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Survey On Wireless Sensor Netwrok on Energy Efficient Protocols

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Abstract: ***Wireless sensor networks have been an emerging technology in past few years due to its application specific functionality. These networks are required to be energy efficient as they can`t run without energy. This paper presents a survey on the ways to make a network energy efficient by using efficient protocols.***

Keywords: Wireless Sensor Network, Energy Efficiency, LEACH, SEECH

1. Introduction

In Wireless Sensor Networks, the main source of lifetime is battery. Due to the recent advances in the field, the applications of Wireless Sensor Networks have been enlarged due to their target specific nature which now include environmental monitoring, machine failure detection, surveillance, Internet-Of-Things application. The communication among the hubs, gathering and transmitting the information to the sink leads to a great amount of energy expenditure. Since recharging or supplanting the battery is almost implausible, the Wireless Sensor Networks need to be energy efficient in order to ensure maximum lifetime. Hence, for the optimization of Wireless Sensor Networks, various approaches have been proposed to optimize the hardware (node), optimization of the communication layers and development of new hybrid protocols.

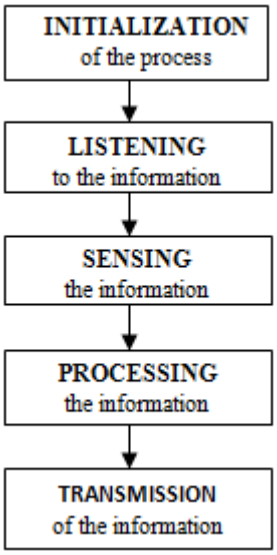

Figure 1: Working of a node in a Wireless Sensor Network

2. Lifetime Elongation Using A Hybrid Routing Protocol

A hybrid protocol that combines the advantages of the direct transmissions and LEACH-C protocol so as to:

1) Overcome the shortcomings of LEACH-C protocol,
2) Maximize the lifetime of the network.

The drawbacks of the LEACH-C protocol include overhead calculations at the Base Stations and data aggregation at the Cluster Heads. These can lead to transmission delays to which some applications of WSNs are sensitive. A Cluster Head failure, in LEACH-C, will result in all the other nodes in the network not to be able to send their data to the Base Station. Moreover, though LEACH-C was an improvement over LEACH protocol that improved load-balancing, the pre-selection of Cluster Heads leads to unbalanced distribution of energy and hence more dissipation of energy by the Cluster Heads than the rest of the nodes. While in LEACH-C, the cluster heads are responsible for collecting data from the sensor nodes, in direct transmission, all nodes directly send their data to the base station. Therefore, the bigger the network and the distance between the nodes and the base station, more energy is required which makes direct transmission undesirable for larger networks. In the hybrid protocol, the sensor nodes are categorized into two type- the ones that lie within a predefined specific distance from the base station and transmit their data directly to the base station, the rest of the nodes beyond this predefined distance will transmit their data using LEACH-C protocol. The categorization done is based on the assumption that the base station is within the range of the nodes directly transmitting data to it.

3. Energy Efficient Cluster Head Selection

Generally the sensor devices are deployed in a random manner over the entire area for various applications , there exist an overlapping region of the sensing areas of different sensor devices. If the sensor device density of a local area is significantly lower than mean, than a target location is covered by only one sensor device and similarly when a local area is significantly higher than mean sensor device density, a target location may be covered by several sensor devices. Therefore in order to obtain overlapping area OF of two sensor device with distance p, $0 \leq p \leq 2P$, apart is estimated using a geometric theory of intersection of two circles which is as follows.

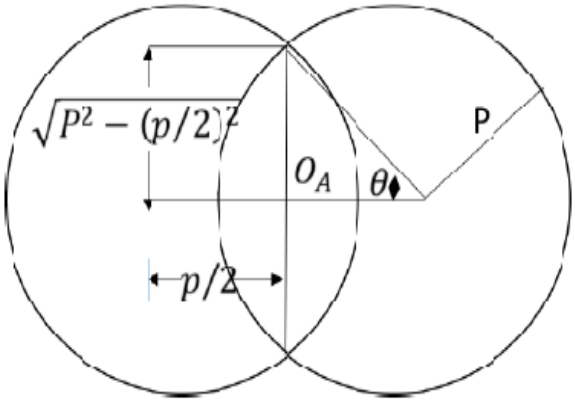

Figure 2: Intersection of two circles

$$O_F = 2P^2\left[\theta - \frac{p}{2P}\sqrt{1-\left(\frac{p}{2P}\right)^2}\right],$$

Where θ=cos−1($p2P$⁄). To obtain a normalized overlapping ω of sensor device in a network is as follows

$$\omega = O_F/\pi P^2 = 2\left[\cos^{-1}(r) - r\sqrt{1-r^2}\right]/\pi$$

Where 0≤r≤1 and r=$p2p$⁄ and the value of ω is in range of 0 and 1.

To enhance the cluster head selection to improve network lifetime by better network coverage different sensor device are assigned different likelihood of being cluster head and to calculate this likelihood it depend on the normalized active sensing coverage area of sensor devices. The active sensing region is represented as the ratio of active sensing coverage region to the maximum sensing region of a sensor device.

4. SEECH: Scalable Energy Efficient Clustering Hierarchy Protocol in Wireless Sensor Networks

Inspired from various clustering protocols like Low Energy Adaptive Clustering Hierarchy (LEACH), Two Level-LEACH (TL-LEACH), Energy Efficient Clustering Technique (EECS), Hybrid Energy Efficient Distributed Clustering Approach (HEED), Topology Controlled Adaptive Clustering (TCAC), SEECH aims to mitigate the energy burden of the cluster heads. SEECH or Scalable Energy Efficient Clustering Hierarchy Protocol is a clustering protocol which selects cluster heads (CHs) and relays based on nodes eligibilities. Single-hop communication consume more energy due to relation between energy required to transmit the data and the distance between the nodes. Multi-hop communication also causes energy balancing since nodes that are closer to the sink have higher traffic load which causes quicker energy depletion. In order to solve the problems sited in the above mentioned protocols and to increase the energy efficiency, a novel method has been proposed:

- Two fitness functions are generated that determine the competence of being cluster head by merely considering their energy consumption.
- In each round, few nodes are selected from high level energy nodes according to fitness functions where some of them are selected as cluster heads and the others would play as relay nodes.

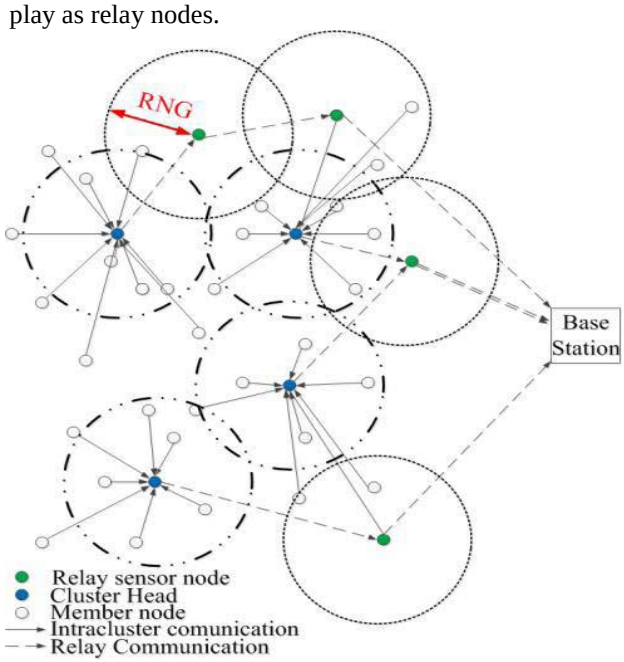

Figure 3: Node category in SEECH protocol

A wireless sensor network is considered, consisting of N sensors uniformly dispersed over a field.

Depending on the distance between the transmitter and the receiver, the free space ($\varepsilon_{f)}$ or multi path fading ($\varepsilon_{m)}$ channel model are employed.

$$E = l\,E_{elec} + l\,\varepsilon_f\,d^2 \quad d \le \delta$$
$$lE_{elec} + l\,\varepsilon_m d^4 \quad d > \delta$$

The electronic energy E_{elec} depends on some factors including the digital coding and modulation. The amplifier energy depends on the transmission distance and the acceptable SNR. To receive a packet the radio consumes energy

$$E = l\,E_{elec}$$

The sensed information is highly correlated so that the cluster head can always aggregate the data gathered from its cluster into a length–fixed packet. A cluster head spends E_{DA}(bit/signal) amount of energy for its cluster data aggregation.

The protocol performs start phase before first round. Each node calculates its distance from data sink and the number of its neighbors n_i in a specific radius. At the end of this phase each node simply derives its degree. Then, in each round, the protocol launches two consecutive phases called setup and steady-state. In setup phase, clusters, cluster heads and relay sensor nodes as well as the path between each cluster and data sink are determined. In steady-state phase, network data is collected from nodes and transmitted to data sink according to the topology which is determined in the same round. Here, the location of each node is taken into consideration so that costly intra-cluster communications

could be avoided and another group of high energy nodes are selected as relay sensor node.

5. Conclusion

Since the area of Wireless Sensor Networks possess a lot of potential, a lot of further work can be done on them. In order to develop a purely energy efficient protocol, either a totally new protocol can be developed, or a hybrid of the above or already existing protocols can be developed in order to increase the lifetime of a protocol.

WSN continues to emerge as a technology that will transform the way we measure, understand and manage the natural environment. Future work in WSN energy management should include further investigation into node platform, the balancing of unequal energy distribution and long term behavioral studies of system in real world deployment.

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