New distance strategie for clustering in Wireless Sensors Networks

S. EL KHEDIRI, N. NASRI, A. WEI , A. KACHOURI

***Abstract*—** Clustering of nodes is one of the basic methods used for data gathering in wireless sensor networks. It has been observed that in most of these clustering method based upon the local attributes of sensor nodes, some of them are selected as cluster-heads. The nodes which are selected as cluster-head have to dissipate more energy as they have to receive and aggregate data of their respective member nodes. Moreover, Cluster-head nodes near to sink dissipate more energy as these nodes have to relay data of far off placed nodes. Due to this fast dissipation of energy, energy holes are created near to sink which in turn decreases network lifetime. In order to address these issues. We present energy efficient clustering scheme and propose to select, the cluster-heads by a probability based on the min distance between node and base station. The epochs of being cluster-heads for nodes are different according to their position compared with others nodes and the base station. The proposed scheme has been named as energy efficient propagation clustering EEPC. We compare EEPC with LEACH and WCA. Our simulation results show that EEPC results into enhanced network lifetime, throughput and balanced energy consumption among sensor nodes.

***Keywords*—**Wireless sensor networks; Network lifetime; clustering algorithm; Energy-efficiency.

I. Introduction

RECENTLY, wireless sensors networks (WSNs) are visioned usually composed of large volumes of sensors, that are densely deployed in a region of interest, that can sense environmental conditions in their immediate surroundings. Each node has several characteristics such as low-power (battery with 1.2 v) and limited capacity. To report tasks to the base station, energy-efficient routing algorithm is an important consideration for these networks [1-2]. These smart nodes become an indispensable part of our daily lives not only for short range and low throughput communications (domestic applications such as lighting), but also for high range and high throughput communications (GPRS and 3G networks, 4G and soon LTE. . .).

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Several techniques are proposed for static WSNs not to resolve all constraints together but it address only one specific constraint at a time. Among these techniques can be cited clustering. Clustering in WSNs has been deeply studied in the literature [1,3,4]. As WSNs often operate in unattended environments, it is challenging to recharge the battery of sensor nodes. However, the goal of several clustering schemes was proposed to minimize the traffic into network to enhancing the energy efficiency of WSNs, so as to extend the network lifetime. Since, cluster heads receive more packets and consume more energy to forward them within a long range. Long distance transmission is not optimal in terms of energy consumption; thus, decreasing the distance can increase energy efficiency and prolong the network lifetime. Thus these schemes achieve the goal of long lifespan by rotating the cluster head role among all nodes and avoiding electing nodes with low residual energy as cluster heads.

This paper is organized as follows: after the introduction, the second section, two presents in details our approach based on clustering for WSN's. In section 3 we analyze our scheme on the performance of the original Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol in a pure analytic approach and simulation results and the final section concludes the paper.

II. Proposed Algorithm

The clustering approach consists of dividing the network into a number of clusters, which are more homogeneous according to a specific metric or a combination of metrics, and therefore forming a virtual topology. A particular node called cluster-head generally identifies clusters. This allows for coordination among members of its cluster, to aggregate their collected data and then transmit it to the base station. The cluster-head is selected for this role based on a very particular metric or combination of metrics. This protocol is inspired from the idea Proposed in Leach [3].

A. Energy model

The energy consumption rate in the sensors networks represents the most important metric in the performance evaluation phase. This parameter depends on the used nodes characteristics (standby mode, nature of data processing, transmitted power, etc), and nodes behavior during the communication (retransmission, congestion, diffusion of the messages,.) [3]. The consumed power by sensor is that the consumed power by these captures units, treatment units and communication units. So the energy consumption formula is defined follows:

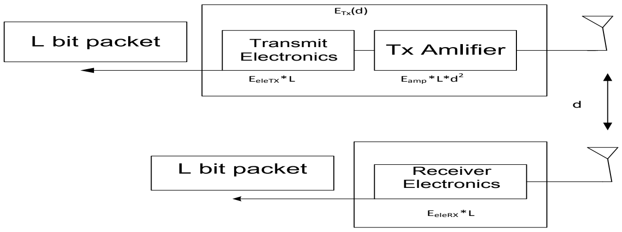

Fig. 1. Energy model [13]

$$E_c = E_{c/capture} + E_{c/treatment} + E_{c/communication} \quad (1)$$

Where:

- $E_{c/capture}$: Is the energy consumed by sensor during the capture unit activation. This energy depends primarialy on the type of detected event (image..) and of the tasks to be realized by this unit.
- *Ec/treatment:* is the energy consumed by the sensor during the activation of its treatment unit.
- *Ec/communication*: is the energy consumed by the sensor the activation of its communication unit.

The consumed energy by sensors during communication is larger those consumed by treatment unit and capture unit. Indeed, the transmission of a bit of information can consume as much as the execution of a few thousands instructions. For that, we can neglect the energy of the capture unit, and the treatment unit compared to the energy consumed by the communication unit. In this, case the equation (1) will be thus:

$$E_c = E_{c/communication} \quad (2)$$

The communication energy breaks up into emission energy and reception energy:

$$E_{c/communication} = E_{TX} + E_{RX} \quad (3)$$

Referring to [14], the transmission energy and reception energy are defined as follows:

$$E_{TX}(k,d) = Eelec*k + \varepsilon_{mp}*k*d\lambda. \quad (4)$$

Where:

- K: message length(bits).
- D: distance between transmitting node and receiving node
- λ : of way loss exhibitor, λ>=2.
- E_{elec}:emission/reception energy, E_{elec}=50 nJ/bit.

The figure number 3 describes the schemes of energy model of our proposed algorithm. This figure is an approach to describe the realistic power consumption in wireless sensors network.

A. Assumptions

Some of the assumptions made in clustered for communicating in wireless sensor network are as following:

- The network is shaped by N sensors nodes deployed in square field and has designed cluster hierarchical topology.
- The base station is located outside the sensing field.
- Nodes are deployed randomly.
- The base station location is pre-determined.
- The cluster head nodes are cognizant of its members and can communicate directly with them.
- The cluster-head nodes communicate with their parent cluster-head, and finally every cluster-head node is communicated with base station.
- Each sensor node communicates with their respective cluster.

B. Formulation

The overall objective is to maximize the duration of network operation before a sensor drains out of battery energy for the first time.

Table 2 summaries the notations used along the paper.

- **Mathematic formulation for Static Sink Mode (SSM):**

With the model were the cluster-heads are in static mode (static sink model, SSM), the base station is centrally located and remains fixed throughout the duration of operation of the network. The routing of data to the base station is done through driver's nodes. When the data become available in a node, it is transmitted to the base station. In general the transfer speed of a sensor node are constant and always they're designed by di. The problem of maximizing the lifetime of our model is formulated as follows:

$$\max \quad T \qquad 5$$

$$\sum_{j\in N(i)} x_{ij}^t - \sum_{k:i\in N(k)} x_{ki} = d_i, \quad i,j,k \in N \qquad 6$$

$$\left(\sum_{j\in N(i)} C_{ij}^t * x_{ij} + \sum_{k:i\in N(k)} \nu * x_{ki}\right) \bullet T \le E_i \quad i,j,k \in N \qquad 7$$

$$x_{ij,} \ge 0 \qquad i,j \in N \qquad 8$$

$$T \ge 0, \qquad 9$$

The constraint (5) is the "flow conservation constraint" which states that, at a node I, the sum of all incoming flows for the commodity d_i. The inequality (7) is the energy constraint and it means that the total energy consumed by a node during the lifetime (T) cannot exceed the initial energy of the node. With this formulation, the routing is dynamic and allows multipath communications. There is no assumption on fixed-path routing, such as the shortest path routing. The above optimization problem can be easily converted into a linear programming (LP) problem.

Table I Simulation Parameters

Parameter	*Value*
Simulation Area	100*100
Probability of a node to become cluster head	0.05
Initial energy	0.5j
Base station	50*50m
Transmitter/Receiver Electronics	50 nJ/bit
Number of nodes	100 & 300
ε_{fs}	10 pJ/bit/m^2
ε_{mp}	0.0013 pJ/bit/m^4

Without losing generalization all simulations are evaluated in the same conditions using MATLAB. We consider in first a wireless sensor network with N=100 and n=200 nodes randomly distributed in a 100m x 100m field. We assume that the base station is fixed in the center of the sensing region. To compare the performance of PC-LEACH with other protocols, we ignore the effect caused by signal collision and interference in the wireless channel. Each

Sensor node is assumed to have an initial energy of 0.5 joules. The network is organized into a clustering hierarchy, and the cluster-heads execute fusion function to reduce correlated data produced by the sensor node within the clusters. The radio parameters used in our simulation are shown in Table 1. To avoid the frequent change of topology, we assume that the nodes are in static mode; the protocol compared with LEACH.

In this section we start to introduce our approach with immobilize sensors.

C. Proposed Algorithm

- The base station (BS) initiates the routing process.
- Election a cluster-head in first round with min distance with the base station.
- Election a cluster-head in second round with min distance with the first elected cluster head and generate this process with iterative procedure until to achieve the final cluster head (Figure.3)
- Repeat the iterative process until drain energy of all sensors
- After selection of the head. Wait for member nodes.
- Create the table TDMA and sent it to members.
- Launch of the transmission phase.

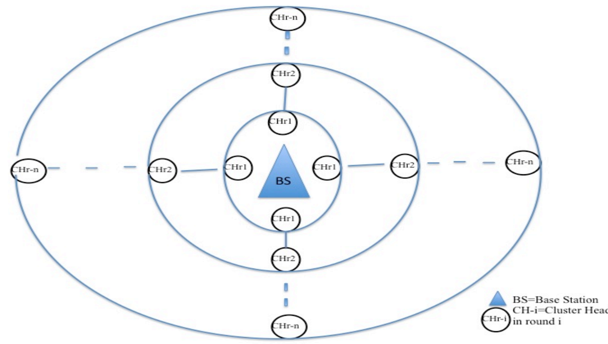

Fig. 3. The process of the elected cluster head of PC-LEACH

III. Simulation Results

The results presented in this section show significant improvements on the maximum energy consumption and the stability of network, at the expense of a little degradation of the PC-LEACH that will be more explain.

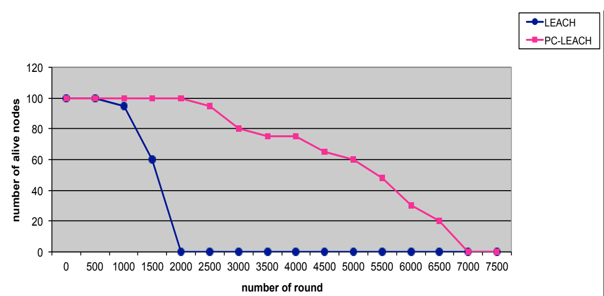

Fig. 4. Simulation rounds vs lifetime (100 nodes)

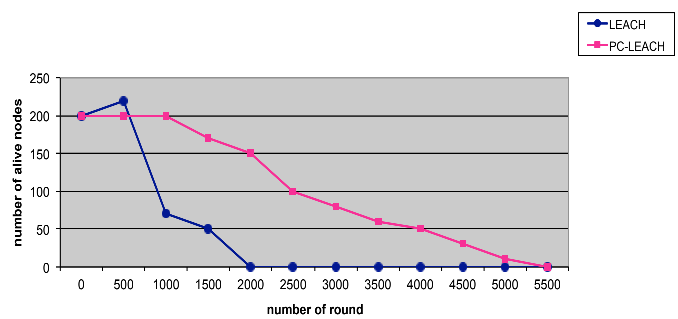

Fig. 5. Simulation rounds vs lifetime (300 nodes)

It is observed from the graph in fig.4 that the performance of our protocol compared to LEACH in terms of the number of alive nodes, the entire node remains alive for 1125 rand, while the corresponding numbers for LEACH are 860. This is because LEACH treats all the nodes without discrimination. PC-LEACH has longer stability period than LEACH just because of discriminating nodes according to their distance with the base station. Besides between the two approaches with density of 300 fig.5, our schemes have also an important stability of network lifetime than LEACH.

Table 2 shows the results of the average number of packets sent by CHs. For LEACH, the number of set packets is very weak, it represents, in fact, the number of CHs devided by the number of nodes. Indeed, each CH sends its data directly towards the BS. LEACH used the topology without take into consideration the distance between nodes. This strategy can increase the energy consumption in the transmission phase. For DMNE and PC-LEACH the Shortest-path procedure, the values measured are higher due to the routing multihop which involves the sending and the reception of the same packet several times to arrive to the BS. The results show that PC-LEACH support packets grater than LEACH and Distance Messages Energy (DMNE) [12].

NodesNumber / *Protocols*	*50*	*100*	*150*	*200*
LEACH	5	6	6	6
DMNE	45	100	146	187
PC-LEACH	74	123	167	203

Table 2. Average Number of transmited packet to CH

IV. CONCLUSION

This paper presents one new energy efficient WSNs routing algorithm EEPC based on minium distance between clusters to construct clusters. Simulation shows: by optimizing cluster distribution, EEPC can reduce the node energy consumption and improve the network lifetime. Especially in the situation that nodes are distributed randomly and BS is placed in the center of the sensing region, EEPC performances better. We hope, the result of this paper would support other works to propose solutions in making sensors networks even more reliable and efficient. Others parameters will be studied mobility in the future work.

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