International Journal of Computer Science
Scholarly Peer Reviewed Research Journal - PRESS - OPEN ACCESS
ISSN: 2348-6600
http://www.ijcsjournal.com Volume 10, Issue 2, No 7, 2022. ISSN: 2348-6600
Reference ID: IJCS-451 PAGE NO: 3052-3060

Extending the Wireless Sensor Network' Life by Using Parallel Processing of the Classification Mechanism

Loubna Ali[1], Shkelqim Hajrulla[2], Eng. Nour Souliman[3]

[1]*Dept. of Information Technology Engineering, Univ. of Tartous, Syria*
[2]*Dept. of Computer Engineering, Epoka University, Albania*
[3]*Dept. of Information Technology Engineering, Univ. of Tartous, Syria*

[1]LoubnaAli@tartous-univ.edu.sy
[2]shhajrulla@epoka.edu.al
[3]slimannoori@tartous-univ.edu.sy

Abstract

Recently, wireless sensor networks have attracted great interest by researchers due to the important role that is played by these networks in all aspects of life. The credit for the widespread use of sensor networks is due to the ease of distribution in the search areas and its low cost compared to other networks. However, the limited energy sources of sensor nodes minimize the network life duration and thus limit its use in some sensitive areas. Therefore, in previous research [1] the sensor nodes energy consumption reduction and extending wireless sensor networks time duration was discussed, to achieve this goal one mobile cluster leader was used to collect data from network clusters. The number clusters will be determined by the network designer as like as the mechanism of (LEACH) protocol, but it differs from LEACH in that the cluster leader was mobile while it was fixed in the LEACH protocol mechanism.

The aforementioned study [1] has accomplished a significant progress concerning power consumption of wireless sensor nodes comparing with the LEACH protocol. However, when the network is dense (large number of nodes and large cluster size), it is possible that the moving cluster leader's power runs out before the end of its specified round, and before completing data collection from all nodes within the cluster.

Therefore, this research will be focused on addressing the problem of running out of energy by using the parallel cluster leading. So that, each cluster will be headed by two leaders who roam in different directions within the tour, in order to collect data from all nodes with perfect time delay and before the end of the specified tour.

Index Terms - Wireless sensor, cluster-based protocols, parallel cluster, insert.

I. INTRODUCTION

Ad-Hoc networks are considered one of the most widespread networks in all fields, especially in places where the infrastructure has collapsed, either because of wars, earthquakes, floods or other disasters. Furthermore, those kind of networks are suitable in the not reachable places by humans, such as in depths of the sea and inside the human body. Ad-Hoc Networks are formed without the need for infrastructure or prior organization. Because the word Ad-Hoc means that devices can establish a connection at anytime and anywhere without the need of a central infrastructure [2]. In addition to its low cost which makes it very easy to spread and use. AD-Hoc networks types are classified into [2] ,[3]:

- Mobile Adhoc Network (MANET)
- Vehicle Adhoc Network (VANET)
- Wireless Sensor Network (WSN)
- Wireless Mesh Network (WMN)

This research is concerned with Wireless Sensor Network (WSN) the third type of Ad-Hoc networks where Parallel Cluster leadership has been implemented to reduce nodes power consumption. Wireless sensor networks suffer from the act sensor nodes running out of power in a short time, which leads in some cases to the death of the sensors' network.

http://www.ijcsjournal.com Volume 10, Issue 2, No 7, 2022. ISSN: 2348-6600
Reference ID: IJCS-451 PAGE NO: 3052-3060

Therefore, most researches in the field of WSN focus on solving this problem. Previous studies focused on the issue of reducing the energy of wireless sensors are divided into three types:

- Table-driven protocols
- On demand-driven protocols
- Hybrid protocols

The previous first protocol works as follows: Each node maintains a table (called a node routing table) that contains all the nodes in the network and the paths that connect each node to the rest of the other nodes. Forming routing tables at each node drains its energy, so this protocol is only suitable for small networks with low node density. While in the second type, each node sends a message requesting a path to the target node when it needs to. Therefore, this type of protocol is not suitable for high dynamic networks (high mobility) because in high dynamic networks the topology is constantly changing, with each change, the nodes will send a route request, and consequently, nodes will consume more energy [2]. As for, the third type combines the two previous types and it did not provide a noticeable improvement in the field of reducing energy consumption [3], [4], [5].

Therefore, subsequent studies have proven that the use of clustering protocols is better than the previously classified protocols, because dividing the network into clusters makes it easier to dealing with and controlling the network regardless its density [1], [6].

Consequently, in previous research [1] the sensor nodes energy consumption reduction and extending wireless sensor networks time duration was discussed, to achieve this goal one mobile cluster leader was used to collect data from network clusters. The number clusters will be determined by the network designer as like as the mechanism of LEACH ((Low Energy Adaptive Clustering Hierarchy)) protocol, but it differs from LEACH in that the cluster leader was mobile while it was fixed in the LEACH protocol mechanism [6].

The aforementioned study [1] has accomplished a significant progress concerning power consumption of wireless sensor nodes comparing with the LEACH protocol. However, when the network is dense (large number of nodes and large cluster size), it is possible that the moving cluster leader's power runs out before the end of its specified round, and before completing data collection from all nodes within the cluster.

Hence, this research will be focused on addressing the problem of running out of energy by using the parallel cluster leading. So that, each cluster will be headed by two leaders who roam in different directions within the tour, in order to collect data from all nodes with perfect time delay and before the end of the specified tour. Thus, extending the life of the wireless sensor network to the longest possible period.

II. RESEARCH IMPORTANCE AND OBJECTIVES

Given the critical importance of wireless sensor networks at all levels [7], [8], [10], [13], this work aims firstly to reduce those networks' problems specially the network death. Network death is presented as the power outage of one or several nodes in the network, and consequently the loss of communicate with the area that those nodes sense.

On the other hand, this research addresses the delay by minimizing it as much as possible in order to take advantage of the WSN in all applications, as most applications need real-time processing, and the time delay in these applications leads to failure performance and inaccuracies in standards [[11], [12]

In order to reach the desired goal, parallel processing will be used for cluster leaders due to the critical importance of parallel processing in achieving work more quickly and distributing the effort in parallel on the network elements [12]. The use of this method will contribute to reducing the power consumption of the wireless sensor nodes and extending the life of the network in order to enhance its use.

We must also remember that what encourages the use of wireless sensor networks is their low cost, ease of configuration, and their ability to transmit all types of data, including multimedia.

III. RESEARCH METHODS AND MATERIALS

Wireless sensors networks' nodes hierarchy can be classified in three types depending the classification level. Those nodes' types are the Access-point, the mules and the Sensors as shown in the following figure [8].

International Journal of Computer Science
Scholarly Peer Reviewed Research Journal - PRESS - OPEN ACCESS
ISSN: 2348-6600
SKRGC Since 2012
http://www.ijcsjournal.com Volume 10, Issue 2, No 7, 2022. ISSN: 2348-6600
Reference ID: IJCS-451 PAGE NO: 3052-3060

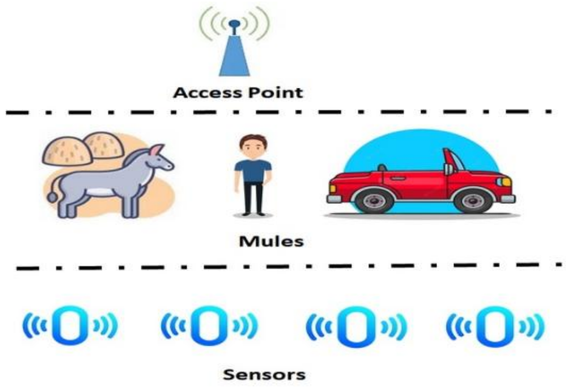

Fig. 1 Hierarchical levels of wireless sensor nodes [8]

Access points are located at the highest hierarchical level, and have the highest power level among all nodes. The access point roams the network browsing all the clusters leaders to collect data. At the end of each round, all information about the network will be collected.

The Mules (data mules) (the leaders of moving clusters) are situate in the second hierarchical level after the access point, the Mule in general has less energy than the energy of the moving access point and higher than the energy of the rest of the nodes within the cluster. In each round, the mule passes through all the nodes within the cluster to collect the data that those nodes have sensed [8].

The lowest hierarchical level is the wireless sensor nodes that sense the data during the tours.

An ID is used for each node representing the type of data it is collecting, when specific data is required the cluster leader moves towards the nodes that look for the requested data type.

In a previous study, we proposed a modified work algorithm from the LEACH algorithm. As it was relied on making the cluster leader mobile instead of being fixed and the node with the highest energy was chosen to play the role of the leader [1].

The work was done according to the algorithm shown in Figure (2). This method has accomplished a significant progress concerning power consumption of wireless sensor nodes. However, we found that this method is of limited use in the case of networks with a high density nodes.

The mentioned problem has prompted us to work on developing this research in order to reach better results in case of high nodes density network and to overcome the problem of node lack of energy.

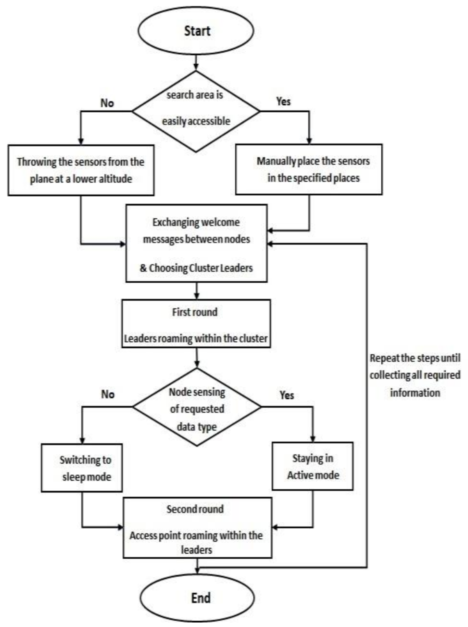

Fig. 2 Algorithm applied in the previous research [1]

The proposed algorithm became as shown in the figure (3).

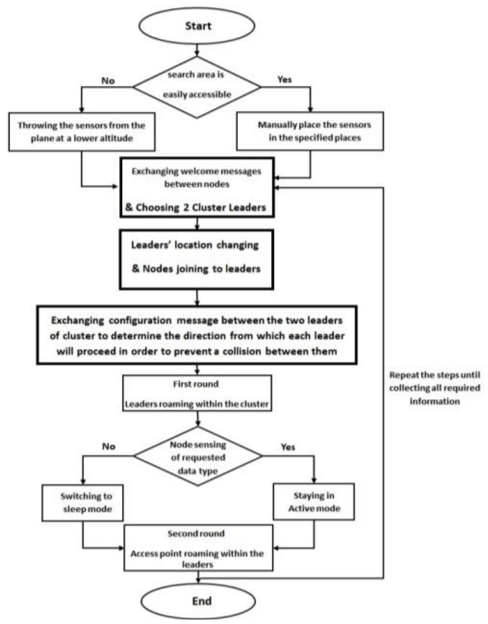

Fig. 3 Proposed algorithm for this research

IJCS International Journal of Computer Science
Scholarly Peer Reviewed Research Journal - PRESS - OPEN ACCESS
ISSN: 2348-6600
SKRGC Since 2012
http://www.ijcsjournal.com Volume 10, Issue 2, No 7, 2022. ISSN: 2348-6600
Reference ID: IJCS-451 PAGE NO: 3052-3060

The working steps of this algorithm can be explained as follows:

In this research, two mobile cluster leaders were used for each cluster. After placing the wireless sensor nodes in their places within the search area, they exchange welcome messages with each other using broadcast messages to all nodes within the network, including access points. These messages contain the node's name, an Id that expresses the type of data that this node senses and the amount of node's energy.

At the start of operation, all nodes that sense the same type of data have the same energy level, so the leaders of the clusters are chosen randomly using the Random function. It also contains a binary (x,y) that expresses the location coordinate of the node within the search area.

After completing the exchange of welcome messages, the access point selects the wireless sensor nodes with the highest amount of energy to be the cluster leaders in the case of a difference in the energy level and randomly in the case of an equal level of energy of nodes. Then, the access point sends two messages containing the same cluster number to the two leaders of the same cluster. And ask them to change places.

Elected Cluster leaders by the access point send broadcast messages to all nodes in the network informing them that they have been selected as cluster leaders.

Each node, after receiving messages sent from cluster leaders, compares its location coordinates with the cluster leaders' coordinates and joins the cluster leader closest to it.

After completing the exchange of joining messages, the cluster leaders send a message containing the names of the nodes to which they have joined and exchange configuration message between them to determine the proceeding path for each one in order to prevent a collision between them.

The Leaders roam within the cluster to collect data.

In order to test the proposed algorithm, we chose the NS2 as a Network Simulator, which is used to simulate a large number of wired and wireless networks, and it supports many protocols. Initially, this program was designed to run on the Linux operating system using a terminal interface, and later the program supports working on the windows xp operating system through the Cygwin program, which is an interface similar to the terminal but is written using dos instructions. We also used XGRAPH which is a program that can show search results in the form of graphs.

IV NETWORK DESIGN AND RESULTS

In this research, we designed the network shown in the figure (4). The studied network consists of two clusters; each cluster includes 18 sensor nodes and an access point. Sensor Nodes were placed in the search area, and the network designer previously determined the location coordinates of each sensor node.

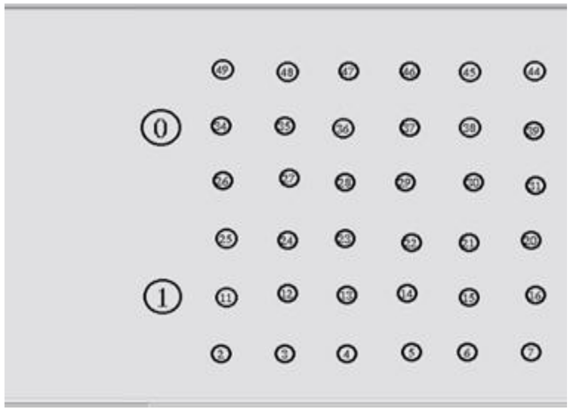

Fig. 4 The network after placing nodes and before forming clusters

The following figure shows the exchange of messages step that share information about the location coordinates and energy of each node in order to select the cluster leaders, as each node sends the welcome message to the rest of the other nodes in the network.

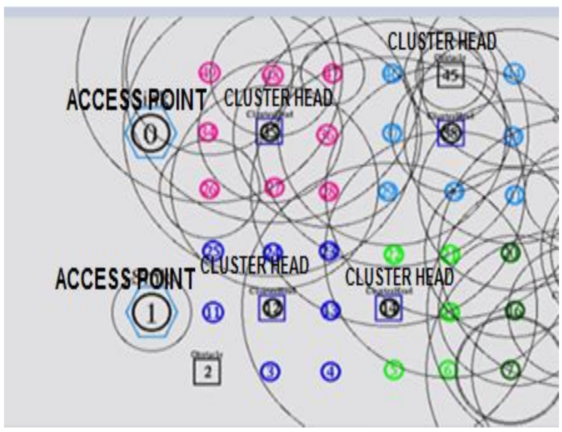

Fig. 5 Messages exchanging

http://www.ijcsjournal.com
Reference ID: IJCS-451

Volume 10, Issue 2, No 7, 2022.

ISSN: 2348-6600
PAGE NO: 3052-3060

As the selection of cluster leaders is shown in Figure (6) where the mechanism for selecting cluster leaders was explained previously in this research. We mention here that we have two clusters and each cluster has two leaders. Therefore, we will get four cluster leaders.

After leaders' selection, each node joins the closest cluster leader. Then the leaders start data collection.

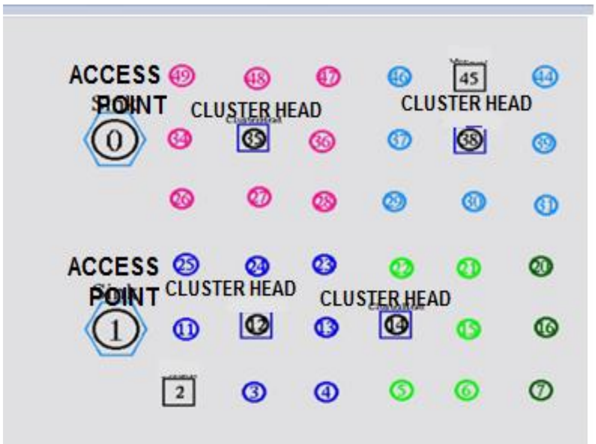

Fig. 6 The network after the election of cluster leaders

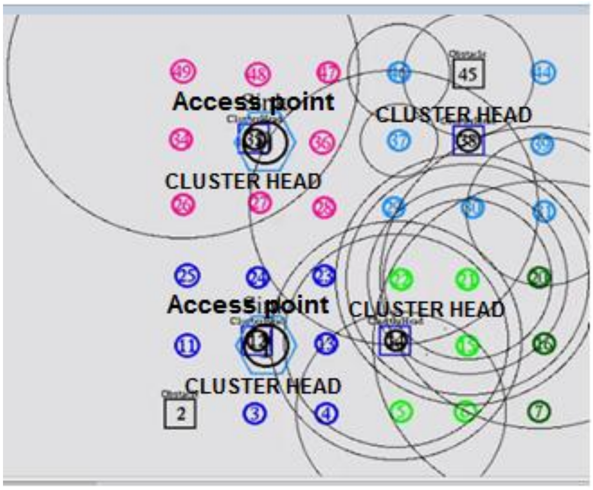

Fig. 7 Access point movement in the network

After the realizing of network, various working scenarios will be implemented and the energy consumption parameter will be studied. We know that power consumption is the difference between the two quantities of power between the start and end of the simulation.

In the first scenario, the network structure that was presented earlier will be used, which represents a dense network with regularly distributed nodes.

However, In the second scenario, the proposed algorithm will be tested with a dense network structure with irregularly distributed nodes

For the first scenario, the power consumption of a remote peripheral node and then of a intermediate positioning node was monitored. The energy consumption parameter has also been studied in the event that we have one cluster leader and two cluster leaders, which is the proposed mechanism in this research, figure(8), figure(9).

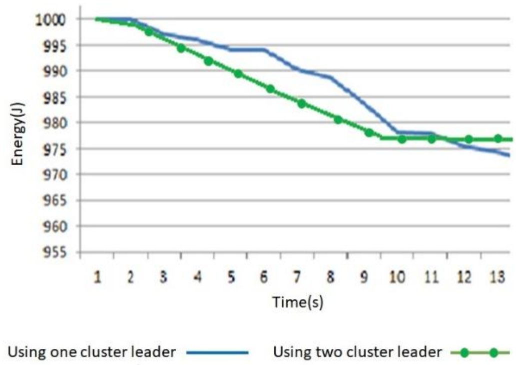

Fig. 8 Remaining energy in the intermediate positioning node of the first scenario

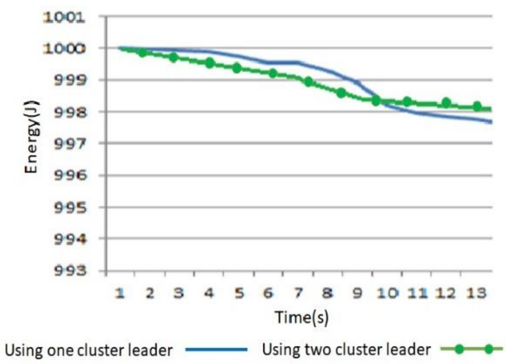

Fig. 9 Remaining energy in the peripheral node of the first scenario

International Journal of Computer Science
Scholarly Peer Reviewed Research Journal - PRESS - OPEN ACCESS
ISSN: 2348-6600
http://www.ijcsjournal.com Volume 10, Issue 2, No 7, 2022. ISSN: 2348-6600
Reference ID: IJCS-451 PAGE NO: 3052-3060

Regarding the previous diagrams, we can conclude that the energy remaining in the intermediate positioned node at the end of the simulation when using one moving cluster leader is 974J, and the amount of energy remaining in the intermediate positioned node at the end of the simulation when using two moving cluster leaders is 976J.
As for the peripheral node, the amount of energy remaining at the end of the simulation when using one moving cluster leader is 997.8 J. While the amount of energy remaining in the terminal node at the end of the simulation when using two moving cluster leaders is 998 J.
Where we found that the proposed mechanism in this research has provided a significant improvement in reducing the power consumption of nodes in the network. We note that the amount of energy remaining in the peripheral node when using two moving cluster leaders is slightly close to the amount of energy remaining in the peripheral node when using one moving cluster leader, because it is located at the end of the cluster. Either way, it will wait for a while for the cluster leader to reach it, but when using two cluster leaders, the waiting time for the peripheral node will be less.
Since it is also important to conserve the energy of the cluster leaders, we show in Figure (10) the graphs that represent the energy consumption when using a single cluster leader and when using two cluster leaders.

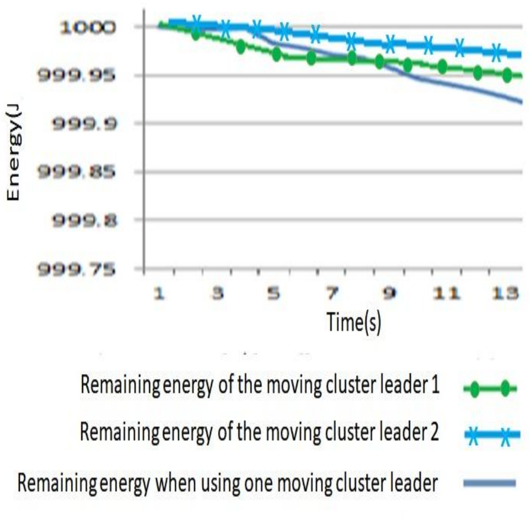

Fig. 10 Remaining energy in moving nodes of the first scenario

We note that the amount of energy remaining in the moving node when using one moving cluster leader equals 999.92 J. While the amount of energy remaining in the moving node at the end of the simulation when using the proposed mechanism in this research (the use of two moving cluster leaders) equals 999.95 J for the first moving cluster leader and It is equal to 999.97 J for the second cluster leader.
In the previous results, the proposed mechanism was applied to the first scenario, i.e. using a dense network with regular nodes' density. Now, applying the proposed mechanism to the second scenario will be discussed when the network has the same number of nodes but with irregular nodes' density in the cluster (A cluster with many nodes and very close together and a cluster with less nodes and nodes far apart).
The following figure shows the irregular nodes' density network on which the proposed mechanism will be applied

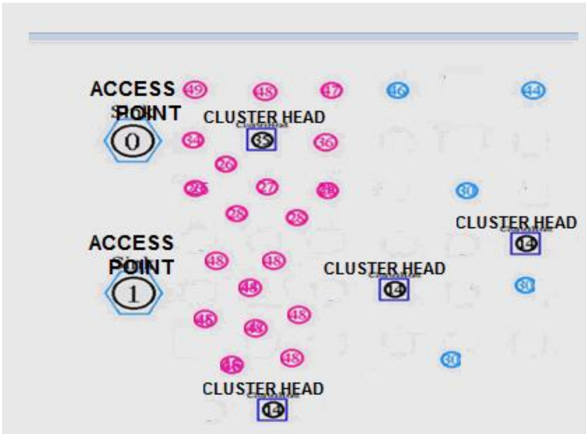

Fig. 11 Irregular nodes' density network

The two figures 12, 13 show the remaining energy in the moving node (cluster leaders) at the end of the simulation in the cluster with the highest density and in the cluster with the lowest density:

International Journal of Computer Science
Scholarly Peer Reviewed Research Journal - PRESS - OPEN ACCESS
ISSN: 2348-6600
http://www.ijcsjournal.com Volume 10, Issue 2, No 7, 2022. ISSN: 2348-6600
Reference ID: IJCS-451 PAGE NO: 3052-3060

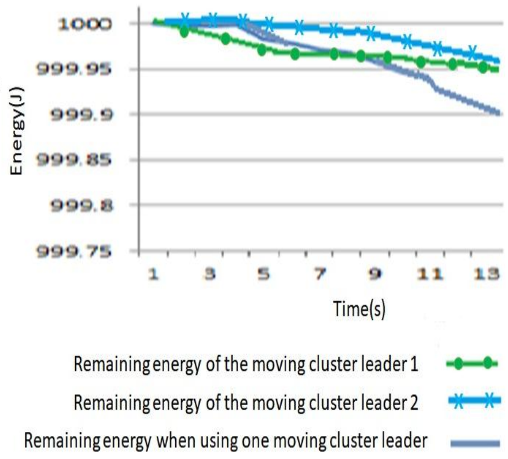

Fig. 12 Remaining energy in the cluster with the highest density

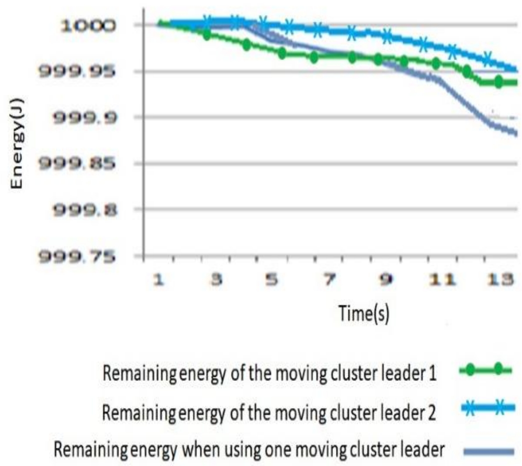

Fig. 13 Remaining energy in the cluster with the lowest density

The results show that the residual energy of the moving cluster leader when using one cluster leader = 999.9 J. When using two moving cluster leaders, the remaining energy of the first cluster leader = 999.95 J, and the remaining energy in the second moving cluster leader = 999.96 J.

As consequence, we notice that the energy saving by using two moving nodes is more than by using one cluster leader, because when the density in the cluster is high, the operations that one cluster leader will perform will be greater and he will pass through all the nodes, which consumes more energy than when using two cluster leaders .

In the less density network, the remaining energy in the moving cluster leader when using one cluster leader = 999.88 J. The remaining energy in the first moving cluster leader when using two cluster leaders = 999.94 J, and the remaining energy in the second cluster leader when using two cluster leaders = 999.96 J.

We note that the use of two cluster leaders provided more energy savings than when using one cluster leader, and we also can note that the increase in density did not negatively affect energy consumption when using two cluster leaders.

In order to connect this research with previous researches, we have implemented the Leach algorithm on the same dense network used previously, and we got the result shown in the following figure, where we can clearly deduce the clear difference in the energy consumption of Leach's algorithm compared to what we got in this research.

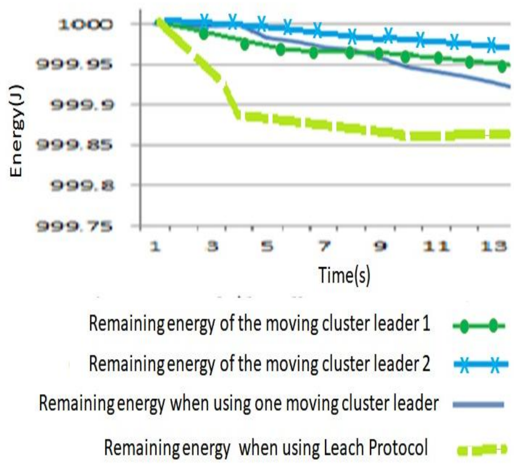

Fig. 14 Leach algorithm Vs. proposed algorithm in dense network

Based on math operations, we can do some analytic approaches for the energy saving. An embedded Markov chain would be use. We will use numerical methods for studding the energy saving mechanism in analytic models of WSN node operations. Based on probability distribution theory and unimodular matrix usage [9], we derive some distributions of the processing period duration from an arbitrary fixed time up to a variable time t.

Using the property of the exponential distribution for some different values of times, the following graphic representations are true.

International Journal of Computer Science
Scholarly Peer Reviewed Research Journal - PRESS - OPEN ACCESS
ISSN: 2348-6600
http://www.ijcsjournal.com Volume 10, Issue 2, No 7, 2022. ISSN: 2348-6600
Reference ID: IJCS-451 PAGE NO: 3052-3060

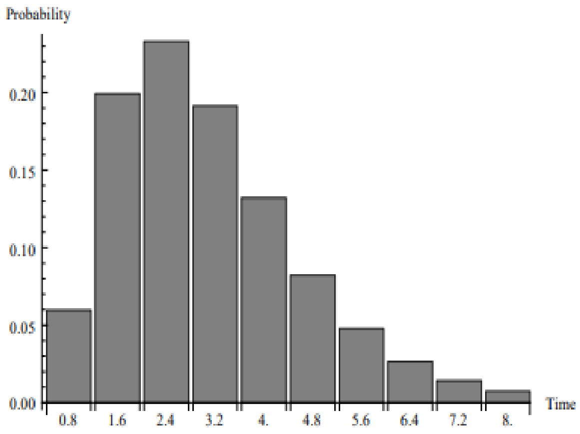

Fig. 15 Distribution of energy duration for λ = 1.0

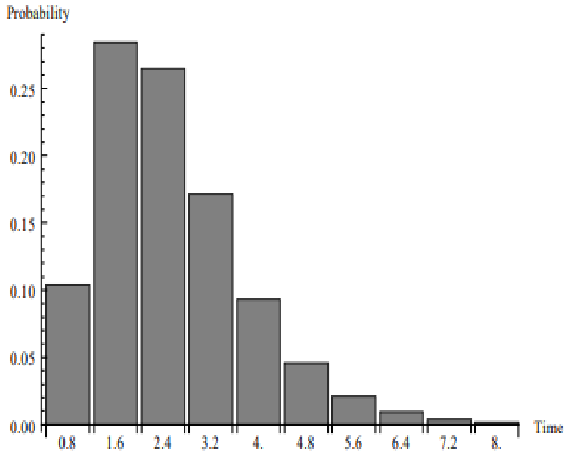

Fig. 16 Distribution of energy duration for λ = 1.2

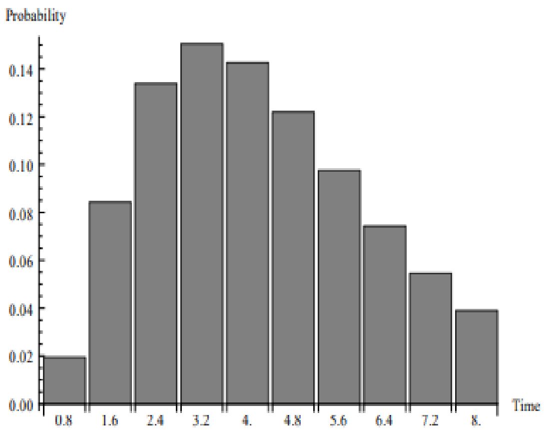

Fig. 16 Distribution of enery duration for λ = 0.8

V CONCLUSIONS

The issue of reducing the energy consumption of the sensor nodes is one of the important topics that researchers address, as extending the life of the network allows those networks to be used in all fields and benefit from their advantages.

This research has dealt with the issue of reducing the energy consumption of the nodes by using the clustering mechanism, as well as by relying on two cluster leaders working in parallel. The results of the research have showed that the proposed mechanism was able to achieve a remarkable progress in the issue of energy consumption. In the following study, we will try to address the problem of time delay by testing the effect of the work algorithm that we adopted in this research on the time delay.

REFERENCES

[1] L. Ali, M. Dergham, and N. Souliman. " Proposing a technique to routing data between wireless sensor nodes for increasing the life time of Wireless Sensor Networks ." Journal of Tartous university 5.2 (2021).

[2] K. Devarajan, and V. Padmathilagam. "An enhanced cluster gateway switch routing protocol (ECGSR) for congestion control using AODV algorithm in MANET." International Journal of Computer Applications 123.3 (2015).

[3] M. Mamoun, "Important characteristic of differences between DSR and AODV routing protocol." MCN 2007 Conference, November. Vol. 50. 2007.

[4] W. Rabiner, A. Chandrakasan, and H. Balakrishnan. "Energy-efficient communication protocol for wireless microsensor networks." Proceedings of the 33rd annual Hawaii international conference on system sciences. IEEE, 2000.

International Journal of Computer Science
Scholarly Peer Reviewed Research Journal - PRESS - OPEN ACCESS
ISSN: 2348-6600
http://www.ijcsjournal.com Volume 10, Issue 2, No 7, 2022. ISSN: 2348-6600
Reference ID: IJCS-451 PAGE NO: 3052-3060

[5] P. Rakhi, and B. Keswani. "Node mobility impact on Zone routing protocol." International Journal of Computer Applications 975 (2015): 8887.

[6] S. Gumaste, U. Kharat, and V. Thakare. "Performance analysis of DSR protocol." International Journal of Scientific Engineering and Research (IJSER), ISSN (Online) (2013): 2347-3878.

[7] L. Kumar, M. Ravi, N. Geethanjali, and N. Babu. "Energy Aware DSDV and FSR Routing Protocols in Mobile Ad Hoc Networks." International Journal Of Computer Trends And Technology 4.4 (2013).

[8] A. Rahayfeh, A. Amer, M. Muder, and A. Abdelshakour. "Parameterized Affect of Transmission-Range on Lost of Network Connectivity (LNC) of Wireless Sensor Networks." (2010).

[9] Sh. Hajrulla, A. Uka, L. Bezati, T. Demir. D. Hajrulla, F. Hoxha.. **"***Unimodular matrix on shallow water wave theory. Unimodularity through matrix method***"**, *Journal:* New trends in Mathematical Sciences**.** NTMSCI Journal 10 No. 1, 25-31 (**2022**)

[10] L. Stephanie, and S. Raghavendra. "PEGASIS: Power-efficient gathering in sensor information systems." Proceedings, IEEE aerospace conference. Vol. 3. IEEE, 2002.

[11] A. Mohammed, M. Mismar, and A. Abuzneid. "Armor-LEACH-energy efficient, secure wireless networks communication." 2008 Proceedings of 17th international conference on computer communications and networks. IEEE, 2008.

[12] L. Ali, H. Mathieu, and F. Biennier. "Monitoring and Managing a Distributed Networks using Mobile Agents." 2006 2nd International Conference on Information & Communication Technologies. Vol. 2. IEEE, 2006.

[13] J. Sushant, et al. "Exploiting mobility for energy efficient data collection in wireless sensor networks." Mobile networks and Applications 11.3 (2006): 327-339.

