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Enhancing Lifetime of Wireless Sensor Networks Using LEACH Protocol

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Abstract:
Wireless sensor networks (WSNs) are considered as one of the most important and essential technologies in today's environment. WSNs sustain a bridge between the real physical and virtual worlds. Sensors nodes can be deployed in hostile environment where there is no access of human beings. However, sensor nodes rely on battery power and it becomes a difficult task to replace the battery in such an environment. Hence, in light of this it becomes very important task to improve the networks energy. To overcome this problem, a routing protocol was proposed. This is known as Low Energy Adaptive Clustering Hierarchy (LEACH). The implementation of this protocol is done by the use of MATLAB. This document focuses on enhancing the lifetime of the sensor node in Wireless Sensor Networks using the LEACH protocol.

Keywords: *Wireless sensor network, leach, MATLAB*

1. Introduction

A Wireless sensor networks are the product of spatially allocated self-governing sensors used to monitor environmental or physical ailments, such as temperature, nausea, pain etc. They compliantly forward the collected data to the main position through WSN network. The ever-growing domain of WSN combines the communication and collected data into an individual small pots. To extend the reach of data network out into the real world, advanced *Mesh Networking Protocols* are used so that the devices are used in the form of sea of connectivity. All the possible communication paths are then quickly passed from one node to another in search of its destination by using the mesh networking connectivity, while the combination of hundreds of devices offers native new mechanical possibilities, However, the competencies of any individual device remains the minimum. The perception of Wireless Sensor Networks is built on an ordinary mathematical statement:
Thousands of potential applications = Sensing + CPU + Radio [1].

The potentials of wireless sensor network are direct combination of modern technology. The comprehensive analysis of the both competence and constraints of each of the hardware components, and also the in-depth understanding of contemporary networking, know-hows and distributed systems theory are essential for combining sensors, radios, and CPU's into an effective wireless sensor network. In order to fulfill this commitment of size, cost and power consumption every singular node needs to be planned to deliver a set of primitives which are compulsory for creation of anorganized web that will materialize as they are installed.
There will be an interior test to sketch the whole process requisite down to each single device competences, needs and actions.

2. Wireless Sensor Network

A wireless sensor network maintains a link between the real physical and virtual worlds and allows the capability to detect an earlier intangible at a reasonable declaration above a sizeable spatio-temporal scale.WSN can provide a huge collection of promising apps to the businesses, commerce, science, transportation, civil infrastructure and security. Building network is energetic and user-friendly way to organize WSNs. Cluster head is used to transfer the data collected by the nodes in its cluster. This will also combine and condense the data before forwarding it to the final destination butendsup with huge loss of energy at the cluster heads. LEACH is the widely used clustering mechanism that can be explained by the likelihood of alternating the role of cluster head between all the nodes. The functioning of the network could be very slow in speed or miles away from the peek output unless each node participates in the fitting role of a cluster head. This paper mainly focuses on enhancing the lifetime of WSN using LEACH protocol [3][4].A wireless sensor network is a framework that disposes multiple agents for the collection and is a flexible, robust, and distributed solution to the data collection problem. Agents carry and accumulate the data being sensed. These agents are disposed such that the sensed data is collected within a time, and the energy utilized is minimized. Distinct from the basic flexibility and load distribution capabilities, we will provide a high degree of robustness. In case of WSNs efficient use of energy is very important research area while maximizing accuracy of data sensing & aggregation. Avoiding the transfer of raw data can save 90 percent of the data transfer time. While tracking

is an object, we can visit and fuse the data with high signal strength from the sensor nodes. This will result in increasing the lifetime of the sensor network and reducing the energy consumption.

3. Routing Protocol

A routing protocol helps understand the way routers interconnect/converse with each other, disseminate the information to permit and select routes between any two nodes on a computer network. Exclusive routes can be determined by applying routing algorithms. Every router has the prior information only for its neighboring network. Routing protocols of WSN are classified as data-centric, hierarchical, and location-based and QoS based routing protocols. Hierarchical protocols are energy efficient routing protocols, which help reduce the energy consumption in WSN [5].Hierarchical routing protocols are also known as cluster-based routing protocol. The additional benefits related to scalability and resourceful communication is provided by these protocols. This concept of routing also helps to enhance and perform energy efficient routing in WSNs. LEACH is widely used clustering hierarchical routing protocols in WSN [6].

3.1. LEACH (Low Energy Adaptive Clustering Hierarchy protocol)

LEACH is a hierarchical protocol allows majority of the nodes to broadcast data to the cluster heads and these cluster heads combine and compress the same to pass it to the base station. The node uses a stochastic algorithm at each round to determine if the node will become cluster head in the given round. LEACH assumes that each node has a radio powerful enough to reach the base station, however, there is a possibility of a loss of potential energy if LEACH is utilizing this radio at full power all the time [2].Anode cannot become cluster head again for P rounds (where P stands for the desired percentage of the cluster heads) once it has officiated as a cluster head [14]. Hence, each node has 1/P probability of becoming a cluster head again in each round [9]. Every un-successful node not being able to convert to cluster head selects the nearest cluster head and joins that cluster at the end of each round. In the next step, the cluster head designs a program for each node in its cluster to transmit the data. The cluster heads originate the schedule for all the nodes that are not the cluster heads and only connect with the cluster head in a TDMA fashion. This is done by the use of minimum energy requirements to reach the cluster head and only required to keep their radios on during its time slot. LEACH uses CDMA to make sure each cluster uses a different set of CDMA codes. This helps LEACH to diminish the obstruction between the clusters [13].

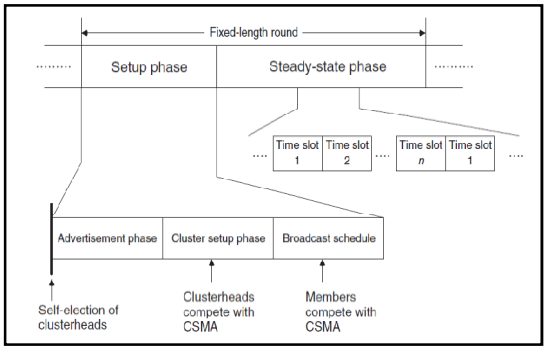

Figure 1

The LEACH network has two phases: The set-up phase and the steady-state [7].
The Set-Up Phase – Where cluster-heads are chosen
Each sensor chooses a random number m between 0 and 1
If $m<T(n)$ for node n, the node becomes a cluster-head where

$$T(n)=\begin{cases}\dfrac{P}{1-P[r*\bmod(1/P)]} & if\ n\in G\\ 0 & otherwise,\end{cases}$$

P: the desired percentage of cluster heads
r: the round number
G: the set of nodes that have not been cluster heads during the last 1/P rounds
A cluster head advertises its neighbors by a CSMA MAC

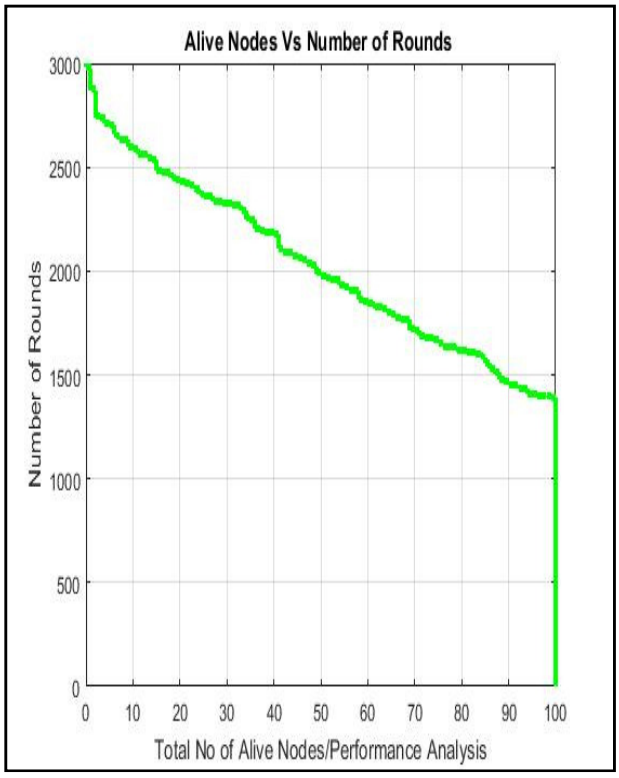

Figure 2

[10]. Neighbor nodes then choose a cluster to join, based on the signal strength of these messages.
Cluster heads assign a TDMA schedule for their members [8].

The Steady-State maintains the cluster head and transmits data between the nodes. In the steady phase, the nodes which are not the cluster heads, becomes sensor nodes and start sensing the data using the TDMA schedule and transmit the data to their cluster head. Data is aggregated and sent to the base station once received from its member nodes.
The process is repeated after some time and the network again goes to the setup phase and selects the new cluster heads [11].
Each cluster communicates using the CDMA schedule to reduce the interfaces from nodes which belong to the other clusters
[12]. In order to minimize the overhead, duration of steady phase is longer as compare to setup phase.

4. Stimulation Result

MATLAB is used to do the simulation. Let us assume 100 sensor nodes having the heterogeneous sensor network and base station is located at the centre. The minimum probability of the cluster head (pmin) is set as 0.1 and initial energy given to each node E0 is 0.5. The simulation parameters are detailed in table 1.

Parameters	Values
No. of nodes	100
Sink (base station)	(50,50)
Eamp	0.0013*0. 000000000001
Data Aggregation Energy, EDA	5nJoul
Initial Energy, E0	0.5
No. of rounds, r	3000

Table 1: Simulation Parameters

In the above figure simulation is carried out with the location of the BS, at (x = 50; y = 50) inside the sensing field. With the increase of number of rounds, number of alive nodes decreases due to power consumption.

5. Conclusion

In this paper MATLAB is used for simulation. The simulation of all the parameters is based on the widely used energy efficient clustering algorithm for WSNs called LEACH algorithm. Threshold equation is used for the calculation of energy of all the nodes. The performance of LEACH protocol is evaluated in relation of number of alive nodes. With this simulation the life time of LEACH protocol is revealed, as the number of rounds increases, due to power consumption number of alive nodes decreases.

6. Nomenclature

Wireless sensor networks (WSNs)
Low-Energy Adaptive Clustering Hierarchy (LEACH)
Time division multiple access (TDMA)
Code-Division Multiple Access *(*CDMA)

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