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REVIEW ROUTING IN WIRELESS SENSOR NETWORKS

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ABSTRACT

Wireless sensor networks (WSN) are emerging in various fields like disaster management, battle field surveillance and border security surveillance. Wireless Sensor Networks (WSNs) are widely used to create a smart environment that relies on sensory data from real world. A large number of sensors in these applications are unattended and work autonomously. But, providing flexible service using wireless sensor network is challenging because they usually contain a large number of resource constraint sensing nodes with small memory, lower processing capability and extremely limited battery life. The effectiveness of WSNs depends on the functionality of all sensors in the network. If the sensor node is active, it proceeds to perform a duty to sense, communicate and process information (temperature, humidity etc).

In this paper, we present an extensive survey on existing routing schemes and propose an effective approach for data communication for such resource constrained sensor network.The main contribution of this paper is, it proposes an enhanced routing scheme which is power efficient and also robust to node failures. It is also a mentionable feature of our research that, it proposed a technique called Clustering to improve the network lifetime, reduce the energy consumption and increase the scalability of the sensor network.

Keywords: DD, LEACH, SPIN, TEEN, WSN

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are widely used to create a smart environment that relies on sensory data from real world. The application of WSN provides an enormous wirelessly connected infrastructure facilitating the function of monitoring physical and environmental conditions, such as temperature sound, vibration, pressure, humidity, acidity, motion and pollutants. The advent of smart environments relies heavily on sensor network for data acquisition and dissemination whether in building, shipboard, intelligent transportation system, habitat monitoring, healthcare monitoring, home automation, traffic control, or elsewhere (Lewis F. , 2004) (Ali, Abdulmaowjod, &Mhammed, 2011).A smart sensor used in WSNs is a combination of sensing, processing and communication technologies[1].

The basic architecture of smart sensor is shown in Figure 2. Sensing unit is used to detect the changes of parameters in the network, signal conditioning responsible for smoothing the analog electrical signal before it is converted to digital domain. The resultant digital signal is used as the input to the application algorithm or processing unit and then cached in the memory. The transceiver is used to communicate with other sensors or base station (BS) which may act as an internet gateway in WSN (Ali, Abdulmaowjod, & Mohammed, 2011).(Dietrich & Dressler, 2009) stated in their study stated that network lifetime is a key characteristic to

evaluate a sensor network. The effectiveness of WSNs depends on the functionality of all sensors in the network. If the sensor node is active, it proceeds to perform a duty to sense, communicate and process information (temperature, humidity etc).

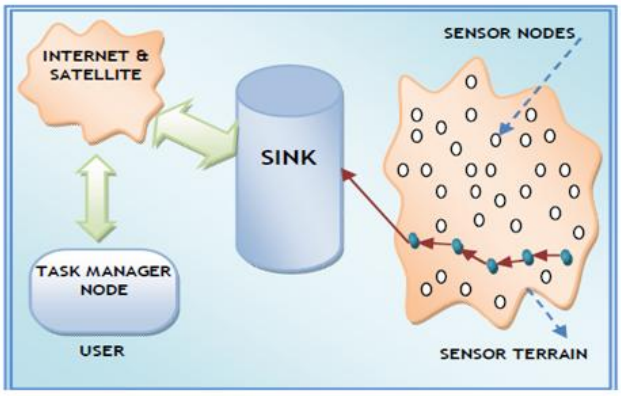


Fig1. Generic view of sensor network

There are two major factors that affect the network lifetime that is how much energy it consumes over time and how much energy is available for the particular node. The proposed technique to deal with network lifetime called clustering, which is an important method. Additionally, a good performance WSNs is highly dependent on energy-efficient clustering routing algorithm [2].

In the current body of research done in the area of wireless sensor networks, we see that particular attention has not been given to the time criticality of the target applications. Most current protocols assume a sensor network collecting data periodically from its environment or responding to a particular query. We feel that there exists a need for networks geared towards responding immediately to changes in the sensed attributes.

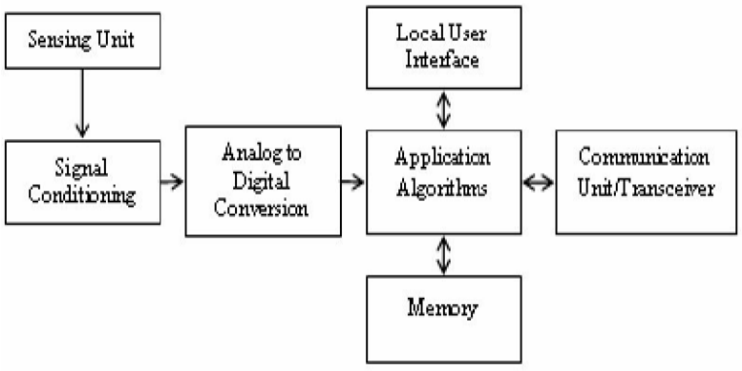


Fig 2.Smart Sensor Architecture

II. CLASSIFICATION OF WIRELESS SENSOR NETWORK

A Wireless Sensor Network can be classified based on their mode of functioning and
The type of target application. There are three types of WSN.

1. Proactive Network
2. Reactive Network
3. Hybrid Network

1.) Proactive Network

The nodes in this type of network periodically switch on their sensors and transmitters, sense the environment and transmit the data to the interest. This sort of network is suitable for application requiring periodic data monitoring. These are used where information about the nodes is continuously required. The nodes sense the network on a regular basis and communicate the data sensed to the other nodes. Every sensor node in the network has a routing table which keeps record of all the destinations and the number of hops that are need to reach the destination. A sequence number is generated by the destination each time the data is broadcast. Each time the cluster changes, and once the cluster-heads are selected, the CH broadcasts the report time and attributes to the network. Report time is the time interval between the successive reports sent by a node. At each report time, the cluster nodes sense the parameters defined in the attributes and send the data to the CH. The CH then aggregates the data and communicates it to the BS. In proactive networks, the nodes periodically switch on their sensors, sense the environment and communicate the data to the other nodes. Thus they provide a continuous report of the parameters [3].

2.) Reactive Network

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 [3].

3.) Hybrid Network

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. Hybrid wireless sensor networks consist of wireless networks (such as cellular network) and wireless sensor networks and such network is important to overcome the limitations of conventional sensor network where transmission range and data rate are quite limited. The focus of this special issue is on the hybrid wireless sensor network formed by wireless sensor nodes and base stations [3]. In hybrid wireless sensor networks, the nodes exchange information over a common wireless channel. Under different traffic scenarios, e.g., bandwidth and power, the amount of data exchanged among these nodes may vary.

2.1 Advantages and Disadvantages of Wireless Sensor Networks

There are numerous advantages which make the sensor network a tremendous field of interest. Firstly, sensors are extremely small in size, which makes it usable to various places for various applications. Since the network setups can be done without fixed infrastructure, it is considered an ideal solution for the hard-to-reachable places such as across the deserts, mountains, deep forests, sea, rural areas and so forth. Moreover, WSNs are not only flexible in nodes additions,removal but also cheap to implement[2]. However, there are several challenges in WSNs including security, power consumptions, speed and configurations. Since, the network may be formed independently; it is extremely vulnerable to attackers.

III. RELATED LITERATURE

3.1 Routing In Wireless Sensor Networks

A sensor network design is influenced by many factors,which include fault tolerance; scalability;productioncosts;operating environment; sensor network topology; hardware constraints; transmission

media; and power consumption. There are several routing techniques for wireless sensor networks. Most of the recent routing approaches proposed energy aware routing. These routing techniques can be classified according to various points of view. However, most of the literature differentiates the routing algorithms into three main categories including Data Centric Approaches, Hierarchical Cluster based Routing Techniques and Location based routing.

To relay data in sensor networks, flooding and gossiping are two fundamental mechanisms. In case of flooding, each sensor node receiving a data packet broadcasts it to all of its neighbors which is continued until the packet arrives at the destination or the maximum number of hops for the packet is reached. On the other hand, gossiping is a slightly enhanced version of flooding where the receiving node sends the packet to a randomly selected neighbor rather than entire nodes, which picks another random neighbor to forward the packet toand so on.

3.2 Flat Based Data Centric Routing Protocols

In data centric routing approaches, normally, the WSN is considered as flat network since all nodes play the same role in data gathering and communication. Flat routing protocol is a network communication protocol implemented by routers in which all routers are each other's peers. Flat routing protocols distribute information as needed to any router that can be reached or receive information. No effort is made to organize the network or its traffic, only to discover the best route hop by hop to a destination. Flat routing protocols are those that don't work under a predefined network layout and perimeter. They enable the delivery of packets among routers through any available path without considering network hierarchy, distribution and composition [2].

In data centric routing protocols, SPIN (Sensor Protocol for Information via Negotiation) and Directed Diffusion aretwo widely adopted schemes.The main advantage of flat based i.e. data centric routing is that, the total approach is very simpler and doesn't focus on specific nodes and also tends towards energy consumption minimization.

3.2.1 SPIN (Sensor Protocol for Information via Negotiation)

The concept of SPIN (Sensor Protocols for Information via Negotiation) is mainly based on naming the data using high level descriptors or meta-data. Prior to transmission, meta-data are exchanged among sensors using some direct data advertisement mechanism. When any node receives any new data, it advertises ADV (advertise) message that to its neighbors and interested neighbors. Here interested neighbors are defined as those nodes that do not have the data. Interested nodes send a request message to retrieve the data [5].

The main advantage of SPIN is, it facilitates a lot in achieving energy efficiency because, the meta-data negotiation proposed in SPIN solves the classic problems of flooding such as redundant information passing, overlapping of sensing areas and resource blindness. Second feature of SPIN is that, topological changes are localized since each node needs to know only its single-hop neighbors.

The main criticism is, SPIN's data advertisement Mechanism cannot guarantee the delivery of data. As the data dissemination is based on neighbors and interested neighbors, if the actual nodes that are interested in the data are far away from the source node and the nodes between source and destination are not interested in that data, such data will not be delivered to the destination at all.

3.2.2 DD (Directed Diffusion)

Directed Diffusion is a data centric protocols commonly used in wireless sensor networks. It consists of several elements: interests, gradients, data messages and reinforcements (positive and negative). An interest is a request, in which it specifies the desired by the base station (sink node) to the sensor nodes. A gradient is a response link to the neighbor from which the interest was received therefore, using the interest and gradients, routes are established between sensor nodes and sink node. Several routes can be set so that one of them is selected according to the rate. It is basically an improvement of SPIN [2].

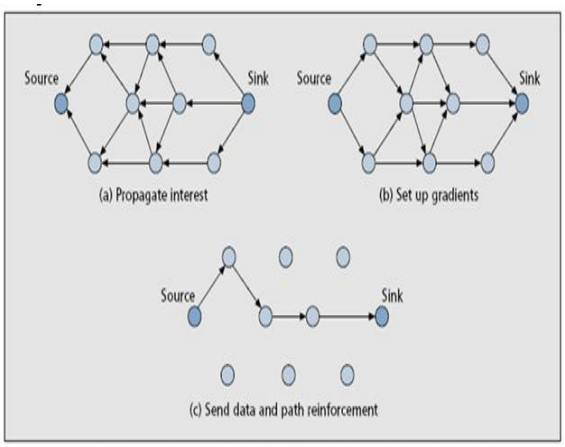
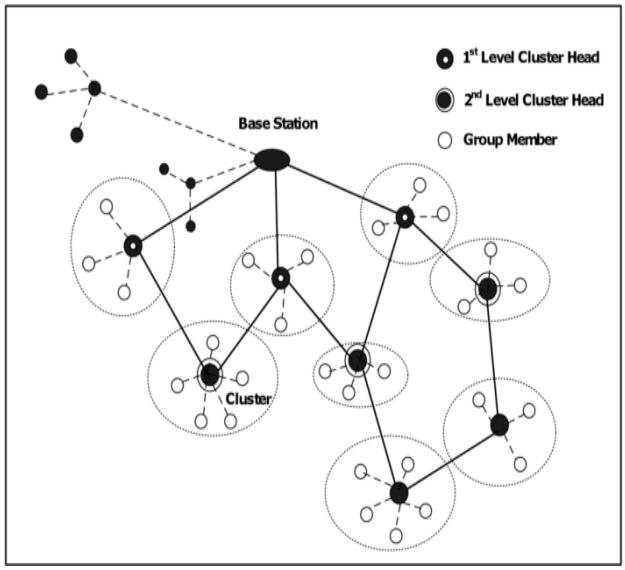


Fig 3. An Example of Interest Diffusion in a sensor network

3.3 Cluster Based Hierarchical Routing Protocols

Clustering is a technique which is used to improve network lifetime, reduce the energy consumption increase the scalability of the wireless sensor network .The main idea of Hierarchical routing protocols (also known as cluster based routing protocols) resides in grouping the sensor nodes on the basis of some suitable criteria. Cluster based protocols normally also chooses node(s) with the highest residual energy as cluster head(s) which eases efficient energy distribution. Main cluster based protocols include Low Energy Adaptive Clustering Hierarchy (LEACH), Power-Efficient Gathering in Sensor Information Systems (PEGASIS), Threshold sensitive Energy Efficient sensor Network protocol [4].*Fig4. Cluster based routing protocol*



3.3.1 Low Energy Adaptive Clustering Hierarchy (LEACH)

The main idea of LEACH resides in forming clusters of sensor nodes based on incoming signal strength and then local cluster heads are used as routers to the sink. It is a hierarchical protocol in which most nodes transmit to cluster heads, and the cluster heads aggregate and compress the data and forward it to the base station (sink). Each node uses a stochastic algorithm at each round to determine whether it will become a cluster head in this round. LEACH assumes that each node has a radio powerful enough to directly reach the base station or the nearest cluster head, but that using this radio at full power all the time would waste energy [8].

Nodes that have been cluster heads cannot become cluster heads again for *P* rounds, where *P* is the desired percentage of cluster heads. Thereafter, each node has a 1/*P* probability of becoming a cluster head again. At the end of each round, each node that is not a cluster head selects the closest cluster head and joins that cluster. The cluster head then creates a schedule for each node in its cluster to transmit its data.All nodes that are not cluster heads only communicate with the cluster head in a TDMA fashion, according to the schedule created by the cluster head. They do so by using the minimum energy needed to reach the cluster head.

3.3.2 TEEN (Threshold sensitive Energy Efficient sensor Network)

TEEN is a cluster based routing protocol based on LEACH which improves at the same time by transferring the data less frequently. The network is considered as collection of simple nodes, 1stlevel cluster heads(CH) and 2nd CH. LEACH strategy used in this protocol for cluster formation. After forming the clusters, the cluster head broadcasts two thresholds namely hard and soft thresholds to all the nodes; which are the key feature of TEEN. Hard threshold is the minimum threshold used to trigger a sensor node to switch on its transmitter and therefore transmit to the CH. Thus, the hard threshold will ask the sensor node to perform transmission only when the sensed attribute is in the required range and reduces the number of transmissions significantly. Once a node senses a value at or beyond the hard threshold, the data is transmitted only when the attribute changes by an amount greater than or equal to the soft threshold. i.e., soft threshold reduces the number of frequent transmissions even after the hard threshold is crossed if there is no change or little change in the value of sensed attribute compared to soft threshold. [9]

IV. ENERGY EFFICIENT ROUTING IN WIRELESS SENSOR NETWORKS

In this paper, we provide an improved routing algorithm on the basis of clustering approach proposed in LEACH. Moreover this paper proposes an effective energy balancing algorithm which makes the overall procedure feasible to power consumption.The proposed approach makes the following assumptions on the network. Firstly, the nodes are considered as static nodes and each cluster head possesses the capability to communicate with the base station or sink [4].

At the network initialization step, it is assumed that, a broadcasting scheme is adopted by each node which informs each node about its residual energy. Also neighbors are also identified by each node. Neighbors are defined as those nodes which is reachable at the radio range of each node. This neighbor detection is particularly important for cluster formation. Whenever the detection is done, it builds an information table with its residual energy, neighbor nodes and corresponding residual energy. There exists other parameter regarding number of rounds it is acting as cluster head (initially zero), number of rounds it is acting as cluster coordinator (initially

zero), current cluster head id, and current cluster coordinator id. The two threshold values including Hard and Soft Threshold (as in TEEN) and Cluster coordinator is aimed to minimize the energy dissipation of nodes of each cluster. Cluster coordinator is selected as the node which has the maximum residual energy in that cluster other than cluster head. The main motivation of incorporating cluster coordinator is to balance the load distribution between inter cluster communication and intra cluster communication.

V. CONCLUSION

Routing in sensor networks is a new area of research, with a limited, but rapidly growing set of research results. In this paper, we presented a comprehensive survey of routing techniques in wireless sensor networks which have been presented in the literature. They have the common objective of trying to extend the lifetime of the sensor network, while not compromising data delivery. Overall, the routing techniques are classified based on the network structure into three categories: flat, hierarchical, and location based routing protocols. Furthermore, these protocols are classified into multipath-based, query-based, negotiation-based, or QoS-based routing techniques depending on the protocol operation. We also highlight the design tradeoffs between energy and communication overhead savings in some of the routing paradigm, as well as the advantages and disadvantages of each routing technique. Although many of these routing techniques look promising, there are still many challenges that need to be solved in the sensor networks. We highlighted those challenges and pinpointed future research directions in this regard.

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