A General Structure for Improving the Lifetime and Stability Period of Wireless Sensor Networks

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Summary
The issue of energy consumption and the age of the network is one of the essential features in the design of the wireless sensor network (WSN), which has led researchers in the field of networks and communications to work on innovative mechanisms to reduce energy consumption in these networks and prolong the lifetime. Experts have suggested several WSN-based clustering protocols, since most clustering protocols are homogeneous, and LEACH and M-GEAR are among the most common examples of these protocols. In this paper, we propose six models for the division of wireless sensor networks (WSNs), in each of these models we will distribute sensor nodes to four zones randomly in the field of the sensor area. We install the cluster heads (CHs) in the middle of the geometry shapes of each area, where the shape of the circle or square or both, will be used, and the location of the sink will be in the center of the sensor area. The sensor nodes that are located around the sink and within the geometric shape used will directly connect to the sink. The external nodes will contact the nearest CHs, and to determine the nearest CHs we will apply the Dijkstra's algorithm. For the average number of dead nodes, the square circle method achieved the best result (73.42), followed by the circle square method which got a result (79,66). The largest number of dead nodes showed when using one square only where the result was (97.15). We make a comparison between the outcomes and M-GEAR and LEACH protocols, our model (square circle) stabilizes energy use within sensor nodes. However, nodes in M-GEAR and LEACH do not stay alive for a long time, they die when the stability period is over.

Key words:
M-GEAR, LEACH, wireless sensor networks (WSNs) and energy consumption.

1. Introduction

Development in hardware and software technologies had led to the ability to control the surrounding environment anytime by using small wireless devices will provide this information. Wireless Sensor Networks (WSNs) are becoming a perfect solution to monitor a physical environment. Each sensor in WSN is built for a specific purpose. Many sensor nodes communicate with each other in a WSN and with the outside world.

Most sensor nodes in WSNs are connected wirelessly, and they share a shared medium for data transferring among themselves. In our world sensors have been built in most buildings and homes for various purposes. Some are used in alarms and warning systems for fire or to apply security applications for house owners. The integration of sensor nodes into the industry; different environments and structures have some benefits for our society. Fewer catastrophic failures, conservation of natural resources, improved manufacturing productivity, enhanced emergency response and home security can be mentioned as some examples of sensor network benefits [1].

Wireless sensor networks have received considerable attention these days because of their versatility and as the basis for the concept of the Internet of things, which is used for environmental control, security and tracking applications in real time and others.

The issue of energy saving is one of the most important issues nowadays, especially in wireless sensor networks, as these networks consist of many sensors that use a limited power source (battery). These sensors are often dispersed in diverse environments and under conditions that make it difficult to recharge these sensors, so it is worthwhile to reduce the energy consumption of these sensors in order to prolong the lifetime of the network as long as Possible.

Through this study, we try to reduce the energy consumption in delivering data from sensors to the base station by controlling the network structure, the data transmission mechanisms using clusters, and the packet routing protocol, which always chooses the shortest path. The proposed approach aims to reduce the energy consumption of sensors to minimize and prolong the lifetime of the network by working on the network structure and dividing it into clusters so that there is a head for each cluster responsible for collecting data from other sensors and sending it to the Station.

This approach is also concerned with the routing mechanism used to transfer data from Remote-station sensors, and there are many routing protocols used in wireless networks, which will be best chosen in order to ensure the best routing of data to achieve the best performance of the Network.

The rest of the paper is organized as follows: Section II includes an overview of related works. Section III presents the experiments design, methods, and the approach to answering the research questions. Section IV describes the experiment implementation. In Section V, we discuss the results. Finally, in Section VI, we present our conclusions.

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2. Theoretical Consideration

[2] Concluded that routing plays an important role to preserve the use amount of energy in the network. The nodes consume a high amount of energy in case if the source node, the destination node is located at a far distance from each other, and data packets have to cover a long distance in order to reach the destination node. In this case, routing will be performed by selecting multiple next hops until the data packets reach the destination. The next hop selection criteria based on multiple parameters such as distance, energy, etc. This study provides a brief review of the routing and related approach issues and a brief review of the energy efficient routing protocol. They compared routing protocols, and define the previous research work to improve the energy effectiveness of the network.

[3] Proposed a distributed data collecting process for WSNs with static node deployment and the execution of process merging mobility into the network. The presentation of the introduced process is evaluated in Tiny OS implementing the TOSSIM simulator depending on the parameters such as load distribution of nodes, percent of a live nodes, and network lifespan. The tracking of that goal is a very traditional application of WSN that requires beneficial and consistent energy management. They proposed the most direct and distributed path of data gathering process for connected target coverage to lengthen the lifetime of WSN as much as possible related to both static and mobile multi-hop WSNs.

[4] Adapted the BFO for cluster head selection, so that multiple objectives like reduced packet delivery ratio, improved cluster formation, improved network lifetime and a reduced end to end delay are achieved. Also, a new Hybrid algorithm using Bacterial Foraging Optimization (BFO) - Bee swarm Optimization (BSO) is attempting to analyze the number of clustered formed, end to end delay, packet drop ratio and lifetime. The optimization algorithm RBFO and Hybrid BFO-BSO gives the lifetime improvement and hence increases the battery life. The packet drop ratio, end to end delay is reduced in these optimization techniques. They revealed by parametric comparisons from the power of view of the overall performance, the order of advancement is Hybrid BFO-BSO, RBFO, KBFO, and LEACH. And suggested further work on the Hybrid BFO- to be the best in the present study may include testing in a MANET environment.

[5] Explained the different clustering techniques to improve the relay, to resolve the computational complexity and to improve the network lifetime. Optimal clustering in the given area is an NP-complete problem. To solve this problem differently nature-inspired algorithms have been used. They described the latest proposed algorithm based on a genetic algorithm. These algorithms give better network lifetime as compared with other previous protocols of clustering in WSN. And they tried to optimize the algorithms by using some other technique.

[6] Projected a new routing protocol that was directional transmission based energy critical routing protocol called PDORP. Using of Power-Efficient Gathering Sensor Information System (PEGASIS) and DSR routing protocols, the routing becomes smoother which was the best feature of the PDORP. To generate and restart the cluster based WSN the genetic model and the Bacterial Foraging Optimization (BFO) was applied in which during the network establishment the network was optimized. The simulation results had explained that the hybrid method was used to evaluate the presentation that had offered minimum bit error rate, minimum delay, reduced energy consumption and improved quantity that indicates the improved QoS and the network lifetime was also increased. Furthermore, with the help of soft computing mechanisms the presentation of both the routing protocols was compared and estimated by adopting the computation model.

[7] Simulated LEACH, SEP, DEEC, TEEN routing protocols, and evaluated their performance by comparing with DT routing protocol in heterogeneous and homogeneous WSN on MATLAB. They noted that the hierarchical protocols offer a solution, as it is by lengthening the network lifespan and increase the stability, thereby increasing the WSN imposed on the power network. Homogeneous and heterogeneous WSN of the reliability of results obtained from the field. Ahmed and Inas have found that the hierarchical protocols offer a solution to the energy restrictions in WSN networks, as they prolong the network's operation and increase the period of stability, thus increasing the reliability of the results obtained from the field in heterogeneous and homogenous WSN networks. The SEP protocol is superior to both the DT and LEACH protocols if some of the nodes are provided with additional power for the purpose of extending the lifetime of the network in periodic monitoring applications. The TEEN protocol is superior to previous protocols, but can only be used in event discovery applications.

[8] Examined the overhead energy caused by hierarchical routing protocols based on dynamic clustering and study its impact on the stability period of the wireless sensor networks, and proposed a solution to limit this energy by reducing the consumed energy in the election of heads and cluster formation operations. It is showing MATLAB simulator's results that the used energy in the LEACH setup stage decreases the stability period of these networks and increases the number of dead nodes. And the use of the proposed solution decreased the use of energy during the election of the heads and the formation of clusters clearly compared to the normal way, followed in LEACH, which has the increased stability period and the number of live nodes in the network.

[9] Suggested a metric approach based on rank to choose clusters from the set of sensors, taking attention to network

presentation parameters and distribute the load mode fairly in the cluster and use the least amount of energy. A cluster head weight selection approach called Cluster Chain Weight Metrics method (CCWM) takes parameters of service for improving the network presentation. A clustering technique aims to choose an appropriate cluster head of the network and form balanced clusters. Cluster heads are chosen first in a network depending on weight metric and then the formation of clusters. This technique is not intended to keep the energy and balances of the sensor the load. A local clustering technique is used in the cluster to decrease the cost of communication and computation. In addition, a new method for data transmission has been explored. The outcomes of the introduced method are compared through simulation with the protocols (LEACH, WCA and IWCA) and shows that an improvement on an average over rounds of 51% over LEACH, 27% from WCA and 18.8% from IWCA of a lifespan and energy use.

[10] Enhanced process of LEACH protocol (LEACH-TLCH) that is aimed to balance the energy use of the overall network and increase the network lifespan. A LEACH protocol that has two levels cluster head is an improvement of LEACH protocol, cluster-head choosing and clusters forming are similar to LEACH protocol. Random election of cluster head in LEACH protocol causes the existing energy of several cluster heads to be less or their distances to the base station to be long due to the heavy energy load, therefore; these cluster heads are going to die. So, a recent developed method of LEACH protocol, which designed to balance the use of energy of the overall network and increase the lifespan of the network by striking a balance in the use of energy of these cluster heads. The recent developed method is simulated by the Matlab simulator, the outcome of this simulation shows that the energy effectiveness and the network lifespan are considered better than that of LEACH protocol.

[11] Calculated overhead energy, which is the used energy in the random cluster head setup stage. The primary model depending on LEACH protocol is developed again to estimate the amount of consumed energy in the three stages of data transmissions from sensor nodes to the sink. It is demonstrated through the intense simulations of this model that the overhead energy is not less than 20% of the total energy consumption of the network in data transmissions. The optimum value of cluster heads, depending on network lifespan has been estimated taking into account the consumption of energy in the setup stage. The results show that the energy used in random and hierarchal cluster head selection protocol of WSN had been deemed as an insignificant overhead in the previous literature. As shown from the outcomes in Table1and Fig, the overhead energy used in the random cluster head selection protocols takes about 20% to 25% of the total network energy consumption of data transmission from a sensor node to the sink. However, it is expected that the network lifetime will increase to not less than 20% only if that overhead is decreased.

[12] Evaluate the presentation of DSR protocol using different WSN scenarios with different performance metrics to examine the way this protocol performs on WSNs, in mobile and static state by NS-2 simulator, these parameters the average of end-to-end delay, routing overhead (ROH), packet delivery fraction (PDF) and the average of the used energy for each delivered packet, with the effect of density and size of the network in addition to the number of sources. It was shown that in almost all of the tested scenarios, the DSR protocol performance is good for the static scenario case. Due to the several paths that are already recorded and saved in the route cache of the nodes, a good level of stability and credibility of the network. The DSR protocol shows high PDF, low energy use and latency, and it is able fit the changes in the network such as size and density. And it is noted that there is performance deterioration regarding to PDF and delay under heavy load conditions.

[13] Clarified the benefits and goals of clustering for WSNs and improved a new classification of WSN clustering routing algorithms depending on complete and detailed clustering characteristics. They examined a few distinct WSN clustering routing protocols, and compare these different methods based on their classification and many important metrics.

[14] Presented a distributed, energy-efficient clustering system for ad-hoc sensor networks. The system is hybrid: cluster heads are probabilistically chosen according to their residual energy, and nodes accede to clusters so that the expenses of communication is reduced to the minimum. They assumed quasi-stationary networks where nodes are location-unaware and have the same importance. They agreed that with suitable bounds on node density and intra-cluster and inter-cluster transmission ranges, HEED can approximately with probability 1 ensure communication of clustered networks. Simulation outcomes show that the introduced system is efficient in lengthening the lifespan of the network in addition to back in scalable data compilation.

[15] Presented an overall survey of routing methods in wireless sensor networks, which have been contained in literary works and lengthening the sensor network lifespan is considered their basic goal. In general, the routing methods are categorized according to the structure of the network into three types: hierarchical, flat, and location-based routing protocols. Also, these protocols are categorized according to the operation of protocol to query-based, negotiation-based, multipath-based and QoS-based routing methods. Moreover; they explained the design tradeoffs between communication and energy operating expense savings in several routing models, in addition to the pros and cons of each routing method. Even though plenty of routing methods seem to be suitable, but still there are a lot of obstacles that are yet to be overcome in WSN.

[16] In this research the author had introduced a new way that was the Power-Efficient Gathering in Sensor Information Systems (PEGASIS). This protocol was a chain-based protocol that was the advanced version of LEACH. In this novel projected method, every node broadcasts its information data or the message to the nearer adjacent node and the turns were taken from that node to transfer that data to the base station as decreasing the use of energy at each round. The output of this protocol had demonstrated that the presentation of the PEGASIS was improved compared to the LEACH as 100% to 300% if 1%, 20%, 50%, and 100% of nodes died for different network sizes and the topologies.

[17] Looked at the protocols of communication, that can have an important effect the whole energy dissipation of these networks. Depending on our results that the conventional protocols of static clustering, multichip routing, direct transmission in addition to minimum-transmission-energy might not be the best for sensor networks, we introduce LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol which uses a randomized rotation of cluster-heads to equally spread out over the energy load through the network sensors. LEACH utilizes localized collaboration to empower scalability and resilience for dynamic networks and integrates multiple data sources into the routing protocol to decrease the quantity of data which have to be transferred to the base station. Simulations indicate that LEACH is able to bring off as a factor of 8 reductions does in energy dissipation in comparison with conventional routing protocols. Moreover, LEACH can spread out energy dissipation equally among the sensors, increasing the beneficial system lifespan for the networks that had been stimulated.

3. Experimental Consideration

3.1 Network Model

In this part, we explain our suggested protocol. Sensor nodes have massive amount of sensed data for BS to process. As a result, it is necessary to implement an automatic process of aggregating or integrating the data into a small group of relevant information (Mcmullen, 2004) (Klein, 1993). This process of aggregating data is referred to as data fusion as well. A sink is deployed at the network field center to increasing the lifetime and the outcome of the network. This sink is assigned to gather data from CHs and nodes close to the gateway. Our outcome confirms that the lifespan of network and the use of energy have enhanced by adding gateway node. A rechargeable gateway node has been added due to its low cost in comparison with the sensor node.

The clustering is considered a method implemented in order to manage the use of energy in the network by reducing the transmission range of the sensors. In this method of work, CH manages the group contact with the sink. Sensor nodes do not transfer data to the BS anymore, instead, they transfer them to the CHs which accept all messages of the group, collect and resend them to the sink. In this paper, we can say that N is a node that is distributed at random in a field in order to observe the environment. Ni stands for the i-th sensor, therefore; the resulting sensor node is N= n1, n2,....., n100 .We assume the network model shown in Figure(1).

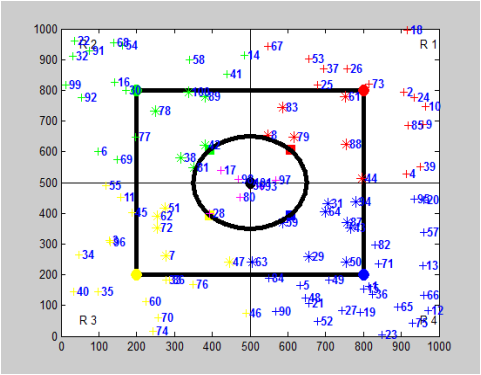

Fig. 1 Our network model

The figure above represents one of the most important models proposed in this thesis, which consists of a circular shape and square shape. It is also noted that the area was divided into four sections, where the red color was adopted for the nodes in the first quarter, the green quarter for the nodes in the second quarter, the blue color for the nodes in the third quarter, while the fourth quarter was used blue to represent it. Also, the pink color was used to express the nodes inside the circle.

The plus signs represent nodes (+) outside the outer boundary of the square. The multiplication signs (*) represents the nodes between the circle and the square. There are many important considerations that will be taken into account in this thesis, which summarize as follows:

i. CH is deployed away from the sensing field, sensor nodes and the CH become nonmoving after deployment.
ii. A CH is positioned in the same network field at the boundary of the network.
iii. CH node is nonmoving and is able to be recharged after deployment.
iv. Homogeneous sensor nodes that have the same capabilities of computation and sensing are used.
v. Each sensor node(n) is assigned with a different identifier (ID).

3.2 Initial Phase

Homogenous sensor nodes which are scattered at random in network area are used. The BS transmits (4000 bits) packet and responding to this, the sensor nodes send their location to CH which calculates the space of every node and save all information of the sensor nodes into the node data table. The node data table is made up of location of node, distinctive node ID, residual energy of node and its distance to the CH and sink.

3.3 Setup Phase

In this part, we split the network field into logical regions according to the location of the node in the network. We split the nodes into different logical regions which are: the first case only one square as in Figure (2-C), in second case two squares (see Figure 2-B), third case one circle only (see Figure 2-A), four case two circles (see Figure 2-F), the fifth case external circle within internal square (see Figure 2-D) and the last case external square within internal circle as in Figure (2-E).

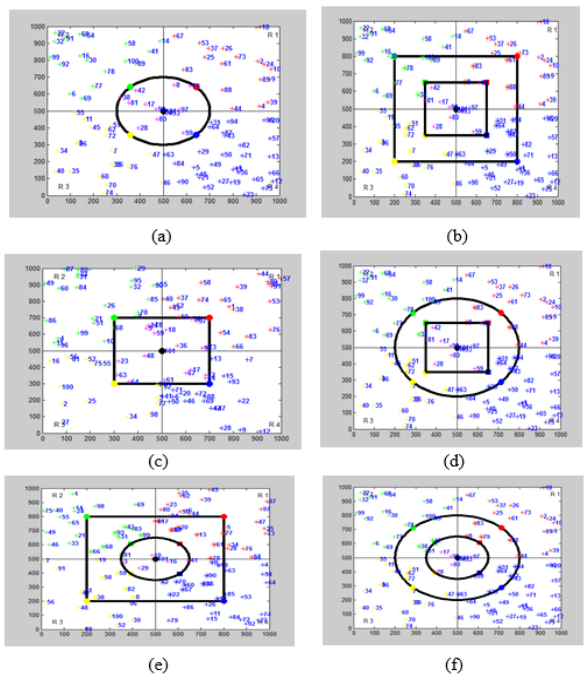

Fig. 2 The proposed shapes for clustering models

Nodes in the first region communicate and transfer their data directly to sink. Moreover; nodes close to CH and that fall outside region one will send their data directly to CH which collects and send data to sink. The nodes that are far from CH and the sink are broken down into four or eight equal half regions. They are known as clustered regions in which sensor nodes arrange themselves into small sets known as clusters.

3.4 CH Selection

First, the network is broken down into regions. CHs are elected in each region separately. Let represents the number of rounds to be a CH for the node ni.

The cluster is considered as an external node, not an existing one, and its energy is calculated by multiplying the number of nodes in each region in node energy which is (0.5 joule) so that it is located in the square angle in the case of the square or in the middle of the circle or in the ring quarter in the case of a circle.

3.5 Scheduling

When all the sensor nodes are organized into clusters, each CH sets up a Time Division Multiple Access (TDMA) tables depending on time periods for its member nodes. All the related nodes transfer their sensed data to CH in its own period. Other than that, nodes shift into idle mode. Nodes turn on their transmitters at the time of transmission. Therefore; this can reduce the waste of energy of an individual sensor node.

TDMA scheduling promotes energy conservation of sensor nodes which can lead to increase the lifetime of these nodes. As a norm, each member node transfers its data to nearby CH, so sensor nodes need only a very little energy for data transmission. CHs perform computation on compiled data and clear the repeated bits; it decreases the quantity of data that have to be sent to the sink. Accordingly, sensor transmission energy decreases substantially.

We presented the sink mobility in developed energy effective protocol in order to increase the network lifespan of Wireless Sensor Networks (WSNs). The multi-head chain, multi-chain concept and sink mobility have a significant impact on improving the network lifespan of wireless sensors. Therefore; it is highly recommended to create Mobile sink enhanced energy-effective routing protocol; a multi-chain model that has sink mobility, to accomplish skilful energy use of wireless sensors. It is necessary to limit the machinery movement of the mobile sink and fix its paths since this movement is run by current or petrol.

In our proposed method, the mobile sink remains at a temporary stay in order to make sure that data compilation is finished. Finally, we make some experiences on a large scale to evaluate the functioning of our technique.

Clustering protocols for WSNs had been widely accepted in several applications because these protocols use little energy. Several protocols of WSN make use of the cluster-based system at multiple levels to reduce energy expenses as much as possible. CH is chosen in almost all of the cluster-based protocols according to the probability. It is not clear that CHs are spread out regularly among the sensor field. As a result, there is a real possibility that the chosen CHs centralized in a single network region. Likewise,

several protocols utilized uneven clustering and attempted to utilize resources skillfully.

In systems that have several levels, a single CH sends information to another CH that broadcasts information to BS. If the last CH is far-off, it is important for the first CH to transfer information with high potential. A node in clustering protocols makes its own decision on being a CH or not. There is a possibility that several faraway nodes are chosen to be CHs. As a result, these nodes require considerable energy to send information to BS. So, these nodes will not live for a long time. In this research, our aim is to set up a gateway-based energy efficient multi-hop routing protocol. This method combines the following points:

i. Network is separated into subregions to help gateway node to decrease the level of transfer distance. Therefore; this can conserve network energy and increase the lifespan of the network.
ii. CH choosing in every region is untouched by other regions, therefore; there is absolutely an existing CH in each and every region. We split the sensor nodes into four or eight logical regions according to their position in the sensing area. The sink is located at the center sensing field and nodes are spread out at random. If the space between a sensor node and BS or gateway is less than the minimum of predetermined space, then the node in field one near the sink communicates directly, since the remaining nodes have connections with the CHS.

3.6 Dijkstra’s Algorithm

It is noted that the distribution of Nodes is the most possible in large areas, which is precisely between the outer frame of the proposed shape and the outer boundary of the area that allowed to the Nodes spread, and to determine the cluster head, we used Dijkstra’s Algorithm.

Dijkstra's algorithm is utilized in this research in order to find the shortest way from one node to another in a cluster. This algorithm can be used to find the shortest path problem for a single source in a graph that has non-negative path costs of each edge by creating a tree of the shortest path which is usually utilized in routing. Dijkstra's algorithm can find the shortest path or that which has minimum costs between a specific source node and other nodes. Moreover; this algorithm is implemented to find the cost of the shortest way between a node and a target node by making the algorithm stop by the time it finds that shortest path [18].

Dijkstra's algorithm finds the shortest way from one point to another on a network by utilizing a graph consisting of edges and nodes. It gives each node a cost, then this value is set to zero for source node and infinity for the other nodes. It splits the nodes into two groups: permanent and tentative. It selects nodes that become tentative and then checks them in order to make them permanent if only they fulfil the pass criteria. Dijkstra's algorithm could be determined by the next steps [19]:

i. Beginning with the root of the tree; the source node.
ii. Giving a zero value to that node and making it first permanent.
iii. It is checking each node that is next to the node that was the last permanent one.
iv. Giving a cumulative value to every node and making it tentative.
v. Determining the lowest cumulative cost within the tentative nodes list and making it permanent. Any permanent node will never be examined once again because its cost is final. B. Choosing the lowest cumulative cost if it is possible to access the node from two or more ways.

The rest of nodes divided into four or eight equal regions whose distance is beyond the threshold distance. We choose cluster heads (CHs) in every region that is untouched by other regions. The selection of CHs depends on certain procedures, where two primary models for the split of the network have been implemented. These two models are the circle and the square. The CH is positioned in the middle of the ring quarter in the case of a circle. However, in the case of a square, the CH is positioned in the square angle i.e. the corner. Our protocol work has been compared to M-GEAR and LEACH. Analyzing the results of this comparison has proved the good quality performance of our protocol regarding to the network lifespan and the use of energy.

The graph below summarizes the main steps of the approach proposed in this letter, it is clear from this diagram that the proposed model consists of six basic steps, which are detailed above. Initially, the area will be divided into four sections. In the second step, the Nodes will be distributed randomly to these areas, the third and fourth steps illustrate the proposed geometric shapes, the fifth step illustrate comparison of geometric shapes according to the number of dead and live nodes, the consumed energy and the number of packets then selects the best geometric shape, the last step is compare the selected model with LEACH and M-GEAR models according to the number of dead and live nodes, the consumed energy, the number of packets and throughput.

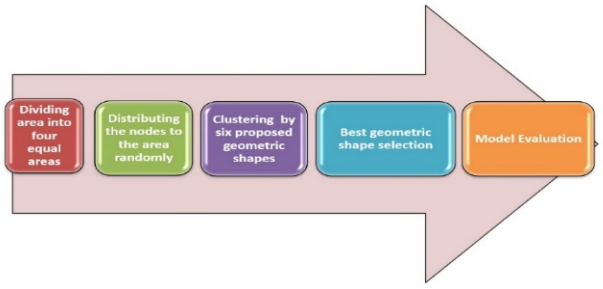

Fig. 3 Our Simulation model

4. Experimental Consideration

We evaluate the performance of our proposed approach and make a comparison with the current WSN protocol which is M-GEAR and LEACH.

4.1 Simulation Setting

We have stimulated our proposed approach by utilizing MATLAB to assess the way it works. We take into consideration a network of a wireless sensor that has 100 nodes which are spread out at random in 1000m X 1000m field. A sink is located at the sensing field center. The CH is positioned distant from the sensing area. Moreover; sink and CH node are fixed after dissemination. The packet is 4000 bits. Our protocol has been compared to M-GEAR and LEACH protocols.

We do not pay attention to the implications of collision and interference in the wireless channel in order to appraise how our protocol performs in comparison with those protocols, Table 1 shows these parameters.

Table 1: Simulation of parameters

Parameters	Values
Number of nodes	100 nodes
Area	1000 x 1000 meters
Number of Rounds	3000 rounds
Data Packet size	4000 bits
Sink Position	(500,500)
Initial energy	0.5 joule

4.2 Performance Parameters

In this subdivision, we introduce the way metrics perform. In this thesis, we assessed three parameters of performance set out below.

i. Network lifetime: It is defined as the amount of time that the network stays operative which ends by the death of the last node.

ii. Throughput: To assess how throughput performs, and to make a comparison between the number of packets that CH receive, and the number packets the nodes send in every round.

iii. Residual Energy: The remaining battery energy of a network is taken into consideration with a view to studying the used amount of energy that the nodes require in each and every round. Residual energy guarantees graceful degradation of network life. The energy consumption formula for transmitting the data is:

$$E_{Tx}(k,d) = E_{elec} * k + Camp * k * d^2, d > 1 \quad (1)$$

Where k is the data volume to be transmitted, d is the distance among the two sensors. E_{elec} is the energy consumption to take out data transmission in terms of nJ/bit [20].

The figures below show the result of the six proposed shapes, Figure 4 shows the average number of dead nodes. The square circle method achieved the best result (73.42), followed by the
circle square method which got a result (79,66). The largest number of dead nodes showed when using one square only where the result was (97.15).

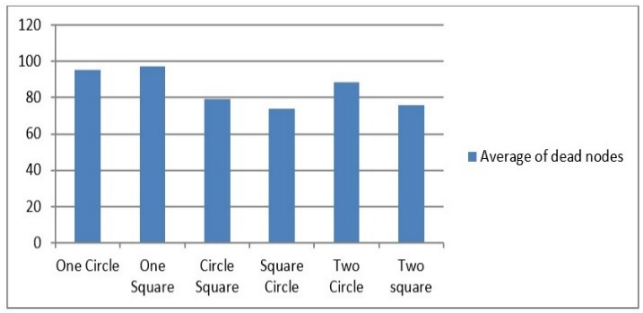

Fig. 4 Average of dead nodes

Figure 5 shows the average number of live nodes. The square circle method achieved the best result (34.02) during the lifetime of the network (3000 laps), followed by two square methods which got a result (32.08). The largest number of dead nodes showed when using one square only where the result was (10.85).

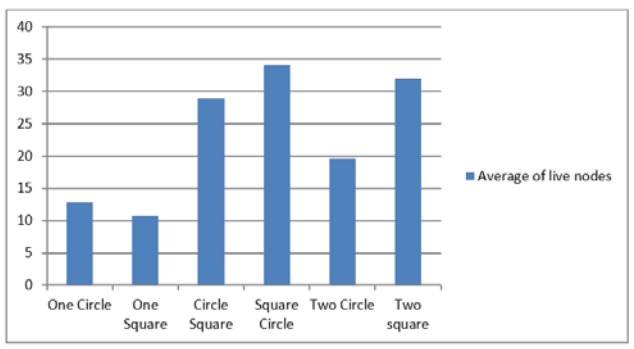

Fig. 5 Average of live nodes

Figure 6 shows the average of packet nodes. The square circle method achieved the best result (79125.94 packets) during the lifetime of our network, followed by two square methods which got a result (75444.626). The largest number of dead nodes showed when using one square only where the result was (16780.43833).

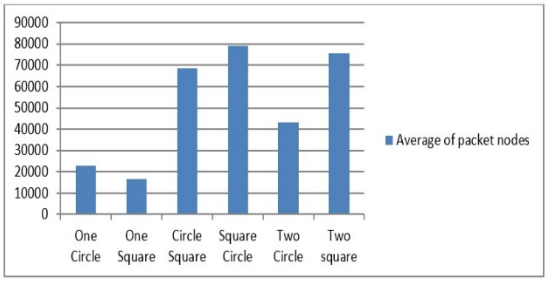

Fig. 6 Average of packet nodes

Figure 7 shows the energy consumption of each of the six proposed models. This Figure shows that the square circle method consumes the largest energy due to the large beam size. Where the average energy consumption was (7.506), and based on the fact that the node rate and the size of packets was a little, only one square method achieved the lowest energy consumption rate of (1.95), and as a general result and based on the previous results, we were selected square circle method as the best proposed of the six shapes

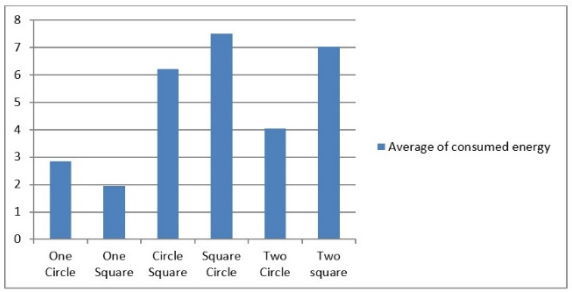

Fig. 7 Average of consumed energy

4.3 Comparing the State-of-the-Art Clustering Protocols

In this section, we illustrate the outcomes of the stimulation. We operate intense stimulations and make a comparison between the outcomes and M-GEAR and LEACH protocols. The following part explains each metric.

4.4 Results

- Network Lifetime

We present the outcomes of the network lifetime in Table 2 and Table 3, after using 0.5 joule energy, nodes die. Our protocol has the longest network lifespan due to the good distribution of energy use within nodes. The network is split into logical regions, each one of them which is also divided into two clusters. Our model topology stabilizes energy use within sensor nodes. However, nodes in M-GEAR and LEACH do not stay alive for a long time, they die when the stability period is over.

Table 2: Average dead nodes

Rounds	Leach	M-GEAR	Proposed
[1-500]	99.05	85.36	10.55
[501-1000]	100.00	89.01	44.00
[1001-1500]	100.00	90.45	73.96
[1501-2000]	100.00	91.92	104.00
[2001-2500]	100.00	93.90	104.00
[2501-3000]	100.00	95.00	104.00
Average Dead nodes	99.84	90.94	73.42

It is not obvious that the predestined CHs in LEACH are spread out regularly among the network area. As a result, it is possible that the chosen CHs will be centralized in a specific network region. So, several nodes will never have any CH around them.

Table 3 illustrates interval of network lifespan that has good confidence interval. We noticed that the outcomes of our protocol differ steadily and have good performance.

Table 3: Average live nodes

Rounds	Leach	M-GEAR	Proposed
[1-500]	0.95	14.64	92.61
[501-1000]	0.00	10.99	65.00
[1001-1500]	0.00	9.55	34.53
[1501-2000]	0.00	8.08	4.00
[2001-2500]	0.00	6.10	4.00
[2501-3000]	0.00	5.00	4.00
Average live nodes	0.16	9.06	34.02

- Residual Energy

Table 4 demonstrates the average of network remaining energy for each round. We suppose that a node has 0.5 joule energy. The whole energy of a network that has 100 nodes is 50 joules. M-GEAR and LEACH protocols use more energy than our protocol does.

Table 4: Consumed energy

Rounds	Leach	M-GEAR	Proposed
[1-500]	0.34	3.53	29.47
[501-1000]	0.00	1.57	9.21
[1001-1500]	0.00	0.76	1.15
[1501-2000]	0.00	0.29	0.00
[2001-2500]	0.00	0.04	0.00
[2501-3000]	0.00	0.00	0.00
Average energy nodes	0.06	1.03	6.64

Also, Table 4 and Table 4 obviously show that our proposed protocol exceeds M-GEAR and LEACH protocol when it comes to the used amount of energy for each round. Dissemination of gateway node at the center and the good possibility of CHs in all of the regions guarantee the use of the least amount of energy. More over our protocol achieves the best result in term of average packets.

Table 5: Average packets

Rounds	Leach	M-GEAR	Proposed
[1-500]	204.50	2024.12	25675.76
[501-1000]	209.00	3618.20	64648.00
[1001-1500]	209.00	4693.00	92893.50
[1501-2000]	209.00	5465.95	98639.00
[2001-2500]	209.00	5842.99	100641.00
[2501-3000]	209.00	5865.00	102639.00
Average packet	208.25	4584.88	80856.04

Figure 8 shows that our proposed model achieved the best results compared to the other two methods, followed by M-GEAR method and ultimately LEACH method in term of average of dead nodes.

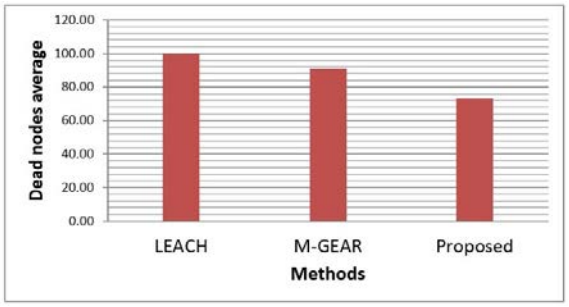

Fig. 8 Average dead nodes

Figure 9 also shows that our proposed models achieved the best results compared to the other two methods, followed by M-GEAR method and ultimately LEACH method in term of average of live nodes.

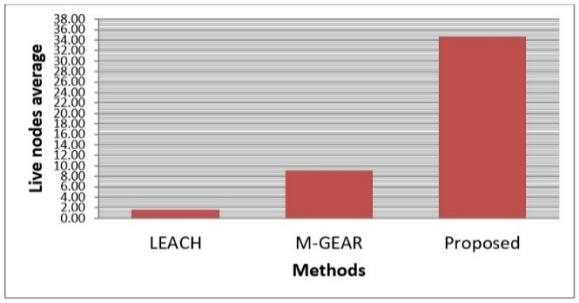

Fig. 9 Average live nodes

Figure 10 shows that LEACH achieved the best results compared to the other two methods, followed by M-GEAR method and ultimately our proposed model in term of average of energy nodes.

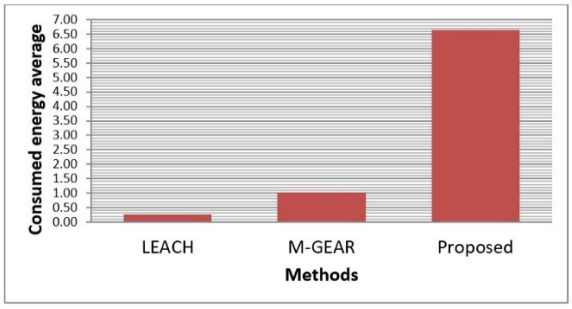

Fig. 10 Average consumed energy nodes

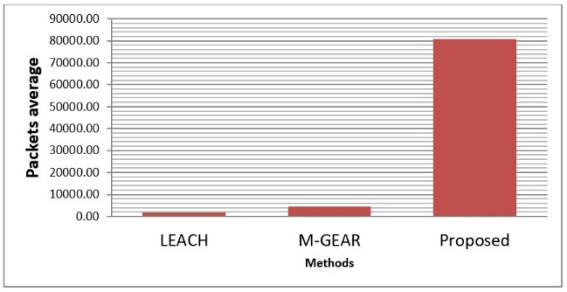

Fig. 11 Average packet

Figure 11 shows that our proposed model achieved the best results compared to the other two methods, followed by M-GEAR method and ultimately LEACH method in term of average of packet.

5. Conclusion and Future work

The results of this study coincided with the results of several similar studies in this field. Our study proved that the clustering protocols reduce the amount of energy consumed, which made these protocols widely accepted in many (WSNs) applications. Many modern (WSN) protocols utilize the cluster-based system at multiple levels to reduce the amount of energy consumed in the transmission of packets. Thus, cluster-based protocols select (CHs) based on probability principles, and (CHs) cannot be uniformly distributed throughout the sensor area.

For this reason, the spread of (CHs) may be concentrated in one area of the network, which is unfairly diffused and unequal. Thus, so many of the node may not get any (CHs) in its sensory domain, and thus will cause this node to die. Similarly, some protocols have applied unequal clustering to try to optimize resource utilization.

We proposed new approach for enhancement of energy-efficient routing protocol using specific distribution to reduce energy consumption of sensor network. In this thesis, we split the network are into different regions according to the four sections of the Cartesian level. We split the sensor nodes into four or eight logical regions according to their position in the sensing area, we presented six models, which are: the first case only one square, two squares, one circle only, two circles, the external circle within the internal square and the last case external square within internal circle.

The Sink is located at the center sensing field and nodes are spread out at random. If the space between a sensor node and (BS) or gateway is less than the minimum of predetermined space, then the node in field one near the sink communicates directly, since the remaining nodes have connections with the (CHs). Also, we used Dijkstra's algorithm to determine the cluster heads that extend beyond the boundaries of the internal geometry shapes.

For the average number of dead nodes, the square circle method achieved the best result (73.42), followed by the circle square method which got a result (79,66). The largest number of dead nodes showed when using one square only where the result was (97.15). We make a comparison between the outcomes and M-GEAR and LEACH protocols, our model (square circle) stabilizes energy use within sensor nodes. However, nodes in M-GEAR and LEACH do not stay alive for a long time, they die when the stability period is over.

In the future, we will evaluate our proposed approach based on more performance metrics such as ETX link, Furthermore, in the future, we can study the effect of the re-clustering process, the mechanism used to select the heads and their number on the energy consumed in the network, and try to find solutions to reduce this energy, which increases the life time of the network and improves its performance of the proposed work will be extended to perform in dynamic environments, and the proposed work will be extended to perform in dynamic environments.

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