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A Review on Wireless Sensor Networks

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***Abstract*—This paper is a review of Wireless Sensor Networks (WSN) which is composed of group of low cost sensor nodes are used to detect physical changes of the environment. The sensor nodes have computing, communicating and storing capabilities. This paper is a survey of different topologies of WSN, the Architecture of Sensor Network, Routing Protocols for effective flow of sensor data, Applications and the comparison between WSN and Wired Sensors.**

***Index Terms*— Wireless Sensor Networks (WSN)**

I. Introduction

A Sensor network is a composition of a large number of low cost, low power sensor nodes which are highly distributed inside the system or very close to it. These individual sensors are limited in processing, but when they are grouped, they are capable of sensing physical data in accurate detail.

Topology of WSN is the interconnection between the nodes for communication. The sensor data will be collected by a collector known as the gateway and this information will be extracted by the system. The Routing protocols are designed to make the nodes effective, fast and most importantly energy efficient.

The WSN is used for many applications, the most common applications are Precision agriculture, Environmental Monitoring, Vehicle Tracking, Health care monitoring, Smart buildings, Security and Surveillance, Animal Tracking. However, Security might be a problem in WSN, for example even if one node gets hacked by a hacker, he might be able hack into the entire network. Hence there is a need for having tight security to overcome these problems.

II. Sensor Network Topology

Sensor nodes can be used for continuous sensing and event detection. These are the different network structures or topologies of wireless network.

A. Single Hop Star Topology

It is one of the basic WSN topology. It consists of a centralized data collector known as Gateway. Every node in this topology communicates with the gateway, the information collected by the gateway will be forwarded to the external memory. The limitations of this topology is that if the node is too far away from the gateway the connection between them to transfer data will be poor. The topology is best only in case of less coverage area and the number of sensor nodes are less. The coverage area for the transmission of data in this topology ranges around 30m [2]. The Single hop Star Topology structure is shown in Fig. 1.

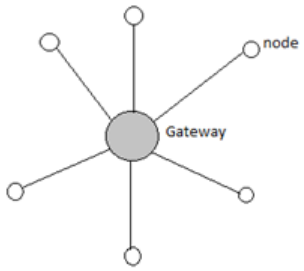

Fig. 1. Single hop star topology

B. Multihop Mesh & Grid Topology

The lack of area coverage in single hop star topology was negated by the Multihop Mesh and Grid Topology. In this topology, the data flows from one sensor node to another, until it reaches the gateway. The flow of sensed data from nodes to the gateway is determined by a routing protocol which makes use of an effective algorithm to increase the energy efficiency. The network could be random or structures as shown in the Fig. 2, and Fig. 3.

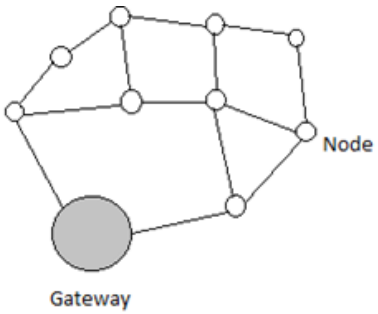

Fig. 2. Multihop mesh

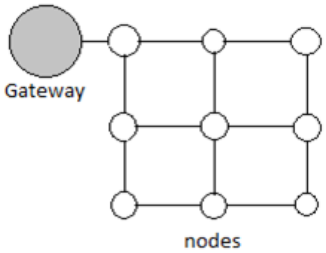

Fig. 3. Grid topology

C. *Two tier Hierarchical Cluster Topology*

The two tier Hierarchical Cluster topology [2] is made of two tiers namely the upper tier and the lower tier. The upper tier consists of highly energetic nodes called cluster heads and a gateway. The lower tier consists of low power sensor nodes, which are grouped together to form cluster nodes. In this topology, the sensed data by the cluster nodes in the lower tier will be forwarded to the cluster heads mounted on the upper tier, which in turn sends the information to the gateway. The two tier Hierarchical Cluster topology is shown in figure 4. This Topology increases the overall performance of the sensor network and it is energy efficient.

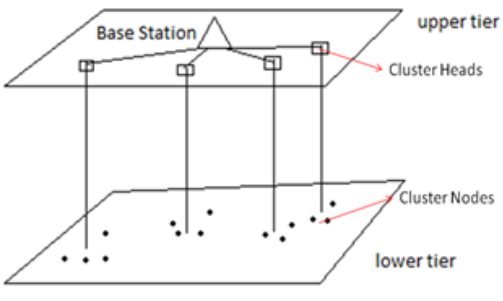

Fig. 4. Two tier hierarchical cluster topology

III. Sensor Architecture

The sensor nodes are deployed in such a way so that it can be used to operate on areas which cannot be accessed and there is a minimum effort from the base station to fetch the sensor data. Sensor nodes are distributed in a sensor field as shown in the figure 5. Each of these sensor nodes can communicate with each other [5]. As shown in figure 5, the sink collects the information from the base station of the sensor field and is responsible for communication with the internet/Server. The task manager node gathers the information from the internet based on the instruction by the user.

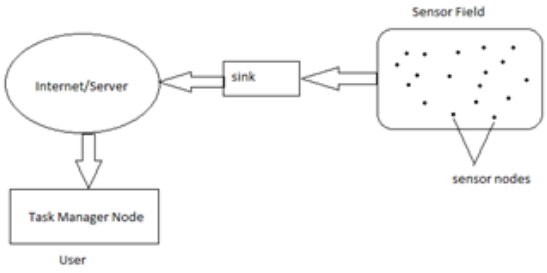

Fig. 5. Sensor architecture

IV. Sensor Characteristics

The sensors have less memory space and battery energy since sensor nodes are small and low cost [5]. The bandwidth of sensor network for communication is narrow and the communication distance is less. If the WSN network topology has reconfiguration property, then new sensor node can be added to the field. Hence it has dynamic nature. Sensor nodes support Multihop communication, where a node will communicate with neighboring nodes to cover large areas.

V. Routing Protocols

Routing Protocol determines the best route for transmission of data. Routing includes node deployment & data reporting methods. There are three classifications of routing protocols [4], they are Data Centric Protocols, Geographic routing protocol and Hierarchical routing Protocol. In data centric, the sensors are deployed randomly without calculation and here the nodes which record the events will straight away forward it to the gateway, which will further forward the data to the external memory. The Single hop Star topology will be used in this protocol. In Geographic routing protocol, the deployment of sensor nodes depends on geographical information of sensor nodes. Here the node communicate with each other based on an algorithm in which nodes are supposed to get all the information from the neighboring nodes. The multi mesh and grid topology is the topology used in this protocol. This protocol will reduce energy consumption. In the Hierarchical routing protocol the topology used will be two tier hierarchical structure. Here the nodes which have more energy will behave as cluster heads and the rest of the nodes with least energy will behave as cluster nodes. As discussed in the two tier hierarchical structure topology, the cluster nodes sense the data & carry it to the cluster heads and the cluster heads forward the sensed information to the base station. This routing protocol is energy efficient and it increases the performance.

VI. Sensor Network Applications

The different applications of WSN are Precision agriculture, Environmental Monitoring, Vehicle Tracking, Health care monitoring, Smart buildings, Security and Surveillance, Animal Tracking, Space Monitoring and Ocean Monitoring.

A. *Precision Agriculture*

Improper irrigation in agriculture leads to crop failure and mainly water wastage. Water wastage problem can be deduced by using proper irrigation system and it can be achieved using WSN. Here Wireless Moisture Sensor Networks (WMSN) will be used which is a WSN with moisture sensors. The amount of water required for the crop will be specified by the agronomist and he should have the knowledge of the amount of water required for the crop. [11] Is an implementation of a system, where WMSN is used for Precision agriculture and the test results show that there is a 1500ml of water saving per day per tree.

B. *Environmental Monitoring*

WSN can be used in environment to determine natural calamities like earthquakes, flood, forest fire, tsunami, gas leakage, rainfall, water quality, volcanic eruption, cyclones and so on. Since the network provides an early detection and prediction of all these environmental calamities, it helps in taking safety measures [10]. The data is sensed using the sensors and is transmitted to the master station via internet. This

helps in taking precautions and also aids in making people aware of the disaster that is about to come.

C. Vehicle Tracking

WSN helps in preventing traffic congestion and is used in parking system and also to find the location of the vehicle [12]. The recent increase in the number of vehicles used in city has urged the need for better smart parking mechanism. In cities, finding a vacant parking space is time consuming and the limited availability of parking space leads to traffic jams and air pollution. WSN provides a cost effective solution for parking problems. The sensor nodes will be deployed in each parking slot & the status of the parking space, whether it is vacant or occupied will be saved in the server. The user can make use of the mobile application, which provides a map of his location and it can be used to locate the vacant parking slot. The application can also guide him to the parking location.

D. Health Care Monitoring

The WSN can be used to sense psychological parameter. The sensed parameters are then passed to the practitioner for further analysis and diagnosis. The parameters may include blood parameter, water content etc. The Wireless Body Sensor Network (WBSN) will be attached to the patient's body and they are able to sense the heart rate, blood pressure and so on [9]. It can also detect abnormal conditions of the patient and issue an alarm.

E. Smart Buildings

Power consumption has been a major issue in buildings. The wireless sensor can be used to accurately monitor power consumption by electrical appliances and the sensed information will be useful to control it. Few WSN systems are capable of measuring both temperature and humidity within the concrete structure.

F. Security & Surveillance

WSN plays as an important element of armed command, control, communication, computing, intelligence, surveillance, and targeting systems [6]. It can be used to monitor equipment, ammunition and detect the movements of enemies and friendly forces, location and position of the enemy vehicle. Since military operations include aggressive actions like destruction and devastation of sensor nodes will not be a problem since the nodes are of low cost.

G. Animal Tracking

In Animal tracking, the sensor nodes will be attached to the animal's body so that the transportation and position of the animal can be identified [7]. The difficulties in tracking the natural habitat of certain animals has been resolved. For example the King Cobra whose life habitat was difficult to track was resolved by inserting the sensor nodes inside the skin of this reptile.

H. Space Monitoring and Survillance

Exploring the outer space has been the dream of mankind [1]. The sensor nods can be dispersed to outer space and also can be sent to the surface of another planet which can be monitored using the help of spacecraft. Since WSN modules are compact and economic, this method is reliable.

I. Ocean Monitoring

WSN has seen recent development in ocean monitoring system. The development of sensor nodes is convenient since there is no need of any base station nor the cable infrastructure [1]. Moreover sensor nodes are not expensive and can be deployed in wide range of water. This helps in the study of aquatic life, detection of ocean soil, to find the depth of the ocean and maintenance of ocean transport system.

VII. Difference Between WSN and Wired Sensors

WSN are easy to install since there are no use of cables for connection for communication [13]. In a same network the WSN nodes may not be able to communicate with few nodes, whereas in wired, all the nodes can communicate with all the nodes of the network. In WSN one network can affect the performance of the other network, which is not in case of wired sensor networks. Time for installation in case of wired connection is more since every computer needs to be connected to each other in the network. The wired sensors are of relatively low cost since wireless adapters and access points are expensive in WSN's. WSN can operate on inaccessible areas, whereas in wired sensors, connectivity is available till the extension of the cable. Speed of transmission of data in wired sensors are relatively high. WSN works on wireless communication through radio waves and microwaves whereas in wired sensors copper cables, ethernet and optical fibers will be used as a means of communication. Security is weak in case of WSN since the communication signal sent through air can be intercepted. Signal loss is more in WSN since the signal encounters reflection, absorption, refraction and interference.

VIII. Conclusion

In this paper, we discussed three topologies of Wireless Sensor Networks, the architecture of senor networks, different routing protocols for the effective flow of sensor data, Applications of WSN and the difference between WSN and Wired. Hence we can conclude that in the future, the WSN will have wide range of application areas to make sensor networks an integral part of our lives.

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