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Design and Analysis of Lifetime Efficient Protocol in Distributed Clustering of WSN

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Abstract:
Efficient design and implementation of wireless sensor network has become a hot area of research in recent years, due to the vast potential of sensor network to enable applications that connect the physical world to the virtual world. By networking large numbers of tiny sensor nodes, it is possible to obtain data about physical phenomena that was difficult or impossible to obtain in more conventional ways. The main design issue for a sensor network must be increasing of network lifetime by designing with advanced protocol. By using advanced protocol lifetime of a network and No. of alive nodes may be increased. In advanced protocol the network is design based on both residual energy of a sensor node and inter sensor communication distance will be minimum. Code is designed and verified in Mat Lab.

Keywords: Cluster, Advanced LEACH, HEED, Sensor, WSN, Routing

I. INTRODUCTION

Efficient design and implementation of wireless sensor network has become a hot area of research in recent years, due to the vast potential of sensor network to enable applications that connect the physical world to the virtual world. By networking large numbers of tiny sensor nodes, it is possible to obtain data about physical phenomena that was difficult or impossible to obtain in more conventional ways. A WSN is a collection of nodes organized to form a network. The energy efficiency and network lifetime are the two important performance parameters in designing of WSN. A sensor network is one of the major rising technologies that required the data transmission at high rate with higher reliability ratio. The wireless sensor network has many sensor nodes these nodes can forward the information and cooperate with each other to accomplish some specific tasks through the application of communication with wireless self organization. The application of sensor nodes can be used in many areas such as the military monitoring, environmental, industry, medical, and agriculture[1].

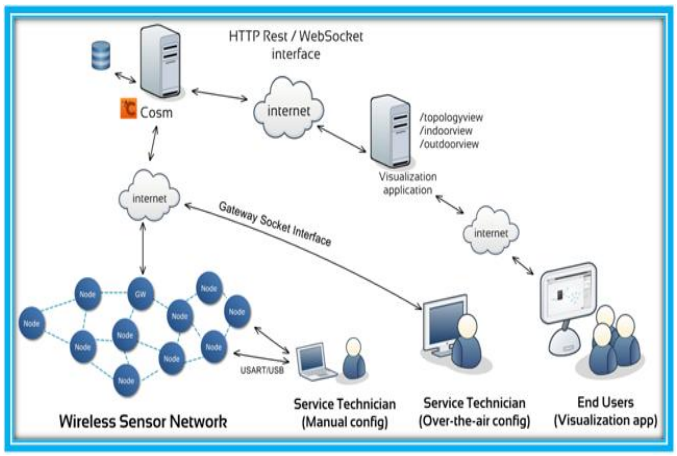

Figure1.1. Architecture of Wireless Sensor Networks

The sensor nodes are usually programmed to monitor or collect data onto surrounding environment and pass the information on the base station for remote user access to various communication technologies. A sensor node is a small device that consists of four basic components:

1. Sensing subsystem for data gathering from its environment.
2. Processing subsystem for data processing and data storing.
3. Wireless communication subsystem for data transmission.
4. Energy supplies subsystem which is a power source of the sensor node.

II. LEACH

Low Energy Adaptive Clustering Hierarchy is designed for sensor networks where an end-user wants to remotely monitor the environment. In such a situation, the data from the individual nodes must be sent to a central base station, often located far from the sensor network, through which the end-user can access the data. There are several desirable properties for protocols on these networks:

- Use 100's - 1000's of nodes
- Maximize system lifetime
- Maximize network coverage
- Use uniform, battery-operated nodes

Conventional network protocols, such as direct transmission, minimum transmission energy, multi-hop routing, and clustering all have drawbacks that don't allow them to achieve all the desirable properties. LEACH includes distributed cluster formation, local processing to reduce global communication, and randomized rotation of the cluster-heads. Together, these features allow LEACH to achieve the desired properties. Initial simulations show that LEACH is an energy-efficient protocol that extends system lifetime The operation of LEACH is broken up into rounds, where each round begins with a setup phase, when the clusters are organized, followed by a steady state phase, when data transfers to the base station occur. In order to minimize overhead, the steady-state phase is long compared to the set-up phase.

2.1 Cluster Setup Phase: After each node has decided to which cluster it belongs, it must inform the cluster-head node that it will be a member of the cluster. Each node transmits

this information back to the cluster-head again using a CSMA MAC protocol. During this phase, all cluster-head nodes must keep their receivers on.

2.2 Schedule Creation

The cluster-head node receives all the messages for nodes that would like to be included in the cluster. Based on the number of nodes in the cluster, the cluster head node creates a TDMA schedule telling each node when it can transmit. This schedule is broadcast back to the nodes in the cluster.

2.3 Data Transmission

Once the clusters are created and the TDMA schedule is fixed, data transmission can begin. Assuming nodes always have data to send, they send it during their allocated transmission time to the cluster head. This transmission uses a minimal amount of energy (chosen based on the received strength of the cluster-head advertisement). The radio of each non-cluster head node can be turned off until the node's allocated transmission time, thus minimizing energy dissipation in these nodes. The cluster-head node must keep its receiver on to receive all the data from the nodes in the cluster. When all the data has been received, the cluster head node performs signal processing functions to compress the data into a single signal. For example, if the data are audio or seismic signals, the cluster-head node can beam form the individual signals to generate a composite signal. This composite signal is sent to the base station. Since the base station is far away, this is a high energy transmission. This is the steady-state operation of LEACH networks. After a certain time, which is determined a priori, the next round begins with each node determining if it should be a cluster-head for this round and advertising this information. In our work, we assume a simple model where the radio dissipates Eelec = 50 nJ/bit to run the transmitter or receiver circuitry and _amp = 100 pJ/bit/m2 for the transmit amplifier to achieve an acceptable *Eb/No*. These parameters are slightly better than the current state of- the-art in radio design1. We also assume an r2 energy loss due to channel transmission. Thus, to transmit a k-bit message a distance d using our radio model, the radio expends:

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

And to receive this message, the radio expends:

$$E_{Rx}(k) = E_{Rx-elec}(k)$$
$$E_{Rx}(k) = E_{elec} * k$$

III DESIGN OF WSN USING ADVANCED LEACH PROTOCOL

3.1Configure the network: In the initial phase of protocol base station transmit signal at different transmission power starting with minimum transmission power as level 1, nodes in the network which can hear that signal set their level L1 and calculate the distance to base station with received signal strength. Base station increased its transmission power to attain the next level And so on up to its predefined ability to transmit at different power level. Nodes which could not hear previous signal set its level according to corresponding signal level. Base station broadcast message containing information about level of that signal, receiving that information all nodes in the network sets their level of transmission. After dividing the network into different transmission level cluster formation is done In this part the network will be configure by heterogeneous nodes. There may me same type or different type of nodes which will arrange in a network in random manner. In proposed work we will take 100 no. of nodes and assign an area of 400 x 400.

3.2 Clusters Formation :- In the cluster formation step clusters Heads are formed using the basic clustering protocol (in our case we have taken it as Advanced LEACH) After cluster formation all sensor nodes transmits data sensed to corresponding cluster head. That aggregates all data received. These part different clusters will assign in the area in random manner. Clusters will define in such a manner that there will be minimum one node in a cluster and a maximum of five nodes in a cluster. The nodes regularly update their sets of neighbors.

3.3 Selection of Cluster Head- Single cluster head will be selected based on residual energy and intra cluster communication. This cluster head will be responsible to take information from other nodes and transmit to base station or other cluster head. The information may be of any type for example temperature, pressure, humidity, sound etc.

3.4 Routing based on Advanced LEACH Algorithm - In this step multi-hop routing between cluster heads of different level take place. Multi hop data forwarding has two key elements. Optimal transmission radius and Forward transmission area

OTR (optimal transmission radius): OTR for different cluster heads OTR is the difference between transmission level of that cluster head and next higher level.

$OTR_{ci} = | level_{i+1} – level_{i} |$

Where OTR_{ci} is the optimal transmission radius of the cluster Ci, $level_i$ is the transmission level of that cluster head and $level_{i+1}$ is the next higher transmission level.

Forward Transmission Area: Forward Transmission Area is subset of Transmission region of a node which eliminates the data transmission in backward direction resulting saving efficient amount of energy which prolongs the network lifetime

IV. RESULTS AND DISCUSSION

Network size is considered as 400m X 400m and the number of nodes is 100 which are deployed randomly in the sensor field.

Table. 4.1. Simulation Parameter

Parameter	Value
Coordinates of Xm and Ym	Xm=400 Ym=400
Total No. of Nodes	100
Sink node location	sink.x=200 sink.y=200
Probability of a node to become cluster head	p=0.1
Total No. of Rounds	2500
Initial Energy	0.5J

4.4 For performance evaluation following parameters is taken into account:

4.4.1. Number of Alive Nodes

4.4.2. Number of Dead Nodes.

4.4.3. Packets to BS

4.4.4. Packets to CH

4.4.1 Number of Alive nodes:- The result of effect on alive nodes with increase of no. of rounds is shown in figure 4.1. It is clear from the figure that alive nodes are continuous decreases with the increase of no. of rounds. At the initial state the alive nodes are maximum (100) but it starts decreasing

when no of rounds is 300. When the no. rounds reach to 500 the alive nodes becomes 50. When the no rounds reach to 1000 the alive nodes become just 18. When the no. of rounds reaches to 1500 the dead nodes become just 08 and finally reached to a value of 02 when the no. rounds become 2000.

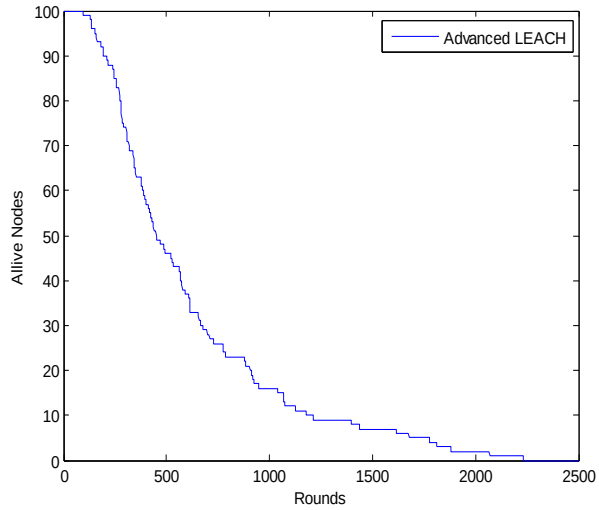

Figure 4.1: Graph showing the no. alive nodes with no. of rounds

4.4.2 Number of Dead nodes: - The result of effect on dead nodes with increase of no. of rounds is shown in figure 4.2. It is clear from the figure that dead nodes are continuous increases with the increase of no. of rounds. At the initial state the dead nodes are nil but it starts increasing when no of rounds is 200. When the no. rounds reaches to 500 the dead nodes becomes 53. When the no rounds reached to 1000 the dead nodes becomes 84. When the no. of rounds reaches to 1500 the dead nodes become 92 and finally reached to a value of 98 when the no. rounds become 2000.

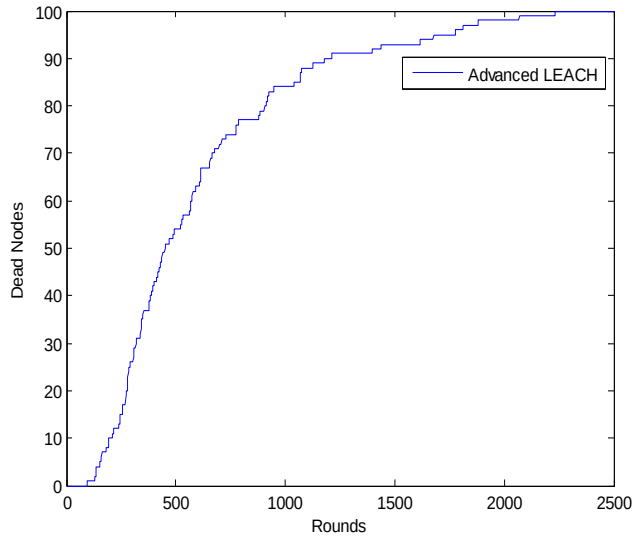

Figure 4.2 Graph showing Dead nodes with No. of Rounds

4.4.3 Packets to BS: -

The results of Energy Packets to Base Station is described in Figure. 4.3. At the starting time the value of packets to Base Station is zero and is continue increases with number of rounds and reach to a value of 20000 when the no. rounds become 500 and 28000 at the end of 1000 rounds. When the no. of rounds increased to 1500 the value of packets to base station becomes 32500 and becomes 33500 at the end of 2000 rounds.

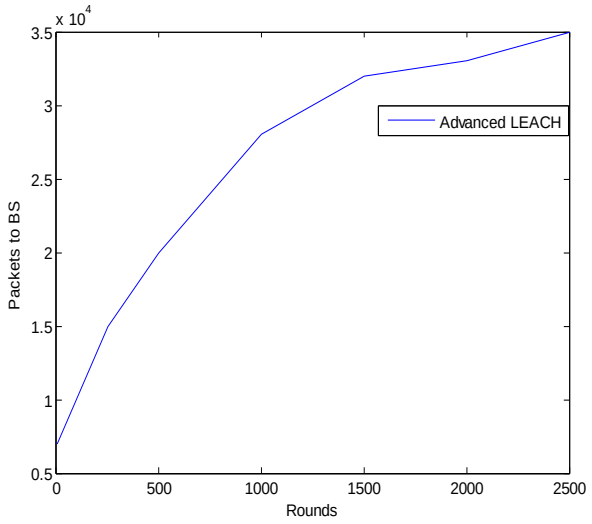

Figure 4.3: Graph showing the Packets to Base Station with No. of Rounds

4.4.4 Packets to Cluster Head: - The results of Energy Packets to CH is described in Figure. 4.4. At the starting time the value of packets to Base Station is zero and is continue increases with number of rounds and reach to a value of 8100 when the no. rounds become 500 and 11000 at the end of 1000 rounds. When the no. of rounds increased to 1500 the value of packets to CH becomes 12200 and becomes 12900 at the end of 2000 rounds

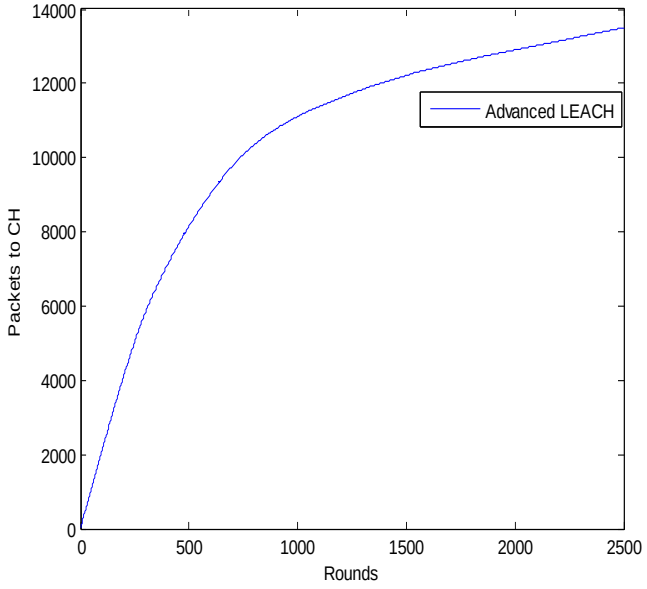

Figure 4.4: Graph showing the Packets to CH with No. of Rounds

V. CONCULSION AND FUTURE SCOPE

In proposed work, a level based clustering approach protocol has been proposed with is based on Advanced LEACH. The network model based on power levels is being developed. The mathematical formulae for choosing the cluster head are provided. The study of clustering, cluster head selection and inter cluster routing of WSN is presented here, since it was earlier proposed that clustering improves the network lifetime. The model developed is simulated in MATLAB. The simulation results of cluster heads, No. of Alive Nodes, No. of Packets to CH, No. of Packets to BS and no. of dead nodes are provided. It has been concluded that the above said parameters for our proposed algorithm which is based on Advanced

LEACH is better in comparison to previous results. Finally, it is concluded that the Advanced LEACH performs better than Basic LEACH and Hierarchical Routing Scheme in case of No. of Dead Nodes, Packets to BS and Packets to CH. In future research, proposed scheme can be extended to optimize the number of levels to efficiently consume the energy of network and improve the network energy, to implement a wider network.

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