power consumption of the sensor nodes and the life span of the sensor network increases. Hence, the main purpose of this study is to reduce the energy consumption of sensor nodes and increase the life span of the sensor body. Energy consumption of sensor nodes is expected to improve compared to non-clustering methods. Flowchart of the proposed method is shown in Figure 1.

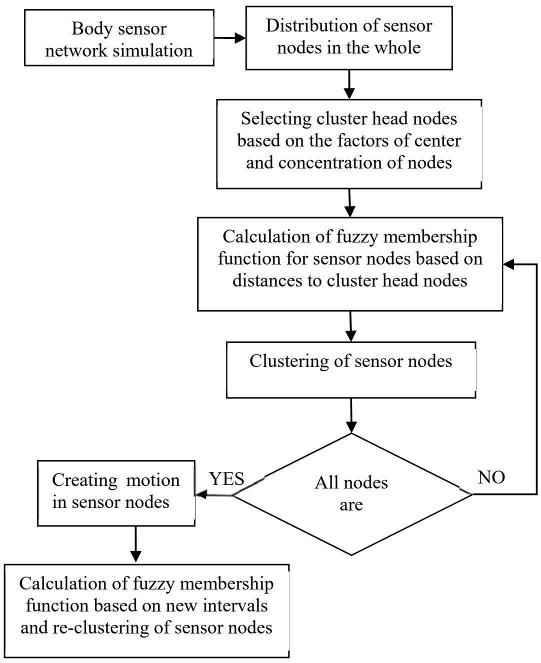

Fig. 1. Flowchart of Proposed Method

As shown in the flowchart of the proposed method in Figure 1, in this study we first simulate the proposed scenario using the Network Simulator 2 software (NS2). In this scenario, the nodes are randomly embedded in the dimensions of their body. After random distribution of the sensor nodes in the human body, we determine the two cluster head nodes based on the density of the surrounding nodes and the center criteria of the cluster head node. The cluster head node should be in the median of the other sensor nodes embedded in the body, so that having the same distance from all of them. Also, based on the density of the nodes in each cluster, the number of sensor nodes around the cluster head should be greater than the rest of the nodes. After selecting the cluster head nodes, we calculate the fuzzy membership function for each sensor node in order to belong to the nearest cluster. After calculating the fuzzy membership function based on the nodes distance from the cluster nodes, we cluster the embedded nodes in the body. The clustering of the nodes creates a connection between the sensor node and a cluster head node. When the sensor node sends data to the transmitter, it sends the data to the cluster head node, through which the data reaches the base station and the necessary care measures are taken.

The use of fuzzy logic in this research has caused the nodes to belong to clusters based on the fuzzy membership function and to be associated with cluster head nodes. The fuzzy membership function calculates the membership probability of each node to the existing clusters, and the most possibility showing that the node belongs to the mentioned cluster. During movement of body organs, the embedded sensor nodes in will also be replaced, and they may move away from the current cluster head node and approach the other cluster head node. In this case, communicating with the previous cluster head node and transmitting data to that cluster head will result in energy loss due to the distance. In such cases, it is necessary to update the clustering, and the probability of belonging to the clusters should be re-checked. The nodes that have been replaced may be assigned to another cluster depending on the update, and exchange information with the new cluster node. Hence, maintaining the shortest distance for data transmission in the nodes is guaranteed and the energy of nodes will not be lost and the network lifetime will increase.

4. TEST RESULTS

In order to simulate the current scenario, the software NS-2 network simulator version 2.35 has been used. Since the existing version does not have the ability to simulate wireless body area networks (WBAN), the Mannasim add-on package added to this version of the software. The simulation environment is a hospital with 10 meters in 10 meters dimensions. Also, the sensor environment is intended to be a typical human body in 1.75 meters in height and 0.5 meters in width. There is also an access point in the hospital environment that is located at the right distance from the cavity. We consider the cavity antenna power to be sufficient to prevent any particular problem in communication for a person getting away from the point of access. Table2 shows the sensor node information used in this study.

As can be seen, in Table 1, energy unit is considered joule (J). Also, the settings for the antenna and other infrastructure in this scenario are applied in accordance with the standard settings in the simulation of previous work.

In the present scenario, when a person moves, the distance between sensor nodes belonging to a cluster may be farther away from the cluster head node and be closer to another cluster head node. These movements can include hands and feet movements and position of sensor nodes. At this time, the mentioned sensor node should become a member of new cluster according to the change of membership function and the new distance criterion. For this purpose, in this scenario, the clustering function is re-called every second to maintain the distance between the sensor nodes and clusters and properly replace the sensor node in the clusters.

Table 2 Information on nodes

primary energy	Node role	Node numbers
-	access point	1
10.5J	cavity node	2
10.5J	cluster head node	3-2
J 0.5	sensor node	15-4

5. PERFORMANCE EVALUATION

In order to the performance evaluation of the suggested method, the data from trace file would be presented as comparison graphs. Since the main goal of the proposed method is to save energy consumption and increase the age of sensor nodes, the findings from the proposed method would be compared with previous methods such as, LEACH, PEGASIS, HITm, HIT, Direct, in respect with the age.

In doing so, first the energy consumption of a sensor node would be illustrated in a graph. As the distance between the sensor nodes and the cluster head node is significant, it can be said that the further the node is, the more energy would be used to transmit the message. In addition, since the behavior of sensor nodes in a cluster is almost the same, the relevant graph also would be the same. Therefore, it has been avoided to draw the energy consumption graph of each node, one by one. Figure 2 shows the energy consumption of one of sensor nodes.

As it can be seen in Fig. 2, the slope of energy consumption of sensor node increases slightly. Moreover, it shows the long age of a sensor node in the nodes sensor network in the patient body.

Next, another graph should be drawn to show the energy consumption of the cluster head node. In the research scenario, the cluster head nodes have had a significant role. Moreover, the cluster head nodes are responsible for packages and messages transmission between the sensor nodes and the cavity node. Therefore, the age of the cluster head nodes would be an important issue. Fig 3-4 illustrates the energy consumption of a cluster head node.

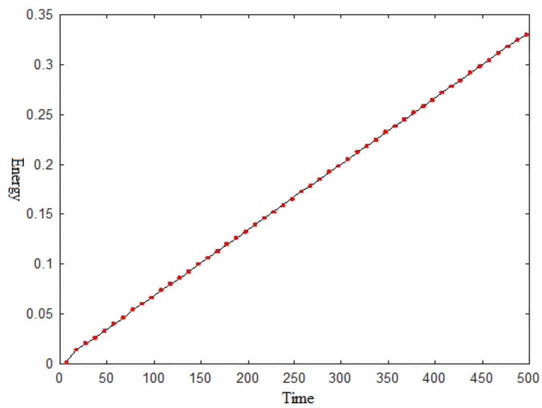

Figure2. energy consumption of sensor node for one node

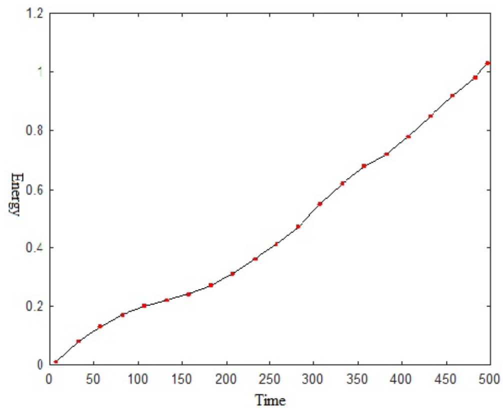

Figure 3. the energy consumption of a cluster head node

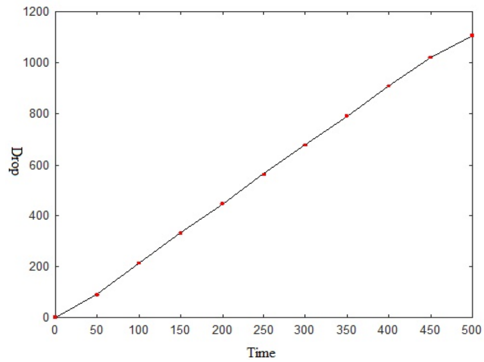

Figure 4. the chart of missed packages

As it can be observed in fig. 3, the energy consumption of a cluster head node has a slight slope in comparison with the sensor nodes. Furthermore, it shows the long age of sensor node in the sensor nodes network at the patient's body. In other words, increasing the number of sensor nodes in the clusters, the cluster head node may lead to deliver more service and transmit the messages to more sensor nodes and it can cause an increase in energy consumption of cluster head node at the body sensor network.

Consequently, the graph of dropped packages and informative messages would be presented, at the body sensor network, losing a message about a malfunction or a risk, at any part of the body, may lead to some irreparable consequences. So, the less missed messages at the body sensor nodes, the higher assurance it would have. The increase of the length of the line among the cluster head node may somehow solve the problem. However, the fixed memory of these kind of nodes and expense increase with memory increase are amongst the challenges which face this solution. Fig 4 illustrates the missed packages in this scenario.

As it can be seen in Figure 4, the more time for simulation we have the more missed informative packages we have. According to the graph, it increases slightly and the correlation between the missed package and time is linear.

Moreover, another significant factor is computational overhead in the cluster head node. Considering the point that the cluster head node is the destination of sent message from other nodes in the network, the cluster head node would be a passageway, in terms of computational overhead. In this case the distribution of nodes is scattered and the number of nodes which are related to one cluster head node is variable at the clusters. In this case, a cluster with the low number of nodes and another cluster with the high number of nodes may be seen. Non-fuzzy clustering keeps the steady correlation between the cluster head nodes and other nodes, in all cases. So, with changing the place of the node there would not be a change at the nodes' membership in the clusters. This phenomenon has a negative impact on the work process of the head cluster node and may increase the delay and miss many messages. Therefore, in order to solve this problem the present research is going to suggest a solution to change the nodes membership in the clusters, considering the current position of the node. The fuzzy clustering method considers some fixed node to each cluster at first step which are related to the head cluster nodes. Changing the patient's situation, these nodes would allocate to another cluster and may balance the computational load among the clusters. Figure 4-9 illustrates the computational load in one head cluster node, with fixed membership and fuzzy membership.

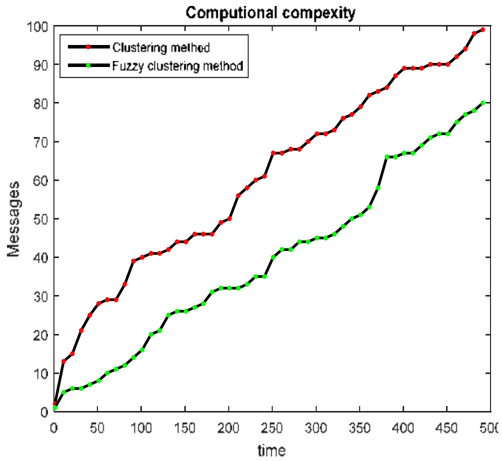

Figure.5 a comparison between the current computational load with fixed membership and fuzzy membership

As it can be seen in figure 5, the number of received messages at one head cluster node with fuzzy membership is less than the head cluster node with non-fuzzy membership. It is mainly because the fuzzy membership can apply balance to allocate the nodes to the cluster and connections to the head cluster node. Then, the next section in the following will compare the proposed method and previous works.

5.1. Comparison between the proposed method and previous works

Since the in wireless body area networks have been among the new research subjects in the wireless area networks, many studies have been conducted about the issue. Furthermore, most research tries to maximize the length of life for the body sensor networks and minimize the energy consumption for sensor nodes. Therefore, the present research is going to compare the suggested method and previous algorithms namely, Direct, LEACH, PEGASIS, HITm, HIT in order to maximize the length of life. In doing so, and exact comparison between the proposed method and existing methods, in theory, the number of suggested nodes have been increased to 100 and the results have been illustrated in Figure 5 to be compared with the previous methods.

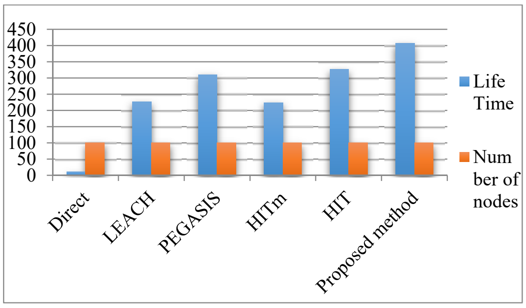

Figure 6. a comparison between the proposed method and existing methods with 100 nodes

As it could be expected and has been shown in figure 6, increasing the number of current nodes, the lifetime network of the nodes have been increased more then the previous methods. The lifetime increase might be due to the impact of fuzzy clustring method and sending messeges to the head cluster nodes with closest distance.

6. CONCLUSION

The body sensor networks have been one of the wireless sensor networks which have been made to a better use of hospital resources and faster and easier diagnosis and finaly reduce the costs of medical care. The reason of applying the body sensor networks in the medical environment has been a unique opportuninty created by these networks. Thus, the medical care may transfere from the hospitals to home environments. In addition, another significant issue of the wireless sensor networks has been how the information may transfere from the nodes of inside of the sensor into the basic station, considering the limit energy of sensor nodes in the body. Hereupon, the present research is a routing based on fuzzy clustering in addition to the mentioned challenge. In this method, the sensor nodes are allocated to the nearest cluster, based on their distance from the cluster head node, and exchange information with the cluster-head at the near distances, and the cluster-head node, due to its high initial energy, can transmit data to the remote server. Obviously, due to the movement of the person and the position shift in the sensor nodes and the distances between the cluster-head nodes, the distances between head cluster nodes and other nodes will change. Therefore, it is probable that the distance of a particular head cluster node would be further and closer to another head cluster node. Overall, it is necessary that the sensor nodes of clusters have been updated and placed in the appropriate cluster and so they may transmit messages to the nearest head cluster node. The simulation results show that the proposed method can be better than other algorithms.

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