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ENHANCEMENT OF THROUGHPUT DEEC ROUTING PROTOCOL

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ABSTRACT

Wireless sensor network is composed of hundreds and thousands of small wireless sensor nodes which collect information by sensing the physical environment. The sensed data is processed and communicated to other sensor nodes and finally to Base Station. So energy efficient routing to final destination called base station is ongoing current requirement in wireless sensor networks. Here in this research paper we propose a multi-hop DEEC routing scheme i.e. G-DEEC for heterogeneous networks where we deploy rechargeable intermediate nodes called gateways in-between cluster head and base station for minimizing energy consumption by sensor nodes in each processing round thereby increasing the network lifetime and stability of wireless sensor networks unlike DEEC.

Keywords: *Wireless Sensor Networks, Heterogeneous Protocol, Gateway, DEEC, Energy Consumption.*

I. INTRODUCTION

Recent advancement in wireless communication and electronics has enabled the development of low-cost, low-power multifunctional miniature devices for use in remote sensing applications. Such sensors can be widely deployed for commercial, civil and military applications such as surveillance, vehicle tracking, climate and habitat monitoring intelligence, medical and acoustic data gathering. A WSN is composed of large number of sensor nodes which consist of sensing, data processing and communication capabilities. Usually sensor nodes are scattered in the sensing field. They coordinate among themselves to get information about the physical environment. The information is routed to the Base Station either directly or through other sensor nodes. The BS is either a fixed or mobile node which is capable to connect the sensor network to the internet where user can access and process data.

The key challenge in sensor networks is to maximize the lifetime of sensor nodes due to the fact that it is not feasible to replace the batteries of thousands of sensor nodes. Therefore, computational operations of nodes and communication protocols must be made as energy efficient as possible. Area coverage and data aggregation [6] techniques can greatly help conserve the scarce energy resources by eliminating data redundancy and minimizing the number of data transmissions. Therefore, data aggregation methods in sensor networks are extensively investigated in the literature [6], [7], [8] and [9].

Considering the challenges of WSN many routing protocols have been already proposed for WSN. They can be classified into flat, hierarchical and location-based network routing. In flat routing all nodes are typically assigned equal roles or functionality. SPIN (Sensor Protocols for Information via Negotiation) [1] and DD (Directed Diffusion) [2] fall in this category. In hierarchical routing the network is divided into clusters to achieve energy efficiency. LEACH [5], TEEN [3], APTEEN [4] are well known hierarchical routing protocol. In location based routing exact position of a node is used to find the optimal routing path e.g. GAF (Geographic Adaptive Fidelity) [10] and GEAR (Geographic and Energy Aware Routing) [11].

1. Wireless Sensor Network

Wireless sensor networks are potentially one of the most important technologies of this century. Recent advancement in wireless communications and electronics has enabled the development of low-cost, low-power, multifunctional miniature devices for use in remote sensing applications. The combination of these factors have improved the viability of utilizing a sensor network consisting of a large number of intelligent sensors, enabling the collection, processing analysis and dissemination of valuable information gathered in a variety of environments. A sensor network is composed of a large number of sensor nodes which consist of sensing, data processing and communication capabilities.

2. Sensor Network Challenges

Wireless sensor network uses a wide variety of application and to impact these applications in real world environments, we need more efficient protocols and algorithms. Designing a new protocol or algorithm address some challenges which are need to be clearly understood [14]. These challenges are summarized below:

- ***Physical Resource Constraints:*** The most important constraint imposed on sensor network is the limited battery power of sensor nodes. The effective lifetime of a sensor node is directly determined by its power supply. Hence lifetime of a sensor network is also determined by the power supply. Hence the energy consumption is main design issue of a protocol. Limited computational power and memory size is another constraint that affects the amount of data that can be stored in individual sensor nodes. So the protocol should be simple and light-weighted. Communication delay in sensor network can be high due to limited communication channel shared by all nodes within each other's transmission range.

- ***Ad-hoc deployment:*** Node deployment in WSNs is application dependent and affects the performance of the routing protocol. The deployment can be either deterministic or randomized. In deterministic deployment, the sensors are manually placed and data is routed through pre-determined paths. However, in random node deployment, the sensor nodes are scattered randomly creating an infrastructure in an ad hoc manner. If the resultant distribution of nodes is not uniform, optimal clustering becomes necessary to allow connectivity and enable energy efficient network operation. Inter-sensor communication is normally within short transmission ranges due to energy and bandwidth limitations. Therefore, it is most likely that a route will consist of multiple wireless hops.

II. ROUTING PROTOCOL IN WIRELESS SENSOR NETWORK

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Energy-Efficient Routing Protocols in Wireless SensorNetworks: A Survey
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During the recent years, many energy efficient routing protocols have been proposed for WSNs. In the above paper author mention the following energy efficient routing protocol for wireless sensor network

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1) Data-centric protocols

In many applications of sensor networks, it is not feasible to assign global identifiers to each node due to the sheer number of nodes deployed. Such lack of global identification along with random deployment of sensor nodes makes it hard to select a specific set of sensor nodes to be queried. Therefore, data is usually transmitted from every sensor node within the deployment region with significant redundancy.

2) Sensor Protocols for Information via Negotiation

(SPIN) [25] is among the early work to pursue a data-centric routing mechanism. The idea behind SPIN is to name the data using highlevel descriptors or meta-data. Before transmission, meta-data are exchanged among sensors via a data advertisement mechanism, which is the key feature of SPIN. Each node upon receiving new data, advertises it to its neighbors and interested neighbors, i.e. those who do not have the data, retrieve the data by sending a request message. SPIN's meta-data negotiation solves the classic problems of flooding such as redundant information passing, overlapping of sensing areas and resource blindness thus, achieving a lot of energy efficiency.

III. PROPOSED PROTOCOL

1. Working of the protocol

A lot of simulation works / experiments are going on in the research field of WSN to make routing protocols more and more energy efficient. Here, we propose a modified version of DEEC called Improved DEEC that can increase energy efficiency than original LEACH. The basic concept involved in increasing energy efficiency is to keep radio communication distance as minimum as possible [42]. The popular technique used to minimize communication distance is the formation of clusters between nodes rather than direct communication [42] but as the distance

between the CH and BS go beyond a certain level single hop communication concept of DEEC routing protocol is not suitable. For this we propose Heterogeneous Multi-hop LEACH routing protocol to increase the energy efficiency of WSN.

As we mentioned earlier, DEEC considers all sensors in the network have the same amount of initial energy i.e. they are homogeneous with respect to energy which is not realistic approach. So the nodes which directly communicate with the BS (i.e. the CHs) will die earlier than the normal cluster member nodes, decreasing the overall lifespan of the network. To make the network more energy efficient we classify the sensors into three types: normal node, intermediate node and advanced node depending on their initial energy level. The advanced node has the highest energy level while the normal node possesses the lowest level of energy. The normal nodes will be the cluster members. They send their data to their CH which will be elected from the group of intermediate nodes. The procedure used to select CH is same as that of DEEC . The intermediate nodes will also sense data from the environment. They will aggregate the sensed and received data and either send it to one of the advanced nodes located nearer to BS or send directly to the BS if no such advanced node is found. The advance node communicates directly with the BS. It also senses data and aggregates all the data it received from different intermediate nodes with its own data. Finally it transmits the data directly to the BS.

2. Energy Efficiency of Proposed Protocol

Our proposed algorithm provides better connectivity and successful data rate as compare to DEEC. The reason behind this enhancement is multi-hop communication adopted by cluster-heads. As member nodes save energy by sending data to cluster-head in LEACH instead of Base station, similarly in Improved DEEC cluster-head at longer distance from Base station transmit data to advanced nodes closer to the Base station instead of direct transmission to Base station. It is more effective energy efficient routing protocol when network diameter is larger. Energy efficiency of Improved DEEC can be better elaborate with the example of linear network having two cluster heads A and B which are communicating to Base station. A is at a distance 'm' from B and B is at a distance m from the Base station.
In order to calculate the transmitting energy cost of cluster heads A and B, which are directly transmitting to Base station will be [42]:

$$E_{dirAB} = E_{eleTX} \text{ X } L_A + E_{amp} \text{ X } L_A \text{ X } 2m^2 + E_{eleTX} \text{ X } L_B + E_{amp} \text{ X } L_B \text{ X } m^2$$

Where E_{dirAB} is total energy cost of cluster-heads A and B, L_A is aggregated data transmitted by cluster-head A and L_B is aggregated data transmitted by cluster-head B towards Base station and m is equal distance among cluster heads and Base station. This happens in case of LEACH when every cluster-head has to communicate directly to Base station.

Similarly total transmitting energy cost can also be calculated when multi-hop communication is taking place. Our proposed protocol utilizes multi-hop communication. In this linear network if cluster-head A transmits data to B instead of Base station then B has to transmit not only its own data but also has to transmit cluster-head A's data to Base station.

$$E_{Multi\text{-}hop} = E_{eleTX} \text{ X } L_A + E_{amp} \text{ X } L_A \text{ X } m^2 + E_{eleRX} \text{ X } L_A + E_{eleTX} \text{ X } (L_A + L_B) + E_{amp} \text{ X} (L_A + L_B) \text{ X } m^2$$

3. Performance Analysis Of Energy-Efficient Routing Techniques In Wireless Sensor Network

For even moderately-sized networks with ten nodes, it is impossible to analytically model the interactions between all the nodes. Therefore, simulation was used to determine the benefits of different protocols. Computation and communication energy dissipation models as well as new MAC algorithms were implemented in matlab to support the design and simulation of the different protocol architectures. In this section DEEC is compared to the proposed algorithm in terms of system lifetime, energy dissipation and amount of data transfer.

- ***Simulation Setting***

A simulation environment is designed and implemented in MATLAB 7.10.0 in order to investigate the energy efficiency with lifetime extension of the mentioned protocol. We compare the proposed Modified Leach algorithm with Leach routing protocol. The simulation parameters used in the experiment is shown in Table 5.1. The nodes are randomly distributed between x=0, y=0 and x=100, y=100 with the base station (BS) at location x=50, y=50. BS and all sensor nodes are stationary after deployment. We consider packet size of 2000 bits. The simulation parameters are summarized in Table 5.1.

- ***Network lifetime***

It is the time interval from the start of the network operation till the last node die.

- ***Throughput***

To evaluate the performance of throughput, the numbers of packets received by BS are compared with the number of packets sent by the nodes in each round.

Table 3.1:Characteristics of the test network.

Parameter	Value
Network Size	100m * 100m
Number of nodes	100
Packet Size	2000 bits
Initial Energy	0.5 j
Number of rounds	5000
Transmitter Electronics (ETX)	50nJ/bit
Receiver Electronics (ERX)	50nJ/bit
Data Aggregation Energy	5nJ/bit

- ***Simulation Results***

The simulated protocols are briefly summarized here. In DEEC , nodes organize themselves into clusters using the distributed algorithm described in chapter 3.1. This protocol has the advantage of being distributed, self-configuring and not requiring location information for cluster formation. In addition the steady-state protocol is low-energy. However, the drawback is that there is no guarantee as to the number or placement of cluster-head nodes within the network and number of cluster members within a cluster.

Protocol	Rounds when nodes start dying	Rounds when all nodes are dead
DEEC	950	2550
Improved DEEC	2020	4680

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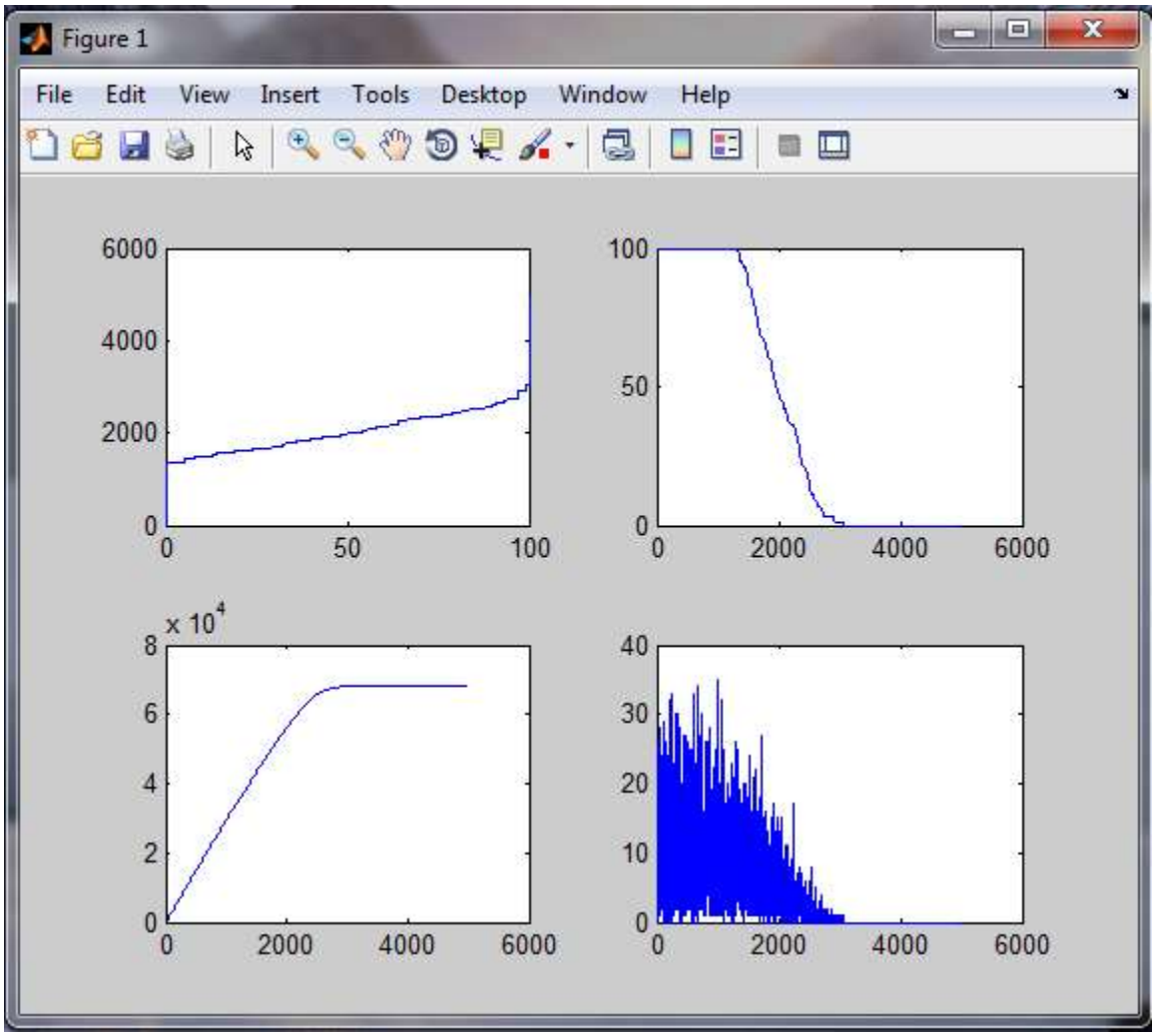

Fig 3.3.1 Threshold DEEC Output result.

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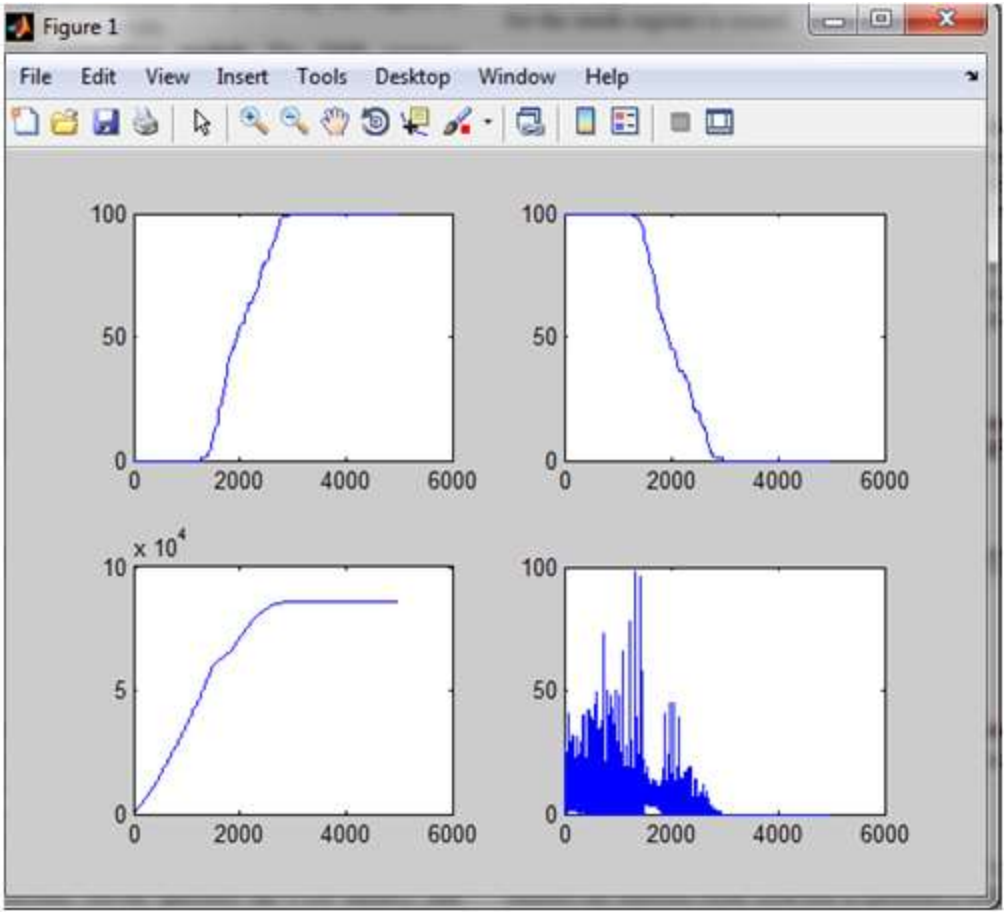

Fig 3.3.2 Improved DEEC Output.

IV. CONCLUSION

Use of the wireless channel is growing at an amazing speed. Advances in energy-efficient design have created new portable devices that enable exciting applications for the wireless channel. While the wireless channel makes deployment task easier, it adds constraints that are not found in a wired environment. Specifically, the wireless channel is bandwidth-limited, and the portable devices that use the wireless channel are typically battery-operated and hence energy-constrained. In addition, the wireless channel is error-prone and time-varying. Therefore, it is important to design protocol and algorithms for wireless networks to be bandwidth and energy-efficient as well as robust to channel errors. The work described in this dissertation shows an energy-efficient routing technique which is mainly suitable for application like environment monitoring where sensor nodes located in nearby region collect similar type of data.

V. FUTURE WORK

There is still much work to be done in the area of protocols for wireless micro sensor networks. The protocols described in this dissertation are for scenarios where the sensors have correlated data. However, there are important applications of wireless sensor networks where this is not the case. For example, sensor networks for medical monitoring applications may have different sensors located on and/or in the body to monitor vital signs. These networks will not be as large-scale as the ones discussed, but they will have similar requirements to the sensor networks discussed – long system lifetime, low-latency data transfers and high quality data. These networks will most likely focus on maximizing quality above all parameters and loss of information will not be acceptable. Therefore protocol architectures need to be developed to support the unique considerations of these networks.

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