Hierarchical Routing Algorithm to Improve the Performance of Wireless Sensor Network

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***Abstract*---Wireless Sensor Networks (WSNs) consists of small nodes with sensing, computation and wireless communications capabilities. Evolution in wireless sensor network has broadened its pervasive and ubiquitous applications in numerous fields. These applications often require accurate information collecting as well as uninterrupted, prolonged active service. Routing protocols have significant impact on the overall energy consumption of sensor networks. Suitable energy-efficient routing algorithms are required to the inherent characteristics of these types of networks are needed. Due to resource limitations in wireless sensor networks, prolonging the network lifetime has been of a great interest. Most of the energy of sensor nodes is utilized for transmission of data to the base station. Thus, it makes them to deplete their energy much faster. In this paper, hierarchical Clustering approach is used along with a fixed base station to reduce the energy consumption of cluster heads to enhance the lifetime of the network. The proposed scheme also shows improvement in performance of WSN compared to other routing scheme.**

Keywords- wireless sensor network, cluster head, base station, routing protocols.

I. INTRODUCTION

Recent advances in Micro-Electro-Mechanical Systems (MEMS) in tandem with significant developments in digital signal processing (DSP) have led to the great development of micro-sensors. While in the past the wired sensors were implemented in limited applications in industries, wireless implementation makes the wide deployment of sensor nodes more feasible than before. In the past decade, there has been much research regarding the great potential capabilities of wireless sensor networks (WSNs) in applications such as environmental monitoring, habitat study, military surveillance in the battlefield and home automation. With sharp decreases in cost and tangible improvements in storage and processing capabilities of sensor nodes, the integrated presence of sensor nodes in human everyday-life, as the connector of the physical environment with virtual digital world, will be dominant in near future. Vast deployment of nodes on large-scale dimensions entails deep investigation on routing protocols to ensure reliable and real-time data transmission, while considering the power constraints inherent in WSNs. Because of their flexibility, efficiency, low-cost, and ease of deployment, WSNs are gaining attention and expanding their domain of applications. Unlike traditional and electrically-powered wired computer networks, a WSN comes with a unique set of resource constraints such as finite on-board battery power, limited processing ability and constrained communication bandwidth. Moreover, a typical WSN is expected to work without human intervention for a long time period. WSN contains hundreds or thousands of these sensor nodes which can be networked in many applications that require unattended operations, these have the ability to communicate either among each other or directly to an external base-station and also allows for sensing over larger geographical regions with greater accuracy[1]. Sensor node comprises sensing, processing, and transmission, mobilizes, position finding system, and power units and also shows the communication architecture of a WSN. Each sensor node bases its decisions on its mission, the information it currently has, knowledge of its computing, communication, and energy resources and have capability to collect and route data either to other sensors or back to an external base station or stations which may be a fixed or a mobile node existing communication infrastructure or to the Internet where users have access to the reported data. These features present unique challenges to come up with new paradigms that can harness the benefits of numerous applications of WSNs. In this paper, Section II discusses cluster based routing techniques. Section III describes the clustering approach and Section 4 provides simulation results and discusses the efficiency of this proposed scheme. Finally, Section 5 gives the conclusion of the paper.

II. CLUSTER BASED ROUTING TECHNIQUES

The design space for routing algorithms for WSNs is quite large, and we can classify the routing algorithms for WSNs in many different ways. In general ,routing in WSNs can be classified into flat-based routing, hierarchical-based routing, and location-based routing depending on the network structure. In this paper the second type hierarchical- or cluster-based routing protocol technique is proposed. A hierarchical routing protocol is a natural approach to take for heterogeneous networks where some of the nodes are more powerful than the other nodes, that is, the higher-energy nodes can be used to process and send the information, while lower-energy nodes can be used to perform the sensing in the proximity of the target. The main

aim of the hierarchical routing is to efficiently maintain the energy consumption of sensor nodes involved in communication within a particular cluster which performs data aggregation and fusion in order to decrease the number of transmitted messages to the sink (base station) as shown in figure 1.

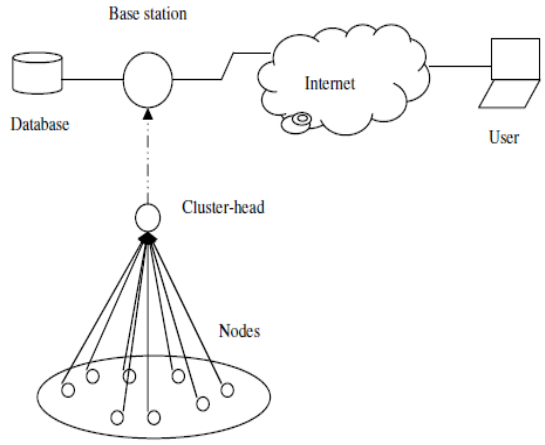

Figure 1: WSN Architecture.

Cluster formation is typically based on the reserve of sensors and sensor's proximity to the cluster head. In these protocols, different nodes are grouped to form clusters and data from nodes belonging to a single cluster can be combined (aggregated).The clustering protocols have several advantages like scalable, energy efficient in finding routes, and easy to manage[2].A typical Wireless Sensor Network's architecture is shown in figure 1. All the sensor nodes in one cluster send their sensed information to the elected respective cluster-heads; the cluster-head in turn integrate or aggregate and then compress the sensed data and transmit directly it to the base station[5]. The lifetime of a sensor network can be extended by applying different techniques. For example, energy efficient protocols are aimed at minimizing the energy consumption during network activities. However, a large amount of energy is consumed by node components (CPU, radio, etc.) even if they are idle. In order to Prolong the life of a WSN A number of algorithms, strategies and approaches have been formulated based on routing algorithms to optimize (reduce) the energy dissipation of nodes in WSN. LEACH, PEGASIS, TEENAPTEEN are some of hierarchical routing protocols. In this cluster based routing techniques, LEACH the most popular energy-efficient hierarchical clustering algorithm is proposed for reducing the power consumption. Each cluster is managed by a special node called cluster head (CH), which is responsible for coordinating the data transmission activities of all sensors in its group. Cluster heads in turn transmits the sensed data to the global sink. The operation is divided into rounds, each has two phases: (i) setup phase and (ii) the steady state phase. In the setup phase, the clusters are organized and Cluster Heads (CHs)are selected. Each sensor generates a random number between 0 and 1. If this number is less than threshold T(n) defined by equation (1), then sensor n would be selected as a cluster head [6].

$$T(n)=\begin{cases}\frac{P}{1-P*(r \bmod 1/p)} & \text{if } n \epsilon G \\ 0 & \text{Otherwise}\end{cases} \quad (1)$$

where, P is the desired percentage of cluster heads, r is the current round and G is the set of nodes left after cluster head election, that is, in the last 1/P rounds. LEACH enables data fusion in each cluster by aggregating the data in order to reduce the total amount of data and then sends them to the sink. The sensors within a cluster transmit their sensed data over short distances, whereas cluster heads communicate directly with the sink.

III. THE PROPOSED SYSTEM

In this method, a clustering approach is implemented; a node which is at equal distances from all other nodes in the cluster is elected as the cluster head. According to the algorithm proposed, the base station and sensor nodes are stationary. Distance can be calculated based on the wireless radio signal strength. Cluster-based routing is an efficient way to reduce energy consumption and extend network lifetime within a cluster. The number of messages transmitted to the base station is reduced by data aggregation and fusion, which reduces the overall energy consumption in each rounds. Cluster-based routing is mainly implemented as a two-layer strategy: one layer is used to select cluster heads, and the other layer is used for routing. High-energy nodes can be used to process and send information, whereas low-energy nodes can be used to perform sensing in close proximity to the target. The clustering algorithm is based on cluster selecting, which incurs an additional energy cost.

In this paper, we assume a simple model where the radio dissipates $Eelec$= 50nJ/bit to run the transmitter or receiver circuitry and E_amp = 100 pJ/bit/m^2 for the transmit amplifier to achieve an acceptable energy E_0. These parameters are slightly better than the current state-of-the-art in radio design. We also assume an r_2 energy loss due to channel transmission. Thus, to transmit a k-bit message a distance d using our radio model, the radio expands:

$$E_{Tx}(k,d) = E_{Tx-elec}(k) + E_{Tx-amp}(k,d) \text{--------} (1)$$

$$E_{Tx}(k,d) = E_{elec} * k + \in_{amp} * k * d^2 \text{----------} (2)$$

and to receive this message, the radio expands:

$$E_{Rx}(k) = E_{Rx-elec}(k) \text{----------} (3)$$
$$E_{Rx}(k) = E_{elec} * k \text{----------} (4)$$

For these parameter values, receiving a message is not a low cost operation; the protocols should thus try to minimize not only the transmit distances but also the number of transmit and receive operations for each message.

IV. SIMULATION RESULTS

In this section, we evaluate the performance of proposed algorithm in MATLAB simulator.100nodes are randomly distributed in a 100 x 1 00 m^2network. Base station is deployed at (110,110). Cluster head is selected for each cluster and energy consumed for each transmission is calculated. Remove the dead sensor. We compare our proposed algorithm with LEACH, in networks Lifetime, Residual energy of the network. Lifetime is considered as the time when the first node dies.

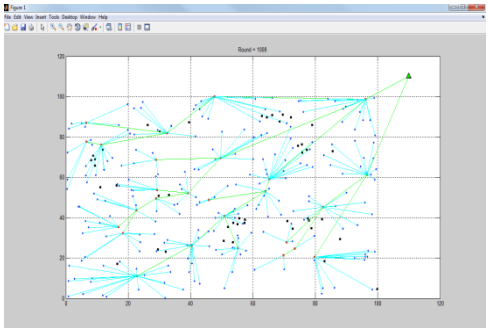

Figure 2: Fixed Base Station Based WSN with sensor nodes at different stage.

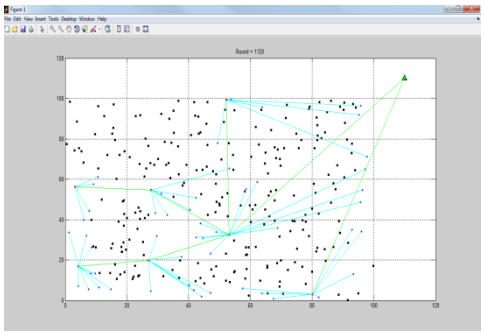

Figure 3: Fixed Base station WSN with dead sensor nodes

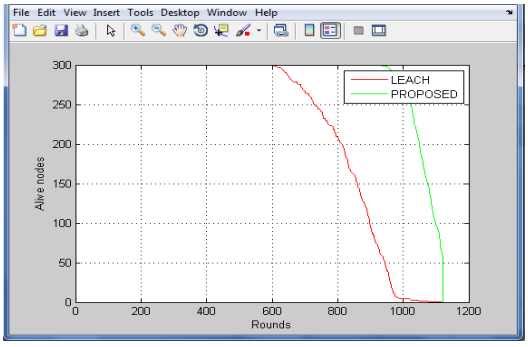

Figure 4: Evaluation of number of alive nodes vs Rounds.

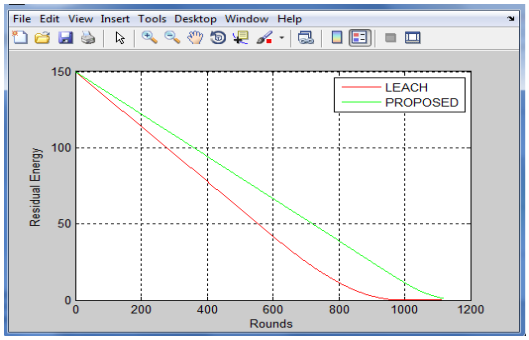

Figure 5: Evaluation of energy consumption

Figure 4 & 5shows the number of alive nodes and residual energy during the operation of the network in rounds. Sensors start dying after 1200th round which indicates the improvement of the network lifetime.

V. CONCLUSION AND FUTURE WORK

Power consumption is an important factor for network lifetime in wireless sensor networks. In clustering hierarchy, the cluster head decision is a major challenge. If network is taken as a whole, then the power consumption can be optimized by the rotation of this cluster head inside the individual clusters. In this report, a new technique is proposed to select cluster head among some of the wireless sensor nodes based on net distance with base station. The proposed technique resulted in the increased lifetime of the whole network, and increased the number of nodes, which will remain alive for the maximum period of time.

Future works in routing techniques focus on different directions. In comparison with the above mentioned routing protocols, the energy consumption is high in the LEACH algorithm when compared to the proposed algorithm. There is a need to decrease the energy consumption of the every sensor node. Also, prolonging the network lifetime has been of a great interest due to resource limitations in wireless sensor networks.

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