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Energy Management in wireless sensor network using PEGASIS

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Abstract

The area of Wireless Sensor Network is one of the fastest growing fields in the communication and engineering world. The main objective of WSN is to sense the crucial information from the environment depending on the type of application for which it is deployed and send this information to its Base Station(BS) so that it can take corrective action. These Sensor Nodes ommunicate with each other through various protocols. The problem of the conventional method is, during gathering of sensed data each node transmits its sensed data directly to the base station for which it will deplete its power quickly. In this project, we propose PEGASIS(Power-Efficient Gathering in Sensor Information System),a near optimal chain-based protocol for extending the lifetime of network. In PEGASIS, each node communicates only with a close neighbour, performing a chain, elect a leader from the chain who collects the data from the neighbours to be transmitted to the base station. As a result the average energy spend by each node per round is reduced and to lower the bandwidth requirement. By using certain algorithm we can propose the shortest path of transmission of data to the base station. As a result less power consumption can be achieved to increase efficiency and life time of the network.

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Keywords: *PEGASIS; LEACH protocol; Sensor*

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1. Introduction

The Wireless Sensor Network (WSN), a specialized network, consists of two main components: 1. Sensor Nodes and 2. Base Station. The nodes monitor various environmental conditions (temperature, pressure, sound) and share (wirelessly) the information obtained with either the base station or amongst various nodes. WSN is foreseen to be appropriate solutions to many applications in fields of defence, industry monitoring, health monitoring, etc.

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Specific, data-centric protocols are the need of these sensor networks. The protocols should be able to collect data and optimize the energy consumption. The sensor nodes are programmed for monitoring or collecting data from the surroundings (environment) and passing the information to base station. This is required for remote user access via different communication technologies. Development of tiny, low cost, low power, multi-functional smart sensor nodes have been made possible owing to the recent technological advancements in the fields of WSN, Wireless communication techniques and Microelectromechanical systems (MEMS). The features of wireless sensor networks are listed below:

- *Varying network size*: The size of a sensor network can vary in size (1-100 nodes)
- *Low cost*: Sensor nodes should be inexpensive so that they can be used in large numbers
- *Long lifetime network*: Efficient protocols have to be designed and implemented so that the network can last as long as possible.
- *Self-organization*: Sensor nodes should be able to form a network automatically without any external configuration.
- *Cooperation/Data aggregation*: Sensor nodes should be able to aggregate data in a meaningful way would improve network efficiency.

2. Structure of Wireless Sensor Network

2.1. Sensor Nodes:

Sensor is a device which senses the information and passes it on to mote. A mote consists of processor, memory, battery and A/D converter to connect with a sensor and radio transceiver for the formation of an ad hoc network. A mote and sensor together form a Sensor Node. Fig. 1 shows the block diagram of sensor node.

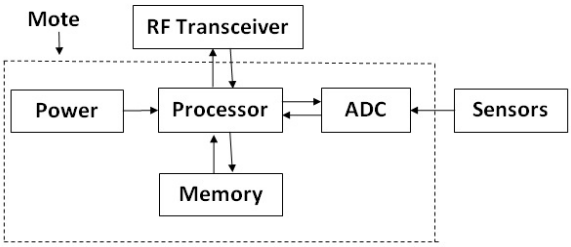


Fig. 1. Block diagram of sensor node

2.2. Base Station:

A base station (consisting of processor, radio board, antenna and USB interface board) links the sensor network to another network. It is pre-programmed with low-power mesh networking software for communication with wireless sensor nodes. Fig. 2 shows the base station architecture.

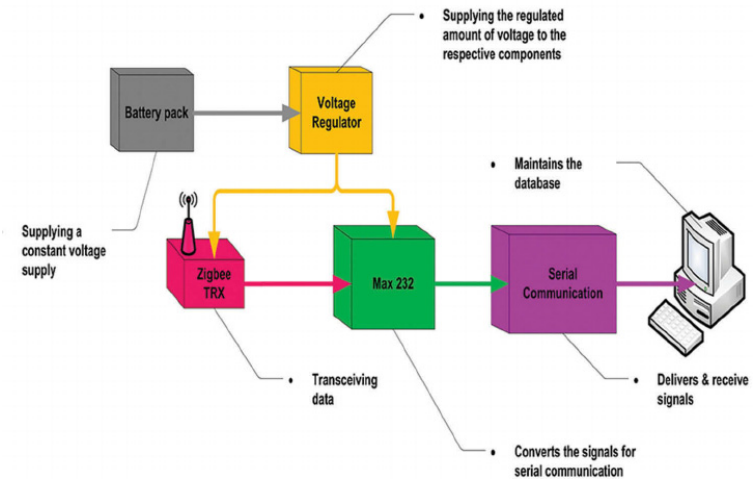


Fig. 2. Base station architecture

2.2. Router:

Router is a microprocessor-controlled device connected between two or more data lines from different networks which makes connection possible between two or more different network present at same or different geographical locations. It also forwards data packets between computer networks. A Router is used to connect different networks; it extracts the packet destination, selects the best destination path and forwards the packet to the next device on selective path. The router determines the destination of the packet by reading the address information in the packet, when a data packet comes in one of the lines. Using the information in the routing table, the packet is directed to the next network.

3. Routing Protocols:

The communication between routers is specified by routing protocol. Each router has a prior knowledge of only directly attached networks. Routing protocol shares this information among the immediate neighbours at first and later throughout the network. In this way, routers gain knowledge regarding the network topology.

Energy efficient routing algorithm can be categorized into:

- data centric routing algorithm
- location based routing algorithm
- hierarchical routing algorithm

Meta-data is used to find the source to destination route in data centric routing algorithm. This is used prior to actual data transmission for the elimination of redundancy in transmission of data. Information regarding the location of all sensor nodes is required in location based routing algorithm. Division of the networks into clusters is the working principle of hierarchical routing algorithm and cluster head (CH) is elected for each cluster. CH collects the data from members, aggregates the data and sends the data to sink. Fig. 3. shows the types of energy-efficient routing protocol (as mentioned above).

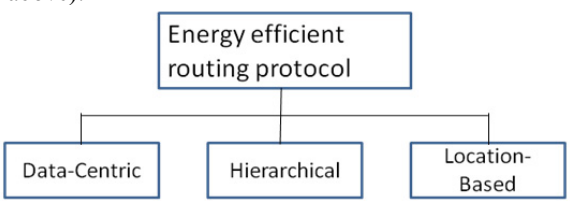


Fig. 3. Types of routing protocol

In this paper we concentrate on Hierarchical Routing protocols, types of Hierarchical routing protocols and PEGASIS protocols.

3.1. Hierarchical Routing Protocols

Hierarchical Routing Protocols (HRP) also known as cluster based routing protocols were originally proposed in wire-line networks. They have benefits such as scalability and efficient communication. The concept of HRP is used to perform efficient routing in WSN.

3.1.1. PEGASIS Protocol:

The main proposal in PEGASIS protocol is node reception from and transmission to close neighbours and take turns for being the leader for transmission of data to BS. This approach evenly distributes the energy load between the sensor nodes. The nodes are placed randomly in the field, organize themselves in the form of chain. Alternatively, BS computes this chain and broadcasts it to all the nodes.

3.1.2. Types of PEGASIS protocols:

i. **Energy Efficient PEGASIS Based** (**EEPB**) is an enhanced PEGASIS algorithm[3] in WSN. In PEGASIS distance algorithm is used to form the data chain and it can result in communication distance between two sensors being too long. Thus, the sensors die early as they consume a lot of energy for the transmission of data. In the chaining process, the average distance of the chain (known as "threshold distance") is considered by a node. If the distance from the closest node and the upstream node is greater than thresh distance, the closest node is the "far node". If the closest node joins the chain, it becomes "long chain". EB-PEGASIS avoids this phenomena using distance threshold. It not only does the energy saving on threshold but also balances energy consumption of all sensor nodes.

ii. The **PEGASIS-ANT**[5]protocol makes use of ANT colony algorithm instead of greedy algorithm to construct the data chain. This helps to achieve global optimization. It forms the chain that makes the path more even-distributed and reduces the transmission distance. It also balances the energy consumption between the nodes. In each round of transmission, on the basis of current energy of each node the leader is selected that directly communicates with the BS. This algorithm has prolonged network lifetime. **H-PEGASIS** [5] is an extended version of PEGASIS protocol. It was introduced with the objective of decreasing the delay of transmission packets to the BS. It proposes a solution to data gathering problems by considering energy X delay metrics. In order to reduce delay, simultaneous data messages are transmitted. To avoid collisions, signal coding is implemented e.g CDMA to avoid signal interference, only spatially separated nodes are allowed transmit data at the same time. With CDMA capable nodes, the chain forms the tree like hierarchy and each selected node transmit the data to the node of upper hierarchy. This ensures parallel data transmission and reduces the delay significantly.

iii. **PEGASIS with double Cluster Head (PDCH)** [5] balances load of every node and increase network lifetime. Generally PEGASIS protocol uses one CH that communicates with the BS. Here instead of one double CH are used in a single chain and is given a hierarchical structure so that long chaining is avoided. PDCH outperforms PEGASIS by eliminating dynamic cluster formation, reducing the distance between nodes, reducing the number of messages sent to and from other nodes and using only one transmission to BS per round. As the energy load is distributed among the nodes, the network lifetime increases and so does the quality of network.

iv. **Improved Energy Efficient PEGASIS Based (IEEPB)**[8] protocol, overcomes the deficiencies of EEPB. When EEPB builds a chain, the threshold adopted is uncertain and complex to be determined and thus forms "long chain". It also selects the leader and ignores the node energy and the distance between the BS and node that optimizes the selection of leader. Based on this, IEEPB compares the

distance between two nodes twice and finds the shortest path to link two adjacent nodes. The chain construction is simplified such that formation of "long chain" is avoided. Also while selecting the leader, IEEPB considers the node's energy, distance between the BS and the node, normalizes these two factors and assigns different weight co-efficient to them. Finally the node with the minimum weight becomes the leader. IEEPB has higher energy efficiency and hence longer network lifetime.

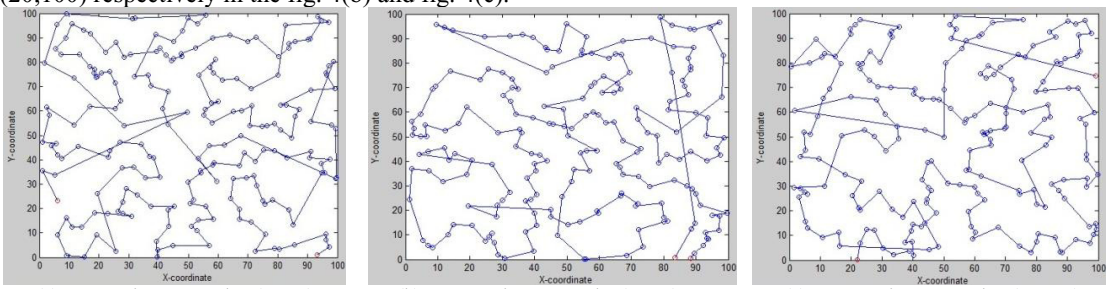
4. Methodology

PEGASIS is a distributed clustering based algorithm[3]. In order to execute the methodologies of PEGASIS there are four steps, listed below:

- Step 1: Broadcasting done by the active nodes.
- Step 2: Nomination for CH(Cluster Head) done.
- Step3: CH((Cluster Head) elected from the nominees given by the active nodes.
- Step4: TDMA schedule prepared by the corresponding CHs(Cluster Head) and passed to the Base station.

5. Result

Matlab 2014a has been used for the simulation of PEGASIS code. The performance of pegasis is evaluated by simulating pegasis code using random 100 nodes in a network. Fig.4(a) shows a random 100 nodes network. The base station(BS) is located at (20,90) in a 100m x 100m field. Similarly the base station is located at (80,90) and (20,100) respectively in the fig. 4(b) and fig. 4(c).



(a)Base station Located at (20,90) (b) Base Station Located at(80,90) (c) Base Station Located at (20,100)

Fig. 4. (a) Base station Located at (20,90(b) Base station Located at (20,90 (c) Base station Located at (20,90

6. Conclusion

In this paper emphasis has been done on the cluster-based routing protocols in wireless sensor networks. Based on observations, it has been concluded that in PEGASIS protocol the cluster head election procedure depends on residual energy and threshold value. Once the cluster head selection process is completed then the data transmission procedure takes place. Primarily, the PEGASIS protocol is very much useful in disaster management field.

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