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Enhancing Energy Efficiency Using Routing Protocol in Wireless Communication

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ABSTRACT

Wireless sensor Network (WSN) consists of spatially distributed autonomous sensor to observe physical or environment conditions like temperature, sound, vibration, pressure and glove pass their knowledge, facultative additionally to regulate the activity of the sensors. The event of wireless detector network was actuated by military applications like parcel of land surveillance: now days such networks are employed in several industrial and client application like process observance and management. The platforms we develop are used to validate a generalized architecture that is technology independent. Our general architecture contains a single Defined protocol that performs both application and protocol-level processing. But still there is a lot of scope of improvement and this can be done as per this dissertation also provide a little bit contribution towards the development of this particular field of wireless sensor networks.

Keywords: Wireless Sensor Networks, Proactive Networks, Reactive Networks, Hybrid Networks, Energy Efficient Protocol, LEACH, Dead Nodes, Alive Nodes.

I. INTRODUCTION

Wireless Sensor Network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, enabling also to control the activity of the sensors. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer application, such as industrial process monitoring and control, machine health monitoring, environment and habitat monitoring, healthcare applications, home automation, and traffic control.

The main characteristics of a WSN include

- Energy constraints for nodes using batteries
- Ability to cope with node failure
- Mobility of nodes
- Dynamic network topology
- Communication failure
- Heterogeneity of nodes
- Scalability to large scale of deployment
- Easy to use
- Ability to withstand harsh environment conditions

WSN represent a paradigm shift in wireless networks. They are being regarded as the enabling technologies for future surveillance-oriented application. A standard wireless sensor network consists of a large number of tiny sensor nodes[8]. A sensor node basically consists of the following modules:

- The sensing module that collects information from the environment.
- The communication module that sustains wireless data communication between nodes.

- The processing module that processes the information provided by the sensor module or received from neighbour nodes.

Applications of WSN:

- Area Monitoring Applications
- Environmental Applications
- Health Applications
- Industrial Applications

Classification of Wireless Sensor Network

A simple classification of Wireless sensor networks based on their mode of functioning and the type of target application is given below.

A) Proactive Networks

The nodes in this sort of network periodically switch on their sensors and transmitters, sense the environment and transmit the data of interest. Hence, they collect the data for the relevant parameters at regular intervals. They are well suited for applications requiring periodic data monitoring. Some known instances or protocols of this kind are the LEACH (Low Energy Adaptive Clustering Hierarchy) protocol[2] , some improvements on LEACH such as [3] and PEGASIS (Power-efficient gathering in sensor information systems) [4].

B) Reactive Networks

The nodes of the networks according to this scheme react immediately to sudden and drastic changes in the value of a sensed attribute. They are well suited for time critical applications. Typical instances of this sort of networks are -

C) Hybrid Networks

The nodes in such a network not only react to time-critical situations, but also give an overall picture of the network at periodic intervals in a very energy efficient manner. Such a network enables the user to request past, present and future data from the network in the form of historical, one-time and persistent queries respectively. Such kind of network takes advantages of Proactive and Reactive networks. Some instances of this kind of networks are [5].

II. DESCRIPTION OF SELECTED PROTOCOL

Energy Efficient Protocol (EEP)

Energy efficient protocol is a clustering based protocol. Grouping nodes into clusters has become into an interesting issue for the research community in order to achieve the network scalability objective. In the last years, a number of clustering algorithms have been specifically designed for WSNs. These techniques widely vary depending on the node deployment, the bootstrapping schemes, the network architecture, the characteristics of the cluster head nodes and the network operation model. A cluster head may also be one of the nodes or one specifically richer in resources. The overall number of cluster heads within the network and the amount of nodes per cluster may be variable or fixed by the user. Cluster heads may form a second tier network, i.e. making another level of hierarchy or they may just pass on the data to the base station[1]. Clustering has numerous advantages such as supporting network scalability or reducing the size of the routing table stored at each individual node. It also allows conserving communication bandwidth since it limits the scope of inter-cluster interactions to cluster heads thus avoiding redundancy in message exchange among sensor nodes. Furthermore, clustering isolate sensor nodes of changes at the level of inter-cluster heads tier reducing topology maintenance overhead. The cluster head can implement optimized techniques to enhance network operation and extend the battery life of sensor nodes. In the same way, cluster heads can schedule the cluster activity so that nodes can switch to the low-power sleep mode most of the time thus reducing power consumption. Some techniques like data aggregation reduce data redundancy in clusters thus further reducing power consumption in sensor nodes.

In energy efficient protocol, besides having a CH in the cluster, there is a vice-CH that takes the role of the CH when the CH dies because the reasons we mentioned above by doing this, cluster nodes data will always reach the BS; no need to elect a new CH each time the CH dies. This will extend the overall network life time. Once the vice cluster head is selected

as cluster head a new vice cluster head is selected based on the parameters of distance and energy. Now we will see how clustering is done in our protocol.

- Cluster head selection: Cluster heads can be pre-assigned or picked randomly from the deployed set of nodes.
- Algorithm complexity: The complexity and convergence rate of these algorithms can be constant or dependent on the number of cluster heads and sensors. It is important to note that some of the enumerated attributes are mutually exclusive, like preset or variable cluster count, and some are not.
- Residual energy as a factor for node selection in WSN: Residual energy meant for that energy of node which remains in node after transmission .when nodes want to transmit data than it communicate with Next Node and Next Node forward data packet to base station. Next Node is selected on the basis of energy which a node have in initial all nodes are same there is no Next Node. After that a node which carries a maximum energy selected as Next Node. When numbers of rounds of data transmission are happened then residual energy decide which node will be Next Node .this dynamic nature of changing Next Node provide better transmission and life time.
- Data aggregation: EEP protocol is basically used in case of multicast or broadcast network. It gives the concept of data aggregation. It means instead of performing n paths for n packet deliveries it gives the concept of chain based routing [6] where the nodes are interconnected in the form of chain and perform the communication respectively. In each round of this data-gathering application, all data from all nodes need to be collected and transmitted to the BS, where the end-user can access the data. In some sensor network applications, data collection may be needed only from a region and, therefore, a subset of nodes will be used. A simple approach to accomplishing this data gathering task is for each node to transmit its data directly to the BS. Since the BS is typically located far away, the cost to transmit to the BS from any node is high so nodes will die very quickly. Therefore, an improved approach is to use as few transmissions as possible to the BS and reduce the amount of data that must be transmitted to the BS in order to reduce energy. Further, if all nodes in the network deplete their energy levels uniformly, then the network can operate without losing any nodes for a long time.

Now we will see how to select CH in LEACH protocol

At the beginning of each round, each node advertises it probability, (depending upon its current energy level) to be the Cluster Head, to all other nodes. Nodes (k for each round) with higher probabilities are chosen as the Cluster Heads. Cluster Heads broadcasts an advertisement message (ADV) using CSMA MAC protocol [7]. Based on the received signal strength, each non-Cluster Head node determines its Cluster Head for this round (random selection with obstacle). Each non-Cluster Head transmits a join-request message (Join-REQ) back to its chosen Cluster Head using a CSMA MAC protocol. Cluster Head node sets up a TDMA schedule for data transmission coordination within the cluster.

Comparison Between LEACH and EEP

In LEACH cluster head selection defines a threshold that resets in every N/K rounds whereas in EEP cluster head selection calculates a probability for each node based on distance of each node to base station.

III. SIMULATION TOOL AND RESULT

MATLAB is a high-performance language for technical computing. It is designed for convenient numerical computations, esp. matrix manipulation. It was being developed by Cleve Moler in 1970s as a teaching tool. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. It can be used very interactively and easy to use. Typical uses include:

- Math and computation
- Algorithm development
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including Graphical User Interface building

The life time of network basically depends on no. of alive nodes. If there is less number of alive nodes then life of network is ended.

The simulation parameters which are used to increase life time of network.

- Dead nodes
- Alive nodes
- Packet transmission rate

The **Result** refers to the measurement of life time. Figure shows the output of modified LEACH protocol. Life time of network related to no. of alive nodes, no. of dead nodes, and rate of packet transmission and how long time cluster of nodes is formed in network. System which is proposed here gives good output in all three parameters.

Here figures are presented which shows the output of modified system, existing LEACH output is also considered for the purpose of comparison.

Modified system output shows improvement in four areas.

- There is less number of dead nodes.
- Number of alive nodes is enhanced.
- Packet transmission to base station occurs frequently.
- Even in last round clustering process is going take place.

SCENARIO

Parameters which are used for simulation in scenario:

n= 50

P= 0.1;

Eo= 0.6;

ETX= 50*0.000000001;

ERX= 50*0.000000001;

Efs= 10*0.000000000001;

Emp= 0.0013*0.000000000001;

EDA= 5*0.000000001;

EDA= 5*0.000000001;

a= 1;

rmax= 5000;

do= sqrt(Efs/Emp);

These are the basic parameter taken for simulation of results in WSN. Here n is number of nodes, p is the probability factor, Eo is the thresh hold energy value, rmax is the no. of maximum rounds.

In this scenario we are taking n=50 i.e no. of nodes in network is 50. The probability factor p and thresh hold value Eo and number of rounds rmax will be taken constant for all the three scenarios. Depending on these parameters we will get different graphs which consist of output of EEP and LEACH protocol. These graphs will show whether our protocol is better or not and if it is better then up to which size of network it will work better. In WSN network size and network topology is not fixed most of the time. So efficient working of EEP protocol with different network size is very much important.

Now we will give the comparison graph of EEP with existing LEACH protocol for the network consists of 50 nodes. The graphs are given below:

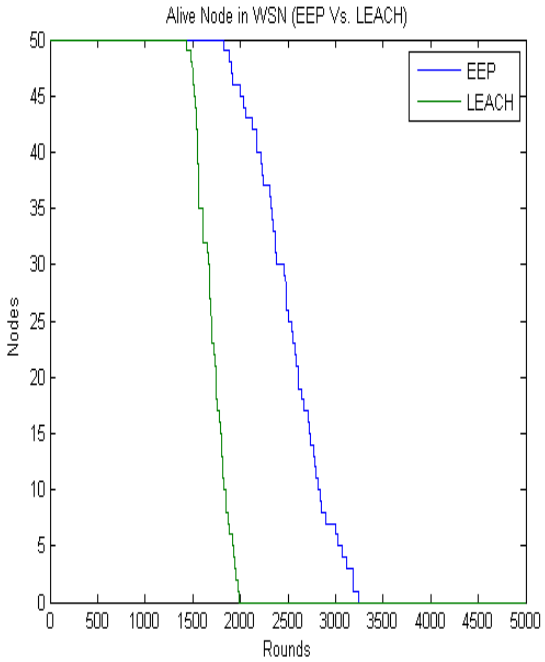

Figure1: No. of Alive nodes in 50 nodes Network

The first graph will be of no. of alive nodes in WSN. The life of nodes in EEP is more than the LEACH protocol. In LEACH the nodes are alive between rounds 1400 to 1500. Up to 1400 rounds the nodes are fully alive in leach. In EEP the nodes are alive between 2400 to 3200 rounds. The network life of smaller network is highly increased in EEP due the reason that time and energy is saved in cluster head selection as we have all ready a vice cluster head. The vice cluster head becomes cluster head once energy is below the thresh hold energy and next vice cluster head will be selected on the distance and energy factor. So, the life of network in EEP will be more than LEACH.

The next graph will be consists of no. of Dead Nodes in WSN.

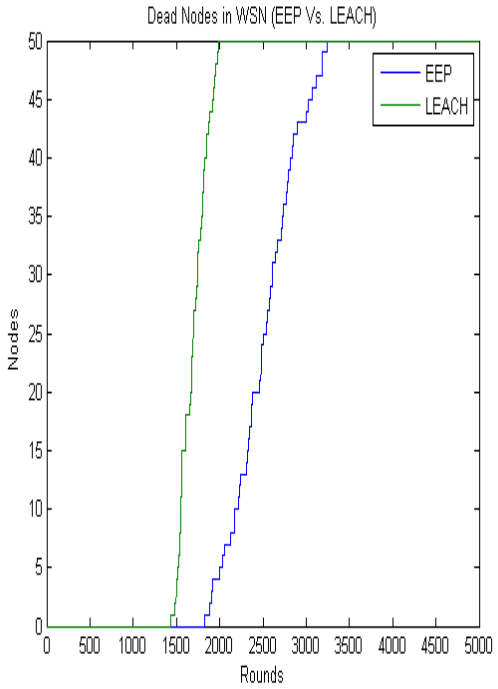

Figure 2: No. of Dead Nodes in WSN of 50 Nodes

The second graph will be of no. of dead nodes in WSN. The life of nodes in EEP is more than the LEACH protocol. In LEACH the nodes starts to die around round 1400. Up to 1500 rounds the network is fully dead in leach. In EEP the nodes are alive between 2400 to 3200 rounds. The network life of smaller network is highly increased in EEP due the reason that time and energy is saved in cluster head selection as we have all ready a vice cluster head. The vice cluster head becomes cluster head once energy is below the thresh hold energy and next vice cluster head will be selected on the distance and energy factor. So, the life of network in EEP will be more than LEACH.

Now we will see the number of packets transmitted to base station in both LEACH and EEP.

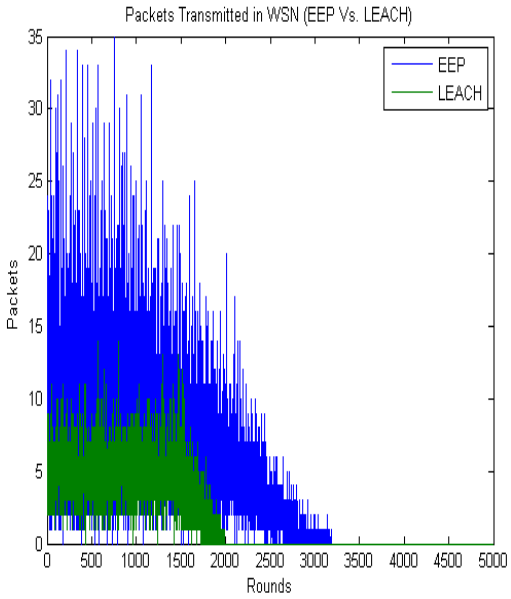

Figure 3: No. of Packets transmitted in 50 Nodes WSN

The number of packets transmitted to base station in EEP is higher than the LEACH protocol. The reason of high data transmitted is that the network life is more in EEP than the LEACH protocol. In EEP the transmission is also for a longer duration i.e. up to 3200 rounds. So for a 50 nodes network the efficiency is more given by an EEP protocol than the LEACH protocol.

CONCLUSION

The core operation of a WSN is to gather and convey the collected data to a distant BS for further processing and analysis. Gathering information from a WSN in an energy effective manner is of supreme importance in order to prolong its life span. This calls for use of an appropriate routing protocol to ensure efficient data transmission through the network. In this thesis, we have proposed an architecture modified EEP which extends the EEP clustering routing algorithm. The result of simulations conducted indicates that the proposed clustering approach is more energy efficient and hence effective in prolonging the network life time as compared to LEACH.

FUTURE SCOPE

The EEP of WSN has the scope of giving better results if the parameters are chosen suitably. The modified cluster head selection technique may give better results if implemented with other clustering techniques which have not been discussed in the thesis (e.g. Fuzzy C-Mean clustering).The network lifetime may also be improved if the clustering algorithms are made distributed as in LEACH. In all of the methods discussed above the energy parameter is taken into consideration only during cluster head selection (after clustering).The performance may be increased by considering energy as a parameter during clustering itself.

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