Self-Organized Hierarchy Tree Protocol for Energy-Efficiency in Wireless Sensor Networks

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Summary
A sensor network is made up of many sensors deployed in different areas to be monitored. They communicate with each other through a wireless medium. The routing of collected data in the wireless network consumes most of the energy of the network. In the literature, several routing approaches have been proposed to conserve the energy at the sensor level and overcome the challenges inherent in its limitations. In this paper, we propose a new low-energy routing protocol for power grids sensors based on an unsupervised clustering approach. Our protocol equitably harnesses the energy of the selected cluster-head nodes and conserves the energy dissipated when routing the captured data at the Base Station (BS). The simulation results show that our protocol reduces the energy dissipation and prolongs the network lifetime.
Key words:
Wireless sensor networks; routing protocol; clustering techniques; energy consumption; optimization.

1. Introduction

Wireless sensor networks (WSN) are comprised of a large number of Nanodevices called sensors. These sensors are usually placed near objects in which we are interested in the deployed environments. These sensors can collect, process, and deliver the environmental data of the region monitored autonomously to specific nodes called sink nodes or base stations [1], [2]. In sensor networks, energy-consumption is of immense importance because the sensors are generally deployed in inaccessible areas. As such, it is sometimes almost impossible to renew the batteries of the sensors once they are depleted. As a result, the consumption of energy at the sensor level greatly influences the lifetime of the entire network. It is, therefore, imperative to set up an effective routing protocol based on energy conservation, taking into account the constraints of the network and the sensor nodes. The majority of research currently being carried out is mainly focused on methods and approaches to minimize the energy consumed in data communication and to maximize the executable lifetime of the network.
In this paper, we propose a new approach for energy-efficient routing by adapting the unsupervised clustering. Clustering consists of partitioning the network into discrete clusters. In each cluster, the Cluster Heads (CH) are assigned are elected by the sensor nodes [3], [4] or assigned by a centralized mechanism [5]. CHs selected not only ensure the management of their respective clusters and data collection but also the transmission of the data collected to the base station. The rest of the paper is structured as follows: section 2 presents the network architecture and network radio model used; section 3 describes our protocol. In section 4, the results of the simulation are interpreted, and section 5 concludes the work.

2. Hierarchical Partitioning of Network

2.1 Network Partition

Clustering a set of wireless sensor nodes means dividing it into subsets groups called clusters. In the case of wireless sensor networks, this partition allows to obtain efficient packet routing by adopting the following configuration:

1. All the nodes gathered in the same cluster can communicate directly between them "in one hop" (one-hop transmission);
2. During the partition, a single node per cluster is designated “leader” of the cluster. It is chosen, deterministically or randomly depending on the algorithm used, among the "normal" nodes of the cluster and is termed as the Cluster Head (CH);
3. When any sensor in a cluster wishes to send data to a node of another cluster or to the base station, it sends its packets to the cluster head of its cluster.
4. The cluster head then retransmits the packets, either directly to the target if it is of the base station and can reach it, either "in several hops" by passing through other cluster heads (multi-hop transmission), until reaching the recipient.

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The diagram of a clustered network is shown in Fig. 1.

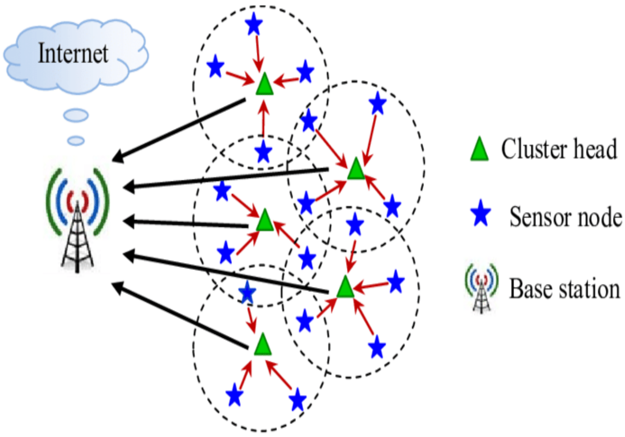

Figure 1: WSN Architecture based on clustered heads

The use of a "clustering" algorithm has the effect of limiting emissions to "Long-range" (relative to intra-cluster communications) to cluster heads only. However, communications over greater distances result in greater energy consumption (since greater transmission power is necessary). Regular sensors (non-cluster heads) do not have to reach nodes directly located outside their cluster; they save that much on energy.

Besides, the cluster heads are ideally placed to perform aggregation operations or even compression on the packets they receive to limit the volume of retransmissions cost in energy. Apart from the substantial energy savings, the clustering of a network presents several other advantages:

- It makes it possible to deploy a "centralized" management of a cluster since the cluster head is able to apply an algorithm taking into account all the sensors of its group. However, the decentralized topology of the whole network is not sacrificed because the clusters are independent of the base, which does not intervene in their internal functioning;
- It allows extensibility since it is easy to add clusters to the network, or even not very restrictive to add nodes in a given cluster. The evolution of the network is thus easier to ensure than if it was necessary to modify a distributed algorithm to consider the integration of new sensors.

2.2. Hierarchical Example

Several data clustering algorithms exist. Several of them are even adapted explicitly to wireless sensor networks. It is the case of LEACH that takes place, as mentioned above, among the most frequently used, so much so that there are many variations. For example, it is possible to extend the algorithm to consider the remaining energy available to each node during the election of CH. This residual energy then intervenes in time as an additional parameter when calculating the threshold value S(i) [6]. Other work is based on LEACH, whether to improve its performance [7], [8] or its security. But there are also many other protocols [9], [10]. Some of them take into account two to three parameters, such as the residual energy of nodes, their distance from potential cluster heads and/or the number of neighbors of these last: this is the case of the HEED protocol [11], which is quite often used, or of the MPC [12], more recent and less widespread, based on k-means. A fourth element, the trust placed in the node, is even sometimes used to make a selection safer from CH [13], [14].

Specific protocols have more precise goals, like FFUCA [15-17], which is based on the exploitation of ultrametric properties in the network to create a distribution of "Ideal" nodes in clusters according to their distance from CH; or like VSR [18], designed for MANETs, which using a virtual structure determines proactive routing for the interior of the clusters (where the nodes transmit to the cluster head in several hops) and on-demand on the backbone of the network that connects between them.

3 Methodology and Implementation

Let us suppose several sensor nodes deployed in the field based on the random distribution in WSN with the Sink being located precisely in the middle. The sensor nodes are constrained to be stationary, and all of them have the same quantity of energy Emax. The nodes in our assumed WSN are arranged into clusters. The nodes are either the non-CH nodes or the CH nodes in WSN. The environment is being monitored and scanned by the non-CH nodes, and the collected data is forwarded to the CH node. Also, the sensor node can become a CH node for gathering the data, compressing it, and sending it to the Sink. The CH and non-CH nodes are assumed to be homogeneous with the constraint on energy consumption. The architecture is modeled by the proposition scheme of the graph

$G = (V, E)$, where V are the non-CH and CH sensor nodes and the $E = (u,v) \in V/D(u,v) \leq R$ is the wireless interface between them. R represents the data transmission distance, and D(u,v) is the distance (Euclidian) between sensor nodes v and u.

3.1 Energy Model

In any WSN, the data communication between the sensor nodes is responsible for utilizing most of the energy of the network. Thus, for a particular WSN, the average energy of all the CH and non-CH nodes shapes the total energy consumption. Also, in particular, for simulation, the energy used in data collection and data aggregation is considered in experimental analysis and simulation. Fig. 2

shows the generic model used in state of the art [9], [10] for energy consumption by the radio interfaces.

The model represented in Fig. 2 is the radio hardware energy dissipation model. For data transmission, the transmitter consumes energy for running radio communication interfaces and for power amplification. For data reception, the receiver also consumes electrical energy for its radio interfaces. In the proposed approach, we consider both the d2 power loss, which is the free The model represented in Fig. 2 is the radio hardware energy dissipation model. For data transmission, the transmitter consumes energy for running radio communication interfaces and for power amplification. For data reception, the receiver also consumes electrical energy for its radio interfaces. In the proposed approach, we consider both free-space propagation and multi-path fading losses. These two models are employed based on transmitter-receiver distance.

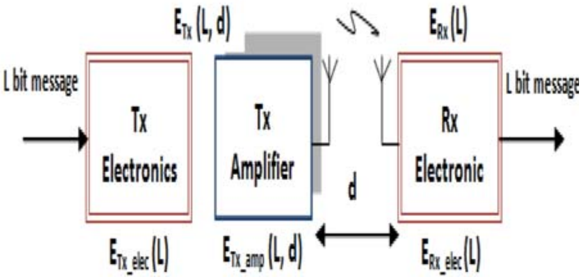

Figure 2: Transmitter and receiver energy consumption model.

According to Heinzelman [10], appropriately setting the power control can address this loss by tuning the power amplification. For the transmission of a message having L-bits among two nodes, the total energy consumed for such operation is as follows:

ETX (L,d) = Eelec * L + Ɛmp * L (1)
ERX (L) = Eelec * L (2)

Where d represents the distance among them; ETX(L,d) is the transmitter's energy; and ERX(L) is the receiver's

$$E_{trans}(l,d) = \begin{cases} lE_{elec} + l\varepsilon f_s d^2 & if \quad d < d_0 \\ lE_{elec} + l\varepsilon_{mp} d^4 & if \quad d \geq d_0 \end{cases} \tag{3}$$

Where εfs and εmp are energy parameters. The threshold is represented by d0. The d0 and d dictate the channel used for communication. If d < d0, then the d2 power loss model is used; if d > d0, then the d4 power loss channel model is assumed. Each sensor in WSN consumes energy. Each sensor employs three components that need energy for its operation. These are the transmitting and receiving unit, sensor unit, and processing unit for each sensor that consumes energy. In this work, however, we limit ourselves to the communication interface, which is transmitter and receiver units. The sensor energy and the energy used in processing information is neglected. Therefore,

Ec(i) = Ec/comm(i) (4)

The energy of communication interface is divided into transmission-energy ETX and reception-energy ERX, so :

Ecu(k,d) = ETx ∗ (k,d) + ERx ∗ (k) (5)

For E_TX and E_RX, we assume the model of [11]:

ETX(k,d) = Eelec ∗ k + εamp ∗ K ∗ d2 (6)
ERX(k) = Eelec ∗ k (7)

where,

- k the bits data in the message
- Eelect is the emission/ reception energy
- d distance of transmission
- µdn is the per bit propagation energy;
- n is a way-loss, λ > 2.

If d < d0, the value of µ is based on the d2 power loss equation. The propagation thus is:

ETX = l Eelec + l εfsd2, for d ≤ d0 (8)

Where nodes distance is d; E_Tx(L,d) is the overall energy of the transmitter node; and E_RX(L) is the overall energy of the receiver end in the node. Eelec is the per bit electronics energy consumed for the transmission and reception in the sensor node. Eelec depends on many factors. These include the coding approach used, modulation technique used, filtering, and spreading the spectrum of the signal. εmp is the amplification energy in the transmitter node.

3.2 Neighbourhood Graphs for Search

The neighborhood searching approach is widely used for locating the relevant data that is correlated by any parameter. So, once this neighborhood is identified, it is optimal to query and find the relevant queried information. For notations and definition perspectives, we use uppercase letters for the sets of data objects. Let V be objects in a p dimensional space Rp and R is the real number. For a set V, the cardinality is |V|. A graph is thus represented by G (V, E), where V is the nodes and E is the edges connected to these nodes. The set E represents a binary relation on the set V. The node pair (vi, vj) in the graph G (V, E) represents a binary relation if-and-only-if (vi, vj) ∈ E. As such, each individual sensor node is mapped to a node in graph G, and a pair of nodes (vi,vj) is in E when they are directly connected by the dedicated link in the corresponding graph.

A N(v) is a function which returns the set of nodes connected to the node v ∈ V, and N(v) = w|w ∈ V ∧ (v,w) ∈ E. The distance function is:

$$d : V \times V \rightarrow R+ \cup \{0\} \quad (9)$$

Where d is specified using the distance measurement (Toussaint (1991)). Neighborhood graphs or proximity graphs can be defined as geometric structures based on the mutual proximity of object pairs. Thus a proximity function fprox: V ×V → {1,0} takes into account the data characteristics neighborhood type.

3.3 Neighbourhood Graph

For neighborhood graph G (V, E), let suppose a set of data V and a function of proximity fprox: V ×V ß{1,0}. The G (V, E) is thus defined as:

$$(vi,vj) \in E \ \text{ifprox}(vi,vj) = 1 \quad (10)$$

For any pair of nodes vi,vj ∈ V,vi ≠vj . Thus a (vi, vj) nodes pair constitutes an edge in the neighborhood graph G (V, E) for the set V if the nodes follow the proximity-constraint which is represented by fprox.

3.4 Principle of Neighborhood Graphs

There are several algorithms for graph construction. One of the optimized approaches is to build the graph is stages. In this approach, the graph built earlier is used to construct a new graph. The connections and edges which violate the neighborhood property of the graph are thus eliminated; thus, this process is termed as Pruning. The neighborhood graph construction is a demanding process in terms of resources. The cost, therefore, evaluates to the O(n3). Toussaint has proposed a complexity of O(n2) for such scenarios. The category of algorithms that fall in the O(n2) complexity and even lesser have advantages; however, these focus on the overall construction of the graph. That is why these algorithms do not support and do not offer insertion and deleting points in the graph. However, these operations are vital for an indexing structure; it is for this reason; these algorithms are also not desirable for the use of the graph as an indexing structure. So, since a modern data index has to support many interactions, translated by frequent insertions, deletions, and queries, we propose the following algorithms capable of taking into account these interactions while preserving the initial properties of the graph necessary for the application of data mining techniques.

3.5 Implementation

The relative neighborhood grouping method allows you to perform different steps on individuals. And by analogy, in wireless sensor networks, we will present the sensor nodes as individuals and apply this method on these sensor nodes to group them into groups of which they are neighbors, so we guarantee the distance the shortest between these nodes and thereafter it ensures a reduced power consumption relative to this reduction in the distance between the nodes. In such a geographical area, two sensors and β are connected when they are neighbors in the sense of a neighborhood structure to be defined. We consider more particularly the graph of the relative neighbors of Toussaint, which is a graph in which, If two sensor α and β are neighbors then they check the following property:

$$d(\alpha, \beta) \leq \max (d(\alpha, \gamma), d(\beta, \gamma)) \ \nabla\gamma, \gamma \neq \alpha,\beta \quad (11)$$

Where d (α, β) is the distance (Euclidean) between two sensor nodes, the α, β, and γ are the three sensors.

3.6 Mathematical Model

We present vital concepts and notations relevant to the proposed model:

S = s1,s2,......sn, where S be the sensor nodes. These nodes are distributed based on random distribution in a specific area. The are has dimensions of m∗m, whereas sn+1 denotes the base station. The sensors operate in a communication radius of r.

Let L be the link between nodes. The link is bi-directional.

Also, Cluster Head be Sch = ch1,ch2,......chk where Sch belongs to S.

Dsisj_max is the largest distance from sensor si to sj. Also,

$$Dsj(max) = Max\{dis(si,sj)\}|\forall si,sj \in S = \|si - s_j\|^2 = \sum(s_i - s_j)^2 | \forall s_i, s_j \in S \quad (12)$$

Dsn+1(max) is the max distance from sensor node si and the BS, and

$$Dsn+1(max) = Max\{dis(Si,Sn + 1)\}|\forall Si \in S = \|Si - Sn + 1\|2 = \Sigma(Si - Sn+1)2|\forall si \in S \quad (13)$$

Dchj(max) is the maximum Euclidian squared distance from node si to the CH chj

$$Dchj(max)=Max\{dis(si,chj)\} \mid \forall s, chj \in S = \| si - chj \| 2 = \Sigma(si - chj)2 \mid \forall si, chj \in S \quad (14)$$

is the squared Euclidian distance between the chj and

$$D_{ch_j}^{S_{n+1}}(\max)\{dis(ch_j, S_{n+1})\} \mid \forall \in S_{ch} = \left\| ch_j - s_{n+1} \right\|^2 = \sum (ch_j - s_{n+1})^2 \mid \forall j \in S_{ch} \quad (15)$$

If the nodes are uniformly distributed m*m setup having k clusters, then there exist n nodes in each cluster. From these, one of n is the CH node, and the remaining are non-CH nodes. The energy consumption of the non-CH node is thus:

$$Enon{-}ch(l,d) = Etrans * (l,d) \quad (16)$$

$$Enon{-}ch(l,d) = l * Eelec + Eamp(l,d) \quad (17)$$

and energy consumption of CH node is:

$$E_{ch}(l,d)=E_{trans}(l,d)+(\frac{n}{k}-1)*l*E_{elec}+\frac{n}{k}l*E_{da}+(\frac{n}{k}-1)E_{a}$$

(18)

where Eda is the data aggregation energy consumption of the CH node.

The energy consumed in the whole cluster is given as,

$$E_{cluster} = E_{ch}(l,d) + (\tfrac{n}{k} - 1) * E_{non-ch} \quad (19)$$

And the per round energy consumed in the network is

$$E_{round} = \sum_{j=1}^{k} E_{cluster_j} \quad (20)$$

Algorithm Toussaint for each pair of sensors:
Main algorithm 1

Data: A set of sensors in a precise simulation area
Result: A neighborhood graph G=(V,E) associated with these sensors
Start
E = ∅
for each sensor (α,β) do k=1 while k ≤ n
IF max [d(α,y),d(β,y)≺ d(α,β) and∀γ,γ ≠α,β]then
Break
End
K++ if $k \succ n$ alors
E=E ∪ (α,β) End
End

This algorithm traverses the network of wireless sensors, which consists of n nodes and compares the distance between a sensor α and a sensor β with a third sensor y, and classifies each neighboring sensor into subsets. By applying this algorithm on the different nodes of our sensor network, we guarantee a short relative distance between each pair of sensors, which ensures a brief communication between the sensors.

3.6.2 Sorting Method for Descending Order of the Graph Edges

By analogy, sorting the edges of the graph is to sort the distances between the nodes in descending order, and to make this sort of distances, we must resort to this algorithm of sorting distances:

Sorting of distances
Data: A set of sensors placed randomly in a geographical area
Result: A set of sensors whose distance between them sorted in descending order
Start
for any sensors (α,β,y)do
if d(α,β) < d(α,y)alors **then** inverser(B,y)
x ≠ B
B ≠ y
Y ≠ x
end if
end

This sorting algorithm makes it possible to sort the distances between the network nodes of the wireless sensors so as to guarantee the construction of the sets of nodes contains very close sensors. After deleting the large distances between the nodes, these nodes are merged away to the nearest node, and therefore subgroups of the nodes in the neighboring and near nodes are obtained. In this way, we guarantee the minimum distance between every two nodes and that all the sensors will be grouped into adjacent and adjacent sets. And since we will have adjacent sets, so we can conclude that the distance between the sensors will be minimum, which serves to minimize the communication distance, so will minimize the energy consumption of the sensors. Because long-distance communication requires more energy, so the fast discharge of the batteries of the sensors. Fig. 3 shows the relative neighborhood grouping flowchart:

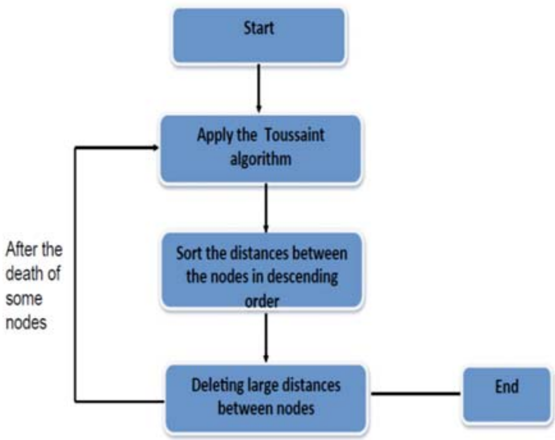

Figure 3: Flowchart for the operation of PC-LEACH

4 Application of Relative Neighbourhood Grouping Method

In the RCSFs: First, consider a wireless sensor network, created by a set of virtual nodes where the nodes are randomly placed to supervise a specific event, collect that information, process it, and send it to the base station via connectivity wireless. Fig. 4 shows the location of the nodes before the sensing event begins.

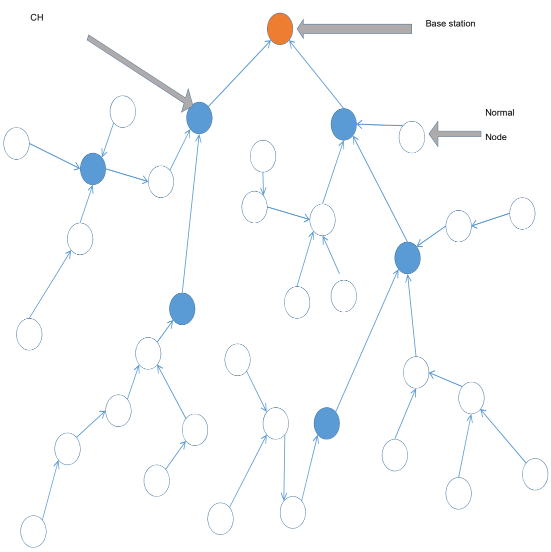

Figure 4: First step

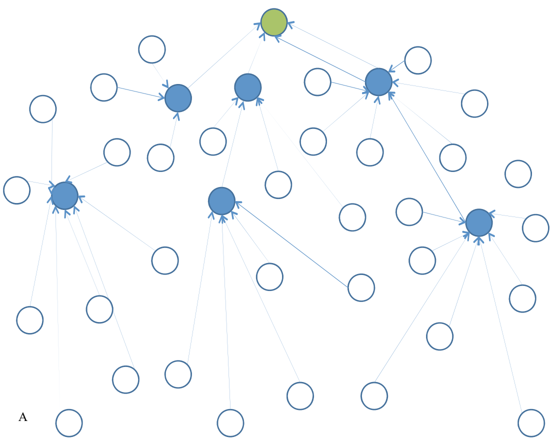

Figure 5: Second step

Secondly, we show the connectivity between the nodes and the way of communication between them and the assignment of group leaders (CHs) before the application of the relative neighborhood grouping method. The different steps of our approach are summarized as follows:

Step 1: Read the distance and position (xi, yj) of sensors nodes S_i,i = {1,2....n}
Step 2: Send Hello message to all the neighbor nodes from the BS and find the distance between them.
Step 3: initiate the Toussaint algorithm to create clusters by joining and grouping the nodes based on distance.
Step 4: The BS coordinates the communication between CH's after the creation of clusters.
Step 5: Create the table of the TDMA. After creation, sending it to other peers.
Step 6: Launching of the transmission phase.
Step 7: Check if energy $\succ 0$•
Step 8: If yes, repeat steps 4 to 6.

Using the Toussaint algorithm, the data collected by the sensors are sent to BS periodically. The algorithm is terminated whenever the reliable path between sensors is exhausted. A neighborhood clustering method is applied in a wireless sensor array, which considers the location of nodes and the base station as a tree and the distances between nodes as edges. This method changes the nodes' location to group the nodes into sets, the distances between them being as close as possible. In this way, we reduce the value of ”d” which represents the distance in the energy model for wireless sensor networks. So we reduce the energy consumption in the communication between the nodes and the transmission of data between them due to the extension of life of this network.

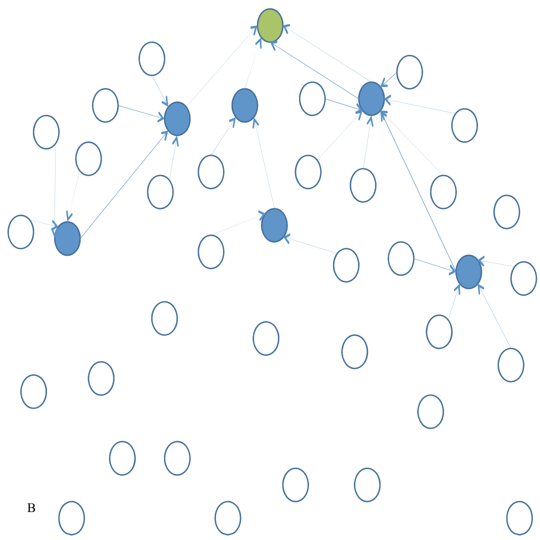

Figure 6. Third step

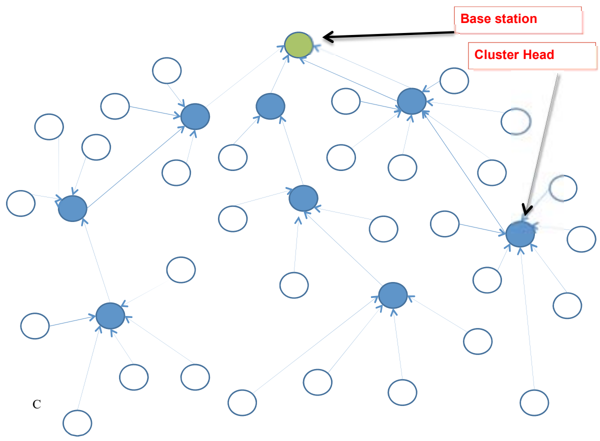

Figure 7. Fourth step

5 Simulation Results and Discussion

For assessing the performance, we focus mainly on two unique situations.

5.1 Simulation Environment

Our simulations consist of packet ratio delivery, power consumption, and delay. Then, we compared these results with those of the LEACH protocol in terms of duration end-to-end network life and delay. For this, we used the Matlab-2014a simulator to implement the proposed algorithm. First, we integrated the implementation of optimum-LEACH. To develop our grouping technique by geographic proximity, we modify LEACH based on the hierarchical-structure in MAC layer association commands and the approach of filling the table of redundancy at the physical layer.

In the model proposed in this work, it is assumed that a node can only be selected if it has enough energy available at the start of the time interval to detect and transmit μ (t) bits of data. LEACH is used as a comparative approach. For justification, we perform simulations using similar parameters for both protocols. Our main emphasis is the node's energy consumption. The reason is that energy consumption is considered the main parameter for assessing the lifetime of the network. We also focus on the end-to-end delay because it is also considered a main performance criterion in the RCSF. The performance parameters used in the analysis are as follows:

1. Energy consumption: for the energy estimation, we obtain the energies at the start of the simulation and current node energy levels from trace files.
2. Lifespan: For lifespan calculation, we obtain the time t, where t is an instance after which the node's energy becomes zero. The number of "still alive" nodes vs. time is analyzed and plotted during the simulation.
3. Packet ratio delivery: To evaluate the number of transmission packets into the network.

We created a static network of N nodes ranging from 100 nodes and tested up to 150 nodes that have been deployed randomly over an area of (100x100) m^2. The coordinates of the base station are (50, 50). Nodes are aware of their position in (x, y) plane. These positions are also communicated to the corresponding CH. The simulation parameters can be seen in Tab. 1. Thus, in order to analyze the robustness of our approach in relation to the number of nodes, we have chosen to evaluate the following metrics and compare them with those from LEACH:

- The average energy consumption of each node as a function of the number of nodes,
- The average uptime of the network while having 100 and 150 nodes,
- The average packets propagated through the network
- The results obtained for these metrics are presented in Fig. 7-9 (with 5% of the nodes as CHs).

In the network organization, a cluster hierarchy is used. The CH reduces correlated data produced by the sensor nodes by executing the fusion function. The parameters for the simulation of the Optimum LEACH are given in Tab. 1. For the frequent change topology avoidance, stationary nodes are assumed. The protocol is thus compared with BeeCluster, PEGASIS, and LEACH.

Table 1: Parameters used for analysis

Parameter	Value
Are of Network	100*100
CH probability of a node	0.05
Init-Energy	1.5j
Location of Base Station	50*50m
Data-Size	500 bytes
Energy consumption	50 nJ/bit
Nodes	50 & 100
E-f-s	10 pJ/bit/m2
E-m-p	0.0013 pJ/bit/m4

In Fig. 8, we can notice that the Optimum LEACH protocol outperforms the LEACH, BeeCluster, and PEGASIS protocols with an average percentage of 15% and 39% compared to LEACH, which exhausts all its energy around 986 rounds, and this is due to the great distances of the nodes at the base station. For The Optimum LEACH, the energy is totally exhausted around round 1195 so than Optimum LEACH which uses multi-hop to be able to send packets to the base station holds up to 1379 rounds. Our

Proposed protocol has a longer stability period than others protocols just because nodes are discriminated according to their position in the network distance with the suitable CH.

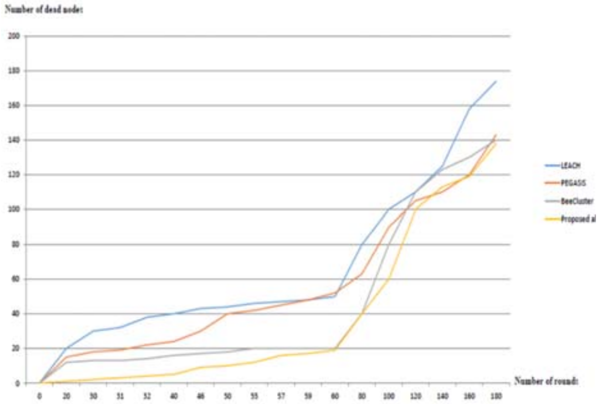

Figure 8: The number of alive nodes for each rotation (100 nodes).

As shown in Fig. 9, the proposed protocol outperforms all other comparative protocols in terms of packet delivery. Fig. 10 represents that the proposed protocol is approximately 30%, 45%, 65% superior to Beecluster, PEGASIS, and LEACH protocols to improve the neighborhood graph method to select optimal CHs. Thus reduce energy consumption in the network. The latter is selected based on their proximity to the BS. The SNs are assigned to their nearest CH. This optimizes energy consumption. Therefore, the overall energy consumption of the entire network is reduced compared to the other protocols.

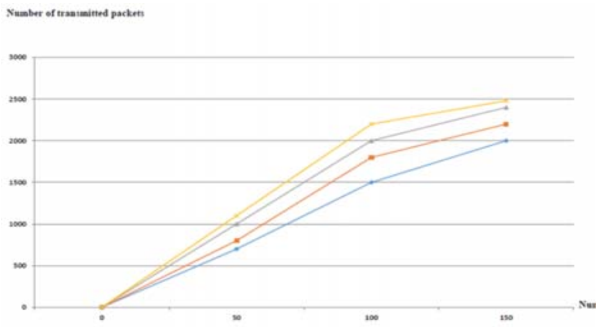

Figure 9: Packet delivery ratio

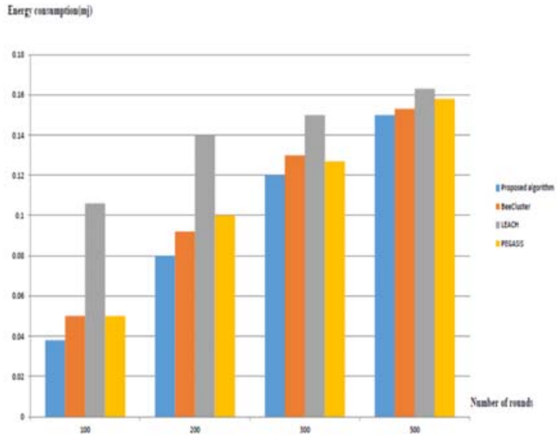

Figure 10: Average energy consumption

With the simulation parameters that we used, we were also able to know the number of nodes that die depending on the number of rounds for the 100 sensors deployed (scenario#1) and 200 sensors (scenario#2).The comparison between the first node dies (FND), and the last node fails (LND) of the network gives us Tab. 2. If we compare the four protocols, We notice that with LEACH, the first node dies at 130 rounds and PEGASIS at 145 rounds, while Optimum LEACH at 185 rounds. For all the nodes of the network to be dead, it takes 480 rounds for LEACH, 629 rounds for PEGASIS, and for Optimum-LEACH it takes 911 rounds, which increases the life of the network by 55% compared to LEACH. And to study the lifespan of the network according to the number of nodes deployed, we followed the evolution of 1000 nodes compared to time for the three BeeCluster protocols, PEGASIS and LEACH at first, 50%, 75% and 100% nodes that die in the network.

Table 2: Performance comparison of LEACH, BeeCluster and PEGASIS with proposed Protocol.

	Experiments scenario #1	**Experiments scenario #2**
	FND LND	FND LND
	185 911	154 690
	165 720	112 501
	145 629	94 438
	130 480	78 288

6. Conclusion

In this work, we were interested in the issue of energy saving during data routing, which is due to deployment areas that are sometimes inaccessible; consequently, the battery of the nodes will also be difficult to recharge and replace. To do this, we have started by presenting the generalities surrounding the field of WSN's. Our approach called Optimum LEACH allows a more efficient management of energy resources when routing data in the network, it organizes the network into levels, according to energy and the distance from the base station of the relay nodes, knowing that a relay node is the most powerful node in terms of energy, which resolves the problem of overloading the relay node closest to the base station (hot spot problem), level splitting allows multi-hop communication between the nodes of the different layers which consumes less of energy to reach the base station, the performance evaluation of our protocol has been simulated in MATLAB in which we found that our approach is much better than LEACH and BeeCluster, PEGASIS knowing that the comparison is made according to two performance criteria such as energy consumption and network lifetime. As a perspective of our work, we would like to apply our approach in a mobile environment and study the possibility of the mobility of the base station and nodes sensors and put OLEACH into practice in a real network environment wireless sensors as SensLab.

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