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ENERGY EFFICIENT ROUTING PROTOCOLS FOR ENHANCING NETWORK LIFETIME OF WIRELESS SENSOR NETWORKS

KEYWORDS: Sensor nodes, Routing Protocols, Network Structure, Protocol Operation, Energy Efficiency

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ABSTRACT *WSNs consists of small devices called sensor nodes having the capability of sensing the environment around them, computation the task, like gathering, storing, transmitting information, and performing wireless communications. Nowadays the main area of interest amongst researcher is the development of energy efficient algorithm in WSNs, so that the lifetime of sensors is enhanced. Since energy awareness is an essential design issue, many routing protocols have been proposed for WSN based on network structure and protocol operation. In this paper, I review only hierarchical-based routing protocol, like LEACH, PEGASIS, TEEN/APTEEN etc, and present a proposed algorithm for WSNs from the recent work and compare it with LEACH regarding lifetime of the network.*

INTRODUCTION

The Wireless Sensor Networks (WSNs) requires an enormous breadth of knowledge from an enormous variety of disciplines, so its study becomes challenging [1]. It is one of the most interesting research areas with profound effect on technological developments [2]. A wireless sensor network basically consists of small devices called sensor nodes having the capability of sensing the environment around them, computation the task, like gathering, storing and transmitting information, and performing wireless communications with other connected nodes in the network.

The sensor node having several components: a transmission unit, a processor /storage unit, sensing unit, and a power unit. *In transmission unit*, the transmission media includes radio frequency, optical communication and infrared. The radio transceiver has functionality of both transmitting and receiving tendency. *In the processor/storage unit*, two major components are processor like microcontroller and storage device like memory. *In the sensing unit*, two major components are sensor and analog-to-digital converter (ADC). *In the power unit*, the sensor node consumes power of usually a battery. Applications of WSNs are found in many fields.

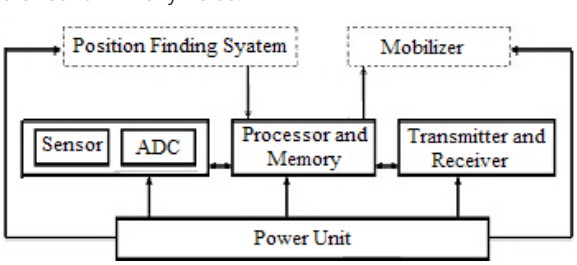

Figure 1 Wireless sensor network components

It plays an important role in military, home, health and environment application. Even WSNs have innumerable applications; these networks have several restrictions, such as limited energy supply, limited computing power, and limited bandwidth of the wireless links connecting sensor nodes. The main design goal of WSNs includes node deployment/heterogeneity, fault tolerance, scalability, transmission media, connectivity, coverage, data aggregation, etc.

The routing protocols which are used in WSNs are unique from the protocols used in other fixed networks [3]. The topology of sensor network changes very frequently even sensor nodes are prone to failures [4] and densely deployed. Since energy awareness is an essential design issue, different routing protocols have been proposed for WSNs based on network structure. In general, based on network structure, routing protocols in WSNs can be divided into flat-based, hierarchical-based, and location-based routing.

In this paper, I focus my review on only hierarchical-based routing protocol and proposed another algorithm for routing protocol in WSNs based upon the LEACH. In section 2 of this paper, I describe some problems and review of the literature. In section 3, I described the proposed algorithm. Finally, in Section 4, I present the results and their analysis.

II. PROBLEMS DEFINED AND LITERATURE REVIEW

The main issues in WSN are protocol design followed by localization scheme, data aggregation, synchronization, battery energy consumption and security technologies. As we know, each node plays important role in a network like, routing node roles and terminal node role. Since a node becomes dead when its battery power runs out of threshold value, means it cannot participate in a network. Due to these dead nodes network partitions occurs so, usual communication becomes impossible in that sensor network. Hence, the significant importance of WSNs is to develop an efficient battery-power management to increase the network lifetime [5]. Nowadays researchers showed their interest in routing protocols in network layer, in order to conclude self-organization capabilities, data aggregation schemes and limited battery power [6, 7].

Hierarchical-based routing protocol is based on cluster. In a cluster based routing protocol, sensor nodes are partitioned into a set of groups, called clusters. In each set of group, a cluster head (CH) is selected, which collects data from normal nodes, completes data aggregation process, and sends them to the sink node. Some of the cluster based routing protocols in WSNs are reviews below:

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A. LEACH (Low-Energy Adaptive Clustering Hierarchy)
LEACH [8] is the first and most popular energy-efficient algorithm that was proposed for reducing power consumption. It is a cluster-based protocol that integrates the cluster formation, whose performance is based on rounds. A CH is selected among the sensor nodes in each round whose main role is to compress data and send an aggregated packet to the BS. The operation of LEACH is divided into two phases, namely the steady state phase and the setup phase. The real data transfer to the BS is taking place in steady state phase while CH selection and the clusters are systematized in setup phase. When the CH is defined in the setup phase, it establishes a TDMA schedule for the transmissions in its cluster [9]. This process will save more energy because the transmissions will only be done by such CHs rather than all sensor nodes.

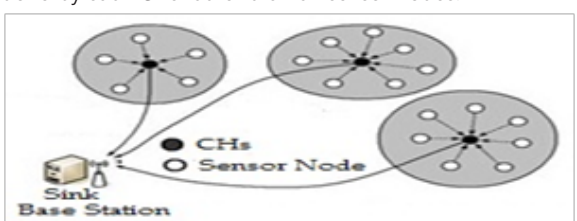

Figure 2 LEACH routing protocol

B. PEGASIS (Power-Efficient Gathering in Sensor Information Systems)
PEGASIS [10], forms chains from sensor nodes rather than dividing nodes in cluster, so that each node transmits to and receives from a nearest node of its neighbor and from that chain only one node is selected to transmit data to the sink (BS). The data gathered is aggregated by node and forwards it from node to node in the chain which communicates with the BS. A greedy algorithm chain construction performance is found in PEGASIS [7].

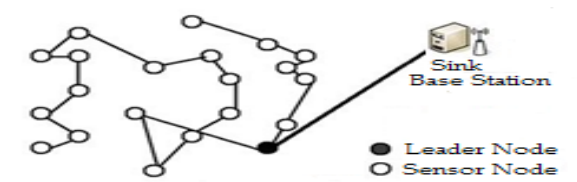

Figure 3 PEGASIS routing protocol

It avoids cluster formation and instead of using multiple nodes, it uses only one node in a chain to communicate with the BS. In LEACH all neighbors send data directly to its CH but in PEGASIS a sensor transmits to its local neighbors in the data fusion phase.

C. Threshold Sensitive Energy Efficient Sensor Network Protocol (TEEN) and Adaptive TEEN
In TEEN [11], the CHs send a hard and soft threshold value of an attribute to trigger a sensor node. It allows the nodes to transmit data only when the sensed attribute is in the range of concern, so number of transmission is reduced. When a node senses at the hard threshold it transmits data in the present cluster period if the hard threshold value is less than present value of the sensed attribute, and the sensed value differs from present value of the sensed attribute by an amount equal to or greater than the soft threshold. Soft threshold also reduce the number of transmission if there is a little or no change in the value of sensed attribute. Thus in both strategy energy reduce transmitting messages is occurred. Figure 4 Hierarchical protocol clustering in TEEN and APTEEN

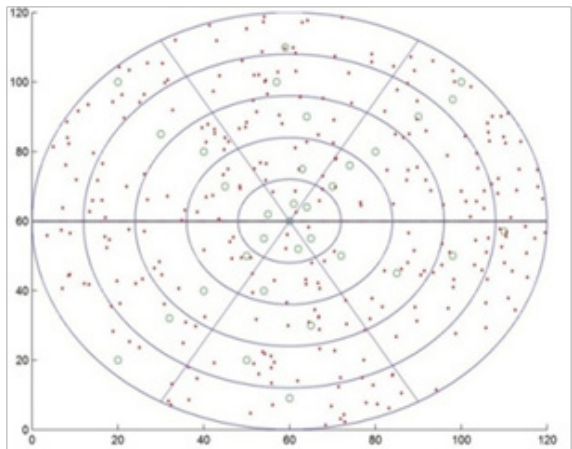

Figure 4 Simulation topology showing CH selection

changes the threshold value or the periodicity which are used in TEEN according to the application. It aims at both capturing periodic data collections (LEACH) and reacting to time-critical events (TEEN) [12]. It allows the sensor to send their transmitted data periodically and react to any change in the sensed attribute by sending the corresponding values to their CHs. In APTEEN, CHs broadcasts four different parameters, namely Attributes, Thresholds, Schedule and Count Time.

III. PROPOSED ALGORITHM
In this paper, I described a grid-clustered routing protocol based upon the LEACH algorithm, which considers a residual energy of sensor nodes to avoid unbalanced energy consumption of the sensor nodes. Without additional overhead of LEACH, this proposed algorithm can lead to node energy consumption balance and extend overall network lifetime without performance degradation. To increase the lifetime of the networks, the proposed algorithm uses a cost parameter. The following formula shows the computation of the cost parameter for a CH.

Cost Parameter $\alpha = e/d$.....(1)

Where d is the distance between the node and the base station. e is the energy of the node. α with largest value is selected as CH.

A. Methodology
The methodology of above proposed algorithm is summarizing in the following steps:

1. Deployment random nodes in X-axis and Y-axis.
2. Rectangular and Circular grid formation.
3. Grid comprises of various nodes having their varying power.
4. CH among these nodes is selected according to equation (1).
5. In each sub circular-grid CH is responsible for aggregation process until its energy is above threshold value.
6. In this way, the aggregated data is transmitted through source to sink (BS) via the CH.
7. When CH in a particular route die or below the threshold energy, new CH is elected to replace the old node.
8. Hence the process continues up till the data has to send to the BS.

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B. Performance Evaluation

The performance analysis of routing protocols is evaluated with the MATLAB. Then our proposed protocol is compared to the LEACH algorithm in terms of the network lifetime, which is shown in section 4.

IV. RESULTS

From the analysis of LEACH and the new proposed algorithm, the results are shown below.

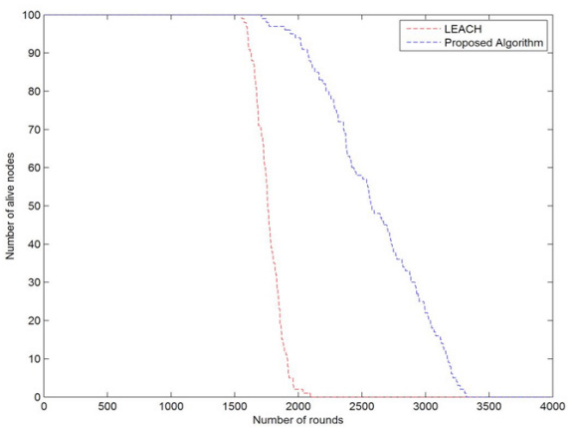

Figure 5 Graph represents the comparison between lifetime of LEACH and the proposed algorithm

V. CONCLUSIONS

Nowadays we will start to see the widespread deployment of WSNs in which routing is a significant issue. In this paper, I proposed a cluster based routing protocol that considers the cost parameter to extend the lifetime of sensor networks. Based upon the MATLAB simulation, we compare two routing protocols for WSN with different number of round. With the results of trace graph, I conclude that in the case of new proposed algorithm the lifetime of CH become maximize with respect to LEACH.

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