

A NEW ALGORITHM FOR INCREASING THE CLUSTER HEAD SCHEDULING (ICHS) IN THE LEACH PROTOCOL FOR WIRELESS SENSOR NETWORK

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Abstract

A Wireless Sensor Network is a collection of sensors that communicate or follow a certain physical or chemical phenomena and then wirelessly transmit data about it to a data processing center. Therefore, one of the most important challenges facing this type of network is extending its lifespan and making efficient use of energy. The main objective of LEACH protocol is to extend the life of wireless sensor networks by improving energy use. The aims of this paper to do this by maintaining the continuity of the network's working time for the longest possible period. The simulation was carried out with Matlab, which included a number of comparisons with other algorithms, as well as working with the LEACH protocol. The results showed a significant improvement in extending the life and optimal use of energy compared to the rest of the algorithms.

Keywords: LEACH; WSNs; Energy.

1. Introduction

Wireless sensor networks have recently piqued the interest of both academia and industry, and this is expected to continue. LEACH is called "Low Energy Adaptive Clustering Hierarchy" [1,2] is composed of a collection of homogenous or heterogeneous sensors that communicate with one another to form a wireless sensor network. The sensors' job is to transmit sensor data to a device, or maybe numerous devices, that has high requirements for the data. This viewpoint allows us to categorize wireless sensor networks into two types: event anticipation networks and event query networks. Some applications may require both reporting and event querying capabilities at the same time, which is why we developed this tool. Sensors may be grossly underpowered and under processed, resulting in poor performance. It is necessary, however, that once the sensors have been mounted, they be left unattended for as long as is reasonably possible [3].

The deployment or distribution procedure is the first step in the process of establishing a wireless sensor network. Sensors are dispersed manually, by helicopter, or by robot at the discretion of the operator during this stage. Routing is the stage that comes after this one and has a significant impact on the previous stage's outcome. The location of sensors in the network's surrounding area, for example, influences network architecture and device communication. When the sensor network is heterogeneous, a multi-stage network is required because the sensors that are monitored and those that are connected are defined by the connections made by all of the sensors, which can be changed [4,5]. The result has been an explosion of new ways to route things in order to conserve energy and extend their useful lives. [6]. Therefore, the energy use is the main limitation of the WSN, energy conservation is necessary to extend the network life cycle and many research difficulties, such as the deployment coverage issue, the data routing issue, and the cluster-head selection issue [7], are referred to as optimization issues. Researchers have therefore planned a number of routing algorithms to reduce network node energy consumption. [8, 9].

To extend the life of the cluster head (CH), We presented a method relying on the LEACH protocol that uses a CH inactive mode. The suggested technique was then compared to current protocols that utilize DTx, LEACH, and LEACH-C as in [7,10]. Calculations are carried out in the MATLAB environment. The simulation results

are used to examine the effectiveness of various clustering techniques in extending the life of a network. approach to energy consumption reduction and network lifetime extension. There are two main medium access approaches for WSNs that are discussed in the literature: TDMA (Time division multiple access) and CSMA (Carrier sensing multiple access) Since this study uses static WSNs; it will be more efficient to use TDMA than CSMA [11]. In [12] Several performance indicators were discovered. The energy dissipation metric is the most important because it is critical in the design of WSN protocols. Our findings support the following theory: LEACH dissipated more energy than LEACH-C, giving LEACH-C the advantage of extending its lifetime over LEACH. The effectiveness of WSNs depends on the scheduling of medium access. However, it uses a lot of energy to send data to the BS. Many authors with the Yang Liu in reference [13] proposed the IEE-LEACH protocol takes into account residual node and network energy. It was suggested that the number of ideal CHs be taken into account, and that nodes closer to the base station (BS) be excluded from cluster formation. A new threshold for electing CHs among sensor nodes is proposed to improve network energy efficiency, as are single hop, multi-hop, and hybrid communications. However, this study has the same issue as the previous investigation in terms of the BS. other researcher is using the In [14,15], PSO , GA and fuzzy logic is built on the foundations of artificial life and social psychology, engineering, and informatics. It typically faces numerous challenges, such as low quality solutions, the need for memory to update velocity, and early convergence, among other disadvantages, in order to function effectively over the lifetime of a WSN and there is no one way to solve a problem using. Due to inaccuracy in results, they are not always widely accepted. The novel algorithm is based on previous research on the LEACH protocol's proposed clustering structure.

2. Materials and Methods

2.1. The aim and objectives

The research is to develop a LEACH protocol by focusing on improving the CH life in WSNs in order to keep the network operating for the longest possible period of time. The following objectives were identified:

- In the LEACH protocol, an algorithm is being developed to extend the life of the CH.
- Wireless sensor networks can benefit from LEACH's TDMA (time division multiple access) protocol-based aggregation and routing capabilities.
- LEACH can have increased the life of a WSN by reducing the amount of energy required to manage clusters.

According to the results of the literature review, many researchers have improved the LEACH protocol's efficiency by utilizing smart methods or identify the requirements links with the BS. Of course this development is in direct conflict with the properties of the sensor such as memory size, transmitting and receiving power. Therefore, an algorithm was created that avoided utilizing smart techniques that minimized communication with the BS and consumed resources irrelevant to sensor characteristics.

2.2. Increasing the CH scheduling (ICHS) algorithm

The proposed algorithm includes a number of steps:

- 1) Definsion of intitial parameters of algorithm
- 2) Publish all nodes at random with their location fixed
- 3) In the beginning, the nodes have the same properties
- 4) Initial Choose the fix number as seven CH energy
- 5) Each normal node will be associated with the nearest head cluster
- 6) Each active CH will be associated with a BS.
- 7) Calculating the amount of energy for all kinds of active nodes
- 8) If energy of normal node equal zero increase counter of death node by 1
- 9) If energy of CH node equal zero increase counter of death CH (death_CH) by 1
- 10) If death_CH < 0 increase round number by 1 and goto step 4 else stop

The amount of energy required to receive r bits is:

$$E_{rx}(r) = E_e * r \quad (1)$$

Where E_e (In Joules/Bit) is the amount of energy consumed by the transceiver's electronic circuits while receiving or transmitting one bit [16].

$$E_{tx}(r, d) = E_e \times r + E_a \times d^\alpha \times r \quad (2)$$

E_a (in Joules/bit/m α) represents the amount of energy is required by the power amplifier to send one information bit over a one-meter distance. [16]. Where d (in meters) is the transmission distance and $2 \leq \alpha \leq 4$ is the channel path loss exponent. The free space path loss model ($\alpha=2$), can be used for short distances, while a multi-path model, ($\alpha=3,4$), is more suitable for longer distances.

3. Results and Discussion

3.1. Running

The use of the TDMA wireless sensor network protocol, time division of access, data organization, transmission, and aggregation from sensors to the BS all contribute to the cluster head's lower power consumption. We chose the LEACH to save energy. protocol and choose a device from among the devices that serve the CH. When designing the variables, they must be calculated before spreading to the rest of the devices. The rest of the devices are connected to the appropriate cluster depending on the signal strength from the CH. To participate in energy reduction, these processes must be divided into rounds to ensure cluster distribution in each round after the information reaches the cluster. The CH collects data from the rest of the cluster's devices and sends it to the main station via a single connection. As a result, we will be able to significantly reduce the amount of data sent to the BS. [17-18]. This protocol will be divided into rounds [11]. The first round is the installation phase and is divided into advertising mode and cluster erection phase (head cluster). The second round the coherent phase (the permanent state) and works on organizing schedules and maintaining the CH, transfer data between sensors and change between CH. Figure1, at start of the installation phase, each device decides independently of the other devices that it becomes CH or not. For the algorithm implementation, we use MATLAB.it is an abbreviation for MATrix Laboratory, which refers to its basic data elements and MATLAB can be used for math computations because it is a matrix (Array). Modelling and simulations include data analysis and processing, visualization and graphics, and algorithm development.

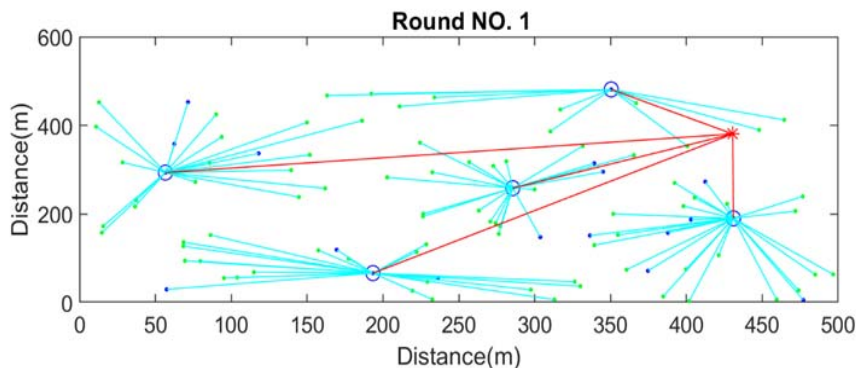


Fig. 1: Basic rocket ship design. The rocket ship is propelled with three thrusters and features a single viewing window. The nose cone is detachable upon impact

Table 1 shows all assessment symbols used in the experiment, and our field dimension is 500m x 500m, with 100 sensor nodes distributed at random in the search space.

| Meaning of symbol in experiment | Symbol |
|---------------------------------|--------|
| Effective sensors | • , • |
| Ineffective (Dend)sensors | * |
| CH | ⊙ |
| BS | ★ |

Table 1. Symbols meaning.

When the device serves the CH to the last, this decision is taken into account. The device that has been unable to become a CH for a long time recently elects itself to be the CH. The CH notifies its neighbours of the data packet received from the CH before it. Whichever is not a cluster header will receive the packet with the highest receive signal. Devices that are members of the head cluster will declare themselves as such and are bound into this packet containing the addresses of these devices. The number of organs or organs that they have, as well as their addresses, are known after the CH installation phase. The cluster header whose work is organized is the TDMA protocol, and the CSMA protocol is chosen at random, and the TDMA table is sent to the cluster members, after which it enters the stand-alone phase. The data is sent as follows during this phase. All devices begin sending data to the CH in an orderly fashion via their sites and the TDMA protocol. This transmission will be the most energy efficient. The TDMA protocol arranges the device locations, and this is the device with the lowest power consumption. When the CH receives all of the data, it collects it and send to the BS. Instead of each node sending data to the BS, LEACH can collect data locally in each cluster and save a lot of energy in the process of transmitting data to the BS. The CH is chosen at random, with no regard for power consumption. It is unable to cover large areas. In the LEACH protocol, each head of a cluster is associated with the main station, and there is no problem in the space between the CH and BS. And CH will gather great energies if the distance is far. On the other hand, The LEACH protocol can select the best path between the CH and BS, and data is sent to the BS along that path. [12].

3.2. Result and performs analysis

The simulation model and results demonstrate the new algorithm's performance analysis and comparison with LEACH, LEACH-C, and IEE-LEACH for network lifetime observing, among others. Table 2 shows the parameters used in the experimental work for the four schemes LEACH, LEACH-C, IEE-LEACH, and ICHS.

| Parameters | Vales |
|----------------------|--------------|
| WSN-area | 50m*50m |
| WSN Nodes NO. | 100 |
| Packed Size | 500 Byte |
| Initial Energy | 2J |
| E-ELEC(TX and RX) | 50*10-9J/Bit |
| Eamp | 100*10-12J |
| Broadcast Mesg. Size | 100 Bytes |

Table 2. Parameters and vales.

Figure 2 shows the total network energy obtained by plotting against each round, which is the sum of all sensor node residual energy. Even after hundreds of runs with 100 sensor nodes, the residual energy level of the proposed scheme is higher than that of LEACH, LEACH-C, and IEE-LEACH schemes. The ICHS ensures that energy of CH of the block is higher than the group members, and by looking at the results of implementing the it, we find that the lifetime of the network continue for large periods. Furthermore, gateway nodes are chosen closer to the BS to reduce CH overload.

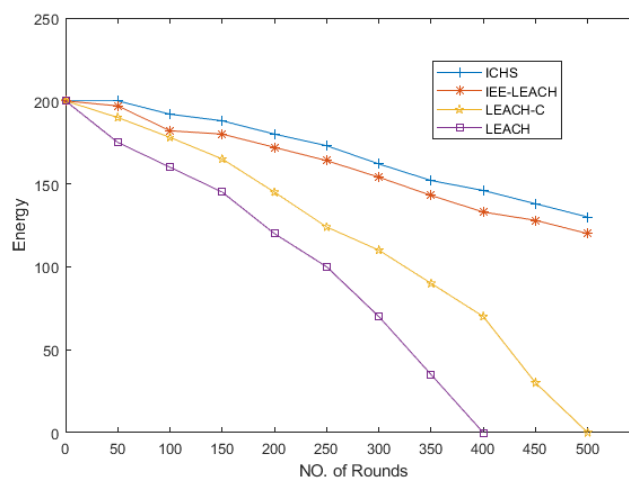


Fig. 2. Network energy over the simulation time.

Thus, the ICHS scheme contributes significantly more energy savings and has a longer lifetime for sensor nodes than DTx, LEACH, LEACH-C, and IEE-LEACH. The results of simulations between the proportion of nodes that died in each round and the number of rounds for several clustering methods, including LEACH, LEACH-C, IEE-LEACH and ICHS, are shown in Figure 3. The following rounds were chosen in order to make the simulation results more understandable: 45, 100, 150, 200, 300, 400, and 500. It is always obvious that each algorithm has a different percentage of dead nodes in each round. Applying the traditional LEACH method results in a high node death rate for each round, however the proposed strategy performs significantly better. This is a definite sign that the network life has increased in comparison to other algorithms during the simulation period.

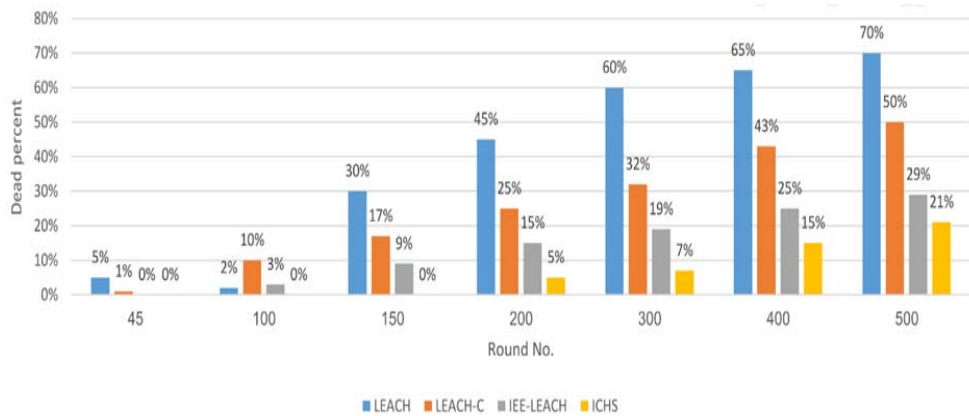


Fig. 3. Different percentage of dead nodes in each round.

The length of time between the beginning of the communication process and the beginning of the percentage of dead nodes increasing until the final dead sensor node can be referred to as the network lifetime in WSN. The round timeline is a key distinction between the proposed protocol, LEACH, LEACH-C, and IEE-LEACH, and the number of rounds is not fixed and is dependent on a specific time. The time between the start of the communication process and the start of the percentage of dead increasing until the last dead sensor node is defined as network lifetime in a WSN. As a result of the separation of cluster management during protocol operation, the behavior of clusters is not constant and is determined by the number of nodes in the cluster. This plan will control how long it takes nodes to become cluster leaders, which will affect the node's lifetime. Furthermore, When the setup stage is moved into a smart environment, the network lifetime is impacted because less communication is required during this stage and nodes are prevented from having to send their data repeatedly, as illustrated in Figure 4, which compares the LEACH, LEACH-C, and IEE-LEACH in terms of percentage rate of starting to dead the nodes.

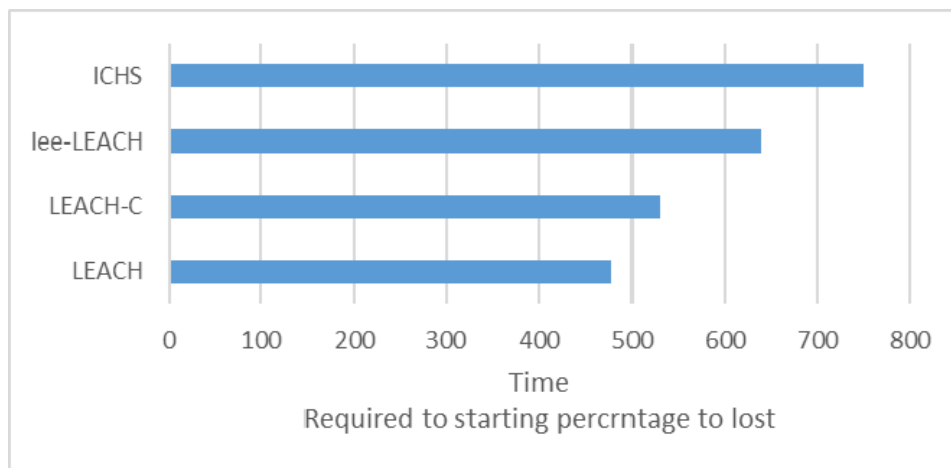


Fig. 4. Comparison ICHS with other algorithms.

Furthermore, When the setup stage is moved into a smart environment, the network lifetime is impacted because less communication is required during this stage and nodes are prevented from having to send their data repeatedly, as illustrated in Figure 4, which compares the LEACH, LEACH-C, and IEE-LEACH in terms of percentage rate of starting.

3.3. Discussion

To show the efficiency that fits this algorithm, the language (Matlab) was used because this language is characterized by showing accurate results. In this program, we are examining the wireless sensor network that operates on. firstly, data collection technology then organizing the (TDMA) time division multiple access, dividing and organizing arrival times. At the beginning of running the program, we note that the devices were deployed in a specific area in order to determine the area in which the sensors operate. The latter coordinates the work of the sensors and the main station. As the cluster header will reduce energy consumption by collecting and sending data, the cluster head's location will change to different places (locations) due to a lack of energy in it. Depending on the energy it possesses, another device is chosen to be another CH. When the energy in the CH is depleted, another device is chosen to serve as a CH. The connection between the sensor and the CH is shown by the light green path, and the data collected from a large number of devices is sent through the red path, rather than each device working alone to send data to the main station represented in red. Thus, this process continues on all sensors, and we note it is problematic for the sensors when the energy rate in them reaches 15% To 28%, it stops working, which is as shown by the black dots, and when all these devices stop working, the entire network stops. With this work, this network has performed the task perfectly, which is sensing and then sending data to the CH and collecting data therein and then sending it to the main station. The proposed algorithm increased network lifetimes in each of five case studies, and its use ensures that routes are chosen more quickly than with other algorithms that use the LEACH mechanism. After several iterations, the percentages of dead nodes in the network were significantly lower than those of the LEACH protocol and other methods, demonstrating the effectiveness of the current system.

4. Conclusions

The energy issue in WSN is still an active research area. The Implementation of the energy efficiency scheme in this structure that contains data routing, organizing the data with Synchronization of work, creating and organizing efficient algorithms that increase the life time of the WSN, reducing energy consumption, and writing down the basic functions of wireless network sensors for each model of the sensors in the network. Organizing the results that proved important in increasing the life of the network in the case of applying the appropriate algorithm for that and comparing them with the application of the inappropriate algorithm in increasing the life of the network.

Acknowledgments

This paper and the research behind it would not have been possible without the exceptional support of my colleagues at the University of Mosul college of Education for pure science\department of computer science for looking over my paper. I greatly appreciate the help from Dr. Marwan AL-dabbagh who help me with the linguistic calendar for research.

References

- [1] Walteneagus, D., & Christian, P. (2010). *Fundamentals of wireless sensor networks: theory and practice*. A John Wiley and Sons, Ltd, 7(8), 46.
- [2] Prabha, D., & Arora, V. K. (2014). A Survey on LEACH and its Descendant Protocols in wireless Sensor Network. In international conference on communication, computing & systems (pp. 162-167).
- [3] Masoud, M., Jaradat, Y., Manasrah, A., & Jannoud, I. (2019). Sensors of smart devices in the internet of everything (IoE) era: big opportunities and massive doubts. *Journal of Sensors*, 2019
- [4] Sharma, V., Patel, R. B., Bhadauria, H. S., & Prasad, D. (2016). Deployment schemes in wireless sensor network to achieve blanket coverage in large-scale open area: A review. *Egyptian Informatics Journal*, 17(1), 45-56.
- [5] Kumar, V., Dhok, S. B., Tripathi, R., & Tiwari, S. (2014). A review study on analytical estimation of optimal number of clusters in wireless sensor networks. *Transactions on Networks and Communications*, 2(5), 75-103.
- [6] Kumar, S. V., & Pal, A. (2013). Assisted-leach (a-leach) energy efficient routing protocol for wireless sensor networks. *International Journal of Computer and Communication Engineering*, 2(4), 420-424.
- [7] Abu Salem, A. O., & Shudifat, N. (2019). Enhanced LEACH protocol for increasing a lifetime of WSNs. *Personal and Ubiquitous Computing*, 23, 901-907.
- [8] Ramesh, S., Rajalakshmi, R., Dwivedi, J. N., Selvakannani, S., Pant, B., Bharath Kumar, N., & Fissiha Demssie, Z. (2022). Optimization of Leach Protocol in Wireless Sensor Network Using Machine Learning. *Computational Intelligence & Neuroscience*.
- [9] Daanoun, I., Baghdad, A., & Ballouk, A. (2021). Improved LEACH protocol for increasing the lifetime of WSNs. *Int. J. Electr. Comput. Eng. IJECE*, 11, 3106-3113.

- [10] Tripathi, M., Gaur, M. S., Laxmi, V., & Battula, R. B. (2013). Energy efficient LEACH-C protocol for wireless sensor network.
- [11] Padmini,S.; Promod Kumar Sahu, Sri.(2015). TDMA Scheduling with Leach protocol, *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 4, Issue 4.
- [12] Al-Shaikh, A., Khattab, H., & Al-Sharaeh, S. (2018). Performance comparison of LEACH and LEACH-C protocols in wireless sensor networks. *Journal of ICT Research and Applications*, 12(3), 219-236.
- [13] Liu, Y., Wu, Q., Zhao, T., Tie, Y., Bai, F., & Jin, M. (2019). An improved energy-efficient routing protocol for wireless sensor networks. *Sensors*, 19(20), 4579.
- [14] Rahman, I., Vasant, P. M., Singh, B. S. M., & Abdullah-Al-Wadud, M. (2016). On the performance of accelerated particle swarm optimization for charging plug-in hybrid electric vehicles. *Alexandria Engineering Journal*, 55(1), 419-426.
- [15] Yuste-Delgado, A. J., Cuevas-Martinez, J. C., & Triviño-Cabrera, A. (2020). A distributed clustering algorithm guided by the base station to extend the lifetime of wireless sensor networks. *Sensors*, 20(8), 2312.
- [16] Bagci, F. (2016). Energy-efficient Communication Protocol for Wireless Sensor Networks. *Adhoc & Sensor Wireless Networks*, 30.
- [17] Nikolidakis, S. A., Kandris, D., Vergados, D. D., & Douligeris, C. (2013). Energy efficient routing in wireless sensor networks through balanced clustering. *Algorithms*, 6(1), 29-42.
- [18] Nakas, C., Kandris, D., & Visvardis, G. (2020). Energy efficient routing in wireless sensor networks: A comprehensive survey. *Algorithms*, 13(3), 72.

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