IJCSN International Journal of Computer Science and Network, Volume 4, Issue 4, August 2015
ISSN (Online) : 2277-5420 www.IJCSN.org
Impact Factor: 0.417

WSN and its Application

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Abstract - The area of wireless sensor network is one of the emerging and fast growing field in the world but a key issue in WSN is maximizing the network lifetime. Network lifetime is important in sensor node when the sensor node, distributed typically in remote area is powered by finite energy batteries. This brought about low cost, low power and multifunctional sensor nodes. However, the major fact that sensor node run out of energy quickly has been an issue and many energy routing protocols have been proposed to sort out the problem and increase the longetivity of the network. This is the only reason why routing protocol in WSN mainly focus on the power conservation. Most of the protocol is designed to minimize the energy conservation in sensor network. This thesis work proposed a hierarchical routing technique which shows energy.

Keywords - *WSN, Sensor Node, Energy Efficiency, Power Consumption.*

1. Introduction

WSN is an important subsidiary of the wireless communication network. The sensor are spatially distributed to monitor physical or environmental condition such as temp, sound, pressure etc and to cooperatively pass their data through the network. WSN is built of nodes that consists of large no of sensor nodes of small size, low power, low cost with limited memory, comm. Resources and a base station these nodes continuously supervise in environment and collect the information and then finally transmit to the base station

A WSN consist of hundreds or thousands of nodes. The Sensor nodes within a sensor field transmit their data to the destination through some intervening node. The destination is connected to a central gateway that is also known as BS. Finally this Central gateway provides a connection when data is collect, process and analyzed. This paper gives a brief introduction about WSN with its components and classification and architecture, various aspects, energy consumption reasons and solutions for energy efficiency and applications of WSN.

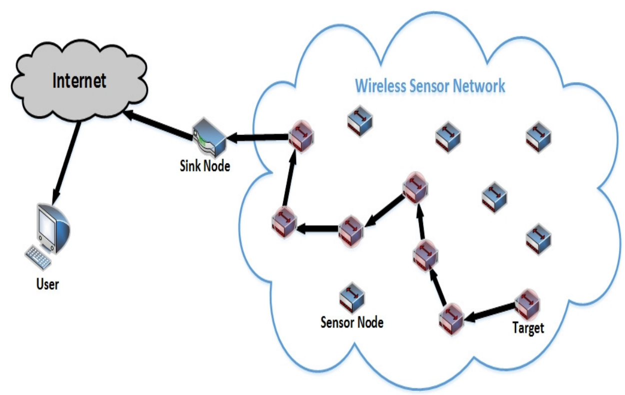

Fig. 1 Example of WSN

The WSN consist of two components
- Sensor node
- Base station

Sensor node: are typically made of few sensors. Sensor is a device which senses the information and sends it on a mote. It is typically used to measure the change in physical parameter like temperature, pressure, sound and vibration. A mote that contain processor, memory, battery , A/D convertor for connecting sensor to sensor and a radio transceiver for forming an ad-hoc network. A mote and sensor together form a sensor node .A sensor network is a wireless ad-hoc network of sensor network. Each sensor node can sustain a multi hop routing algorithm and function as forwarded for relying data packet to base station.

Base station – connects the sensor network to another network, as it includes antenna, processor radio board and USB interface board. Deployment of the base station in a WSN plays a very crucial role, as all sensor node hand over data to a base station for further processing and decision making of data. Thereabout base stations are static in nature but in same situation they are assumed to be mobile to collect data from sensor node.

Classification of WSN

Sensor network based on their mode of functioning and the type of target application. They are classified as proactive, reactive and hybrid.

1.3.1 Proactive Network

The node in the network sporadically switches on their sensor and transmitter, sense the environment and transmit the data .Hence they provide a snapshot of the likely parameter at constant interval. They are well suited for applications which require periodic data monitoring. E.g. LEACH, improvement of LEACH[6].

1.3.2 Reactive Network

The nodes of the network react immediately to abrupt and drastic changes in the values of sensed attributes. They are applicable for the time critical application. The path values are calculated only when it is required. Whenever a sink want to connect a particular node, first path are calculated and from the calculated path we have to take the best path for the data transmission. [6,7].

1.3.3 Hybrid Network

In this network the node, not only react to time critical but also provides an overall picture of the network at regular interval in a energy efficient manner. In general, it is a composite of both proactive and reactive protocol. Depending on the type of communication , it decide whether to calculate path from sink(BS)to source .proactive are considered to be better when the nodes are static and in this it is not assure to search the nearest neighbor for every next hop when data is transmitted [8,9,10].

Why Microscopic Sensor Nodes?
The transition from large to small scale sensor nodes has several advantages.

(1) Small sensor nodes are easy to manufacture with much lower cost than large scale sensors. They are even disposable if the envisioned US$1 target price can be realized in the future.
(2) With a mass volume of such low cost and tiny sensor nodes, they can be deployed very closely to the target phenomena or sensing _eld at an extremely high density. Therefore, the shorter sensing range and lower sensing accuracy of each individual node are compensated for by the shorter sensing distance and large number of sensors around the target objects, which generates a high signal to noise ratio (SNR).
(3) Since computing and communication devices can be integrated with sensors, large-sample in-network and intelligent information fusion becomes feasible. The intelligence of sensor nodes and the availability of multiple onboard sensors also enhance the flexibility of the entire device and communication system.

2. WSN Architecture

It is made of four basic components i.e.: a sensing unit, a processing unit, a transceiver unit, and a power unit.[3,4]

Sensing unit is usually designed of two subunit i.e. sensor and analog to digital convertor. Sensor is a device which is used to convert the physical phenomena to electrical signal there exist a variety of sensor that measure environmental parameter such as temp., light, sound etc the analog signal produced by the sensor are transform to digital signal by the analog to digital convertor then finally supply into processing unit. When using sensors it should be microscopic sensors.

Processing unit mainly provides intelligence to the sensor node .It contains microprocessor, which is responsible for the execution of communication protocol, control of the sensor and signal processing algorithm on the aggregated sensor data. In general, there are mainly four processor states in a microprocessor which can be categorized as Sleep, Idle, Off and active .In the sleep mode, most of the internal devices and CPU are turned on and can only be activated by some external event but in case of idle mode, the CPU is still in active but other peripheral are active.

Transceiver can handle in transmit, receive, idle and sleep mode operating in idle mode results in considerable high power consumption which is almost equal to the power consumed in the receiver mode .Hence it is important to completely shut down the radio rather than set it in a idle mode when it is not transmitting or receiving data due to the high power consumed. Sleep mode is an important state among four states in WSN in terms of Energy Saving.

Battery The battery provides power to the entire sensor node. It plays a crucial role in deciding the lifetime of the sensor node. The amount of power drawn from a battery should be carefully supervised. Sensor node is almost small, light and cheap, but the size of the battery remains limited. In this battery replacement is not an option for network with thousand of embedded nodes. This induces the energy consumption to be the most important factor in determining the sensor network lifetime.

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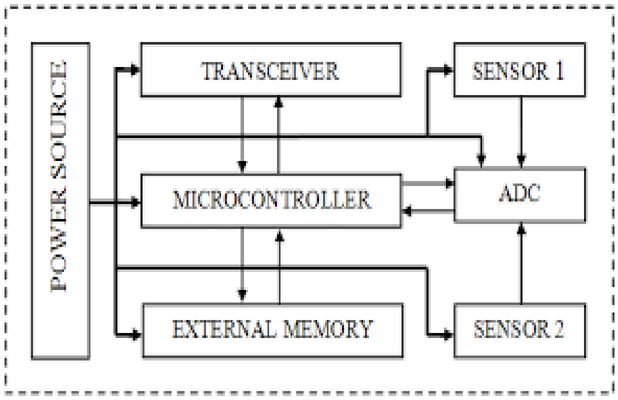

Fig. 2 Architecture of WSN

2. Aspects of WSN

1) QOS
2) Energy Efficiency
3) Scalability
4) Robustness

2.1QOs

Qos in a wsn is more complicated

- Event detection and reporting probability
- Event classification error
- Detection delay
- Probability of missing a periodic report
- Approximation accuracy
- Tracking accuracy

2.2 Energy Efficiency

- Energy per correctly received bit
- Energy per reported event
- Delay/energy trade off
- Network lifetime
- Time to first node dead
- Network half lifetime
- Time to partition]
- Time of loss of coverage

The evaluation of these metrics is clear assumptions: Node energy consumption, network load, radio channel behaviors

2.3 Scalability

Maintain performance characteristics regardless of the number of nodes

- Scalability has direct conseques for the protocol design
- Often penalty in performance and /or complexity for small network.

2.4 Robustness

3. Power Consumption

Fig. 3 Architecture of WSN

With the advance in the technology the use of wireless sensor networks is multiplying day by day and at the same time it faces the problem of energy constraints in terms of restricted battery lifetime. As each of the nodes depends on energy for its activities, this has become a major consequence in wireless sensor networks. The failure of one node can interrupt the overall system or application. Every sensing node can be in active, idle and sleep nodes. If it is in active mode nodes consume energy when receiving or transmitting data but in idle mode, the nodes consume almost the same amount of energy as in active mode, while in sleep mode, the nodes shutdown the radio to save the energy.

The main challenges in maximizing network utility in data gathering .these are mentioned below [41]

1) The path from any sensor to sink is selected depending on the network topology.
2) The same path is shared by the different sensor for sending data to save energy. This causes link failure
3) A number of sensors having data to sink increase the complexity of the problem.
4) The delivery ration for a path/ link increases the retransmission as well as increase transmission delay and energy consumed.

3.1 Reason of Energy Waste

WSN, energy is released during sensing, processing, transmitting, or receiving data to fulfill the goal/target required by the application

a) Collision when the node receives more than one data at the same time. These data may collide. All the data that cause the collision are to be discarded and retransmission of data is done.

b) Overhearing
c) Control packet overhead: a minimal no of control packet should be used to enable data transmission.

***d)* Idle listening** Is one of major source of energy wasted. It happen when a node is listening to an idle channel in order to receive possible traffic.

3.2 How to Save Energy Save Energy

The subsequent steps can be taken to save energy which is affected by communication in wireless sensor networks are: [24].

1. Schedule the state of the nodes (i.e. transmitting, receiving, idle or sleep).
2. Changing the transmission range between the sensing nodes.
3. Efficient routing and data collecting methods are taken into consideration.
4. Avoiding the handling of undesirable data as in the case of overhearing.

In WSNs the only source of life for the nodes is the battery. While communicating with other nodes or sensing activities take place it consumes a lot of energy in processing the data and transmitting the collected data to the sink. In many cases (e.g. surveillance applications), it is undesirable to replenish the batteries that are used up or drained of energy.

One hop model (single hop) This is one of the simplest approach which represent direct communication. In this each and every node in the network transmit data to the BS directly. This communication implies not only costly in terms of energy consumption but also infeasible because nodes have limited range. In a large area network most of the nodes which are far away will not directly reach the BS.One hop or direct communication is not a feasible node for routing WSN.

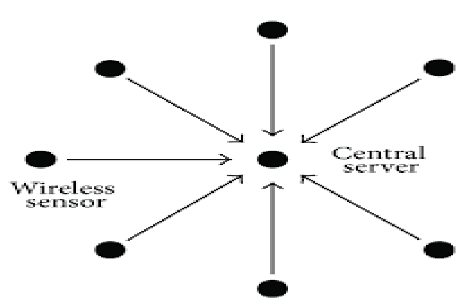

Fig. 4 Architecture of WSN

Multi -hop model In this model a node transmit to the BS by passing its data to one of its neighboring data, which is close to BS. Therefore the information travel from source to destination by hop from one node to another until it reaches the destination (sink/BS) .One of the techniques is data aggregation used in all clustering based routing protocol. Even though optimization technique improve the performance of this model.

Fig. 5 Architecture of WSN

Why limited battery source in sensor node?
The WSN are powered by estimatable energy batteries. Being deployed in remote areas these batteries do not easily replaced or recharged. Therefore end of battery in a node mean, end of node lifetime which in turn can change the network topology. So the network lifetime shows strong dependency on battery lifetime. Efficient use of battery energy is hence requisite to enhance the network lifetime.

4. Applications of WSN

Several applications have been benefited from the advances in wireless sensor networks.

4.1 Data Gathering Applications

4.1.1 Habitat Study

Habitat study is one of the driving applications for WSNs. Such applications usually require the sensing and gathering of bio-physical or biochemical information from the entities under study, such as Redwoods, Storm Petrels, Zebras, and Oysters. In many scenarios, habitat study requires relatively simple signal processing, such as data aggregation using minimum, maximum, or average operations. Hence, motes are ideal platforms for such applications. For this the network was designed to have a tiered structure. The motes were grouped into patches so that data collected in each patch could be relayed via a gateway to a base station, where data logging was performed.

Environmental Monitoring
Environmental monitoring is another application for WSNs. The vast spaces involved in such applications require large volumes of low cost sensor nodes that can be easily dispersed throughout the region. For instance, WSNs have been studied for forest fire alarm, landscape flooding alarm, soil moisture monitoring, microclimate and solar radiation mapping, and environmental observation and forecasting in rivers. The system distinguishes itself by using a reactive data gathering strategy l frequent soil moisture readings are collected during rain, while less frequent readings are collected otherwise. This strategy helps increase the system lifetime.[1]

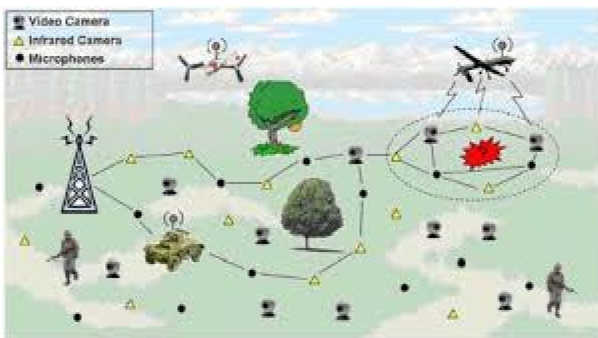

Fig. 6 Architecture of WSN

Greenhouse Monitoring
To ensure that the automation system in a greenhouse works properly, it is necessary to measure the local climate parameters at various points of observation in different parts of the big greenhouse. A WSN based application for this purpose using many small size sensor nodes can be equipped with radio for a cost effective solution. Wireless sensor networks are also used to control the temperature and humidity levels inside commercial greenhouses. When the temperature and humidity drops below specific levels, the greenhouse manager must be notified via e-mail or cell phone text message, or host systems can trigger misting systems, open vents, turn on fans, or control a wide variety of system responses. Because some wireless sensor networks are easy to install, they are also easy to move as the needs of the application change.

Water/Wastewater Monitoring: There are many opportunities for using wireless sensor networks within the water/wastewater industries. Facilities not wired for power or data transmission can be monitored using industrial wireless I/O devices and sensors powered using solar panels or battery packs. As part of the American Recovery and Reinvestment Act (ARRA), funding is available for some water and wastewater projects in most states.[2]

Computation-Intensive Applications

4.2.1 Structural Health Monitoring

Health monitoring for civil structures has long been a research topic for industry and academia. Traditional methods include visual inspection, acoustic emission, ultrasonic testing, and radar tomography. The emergence of WSNs has prompted new, non-destructive, and cheap methods for many tasks related to structural health monitoring. Many sophisticated and computationally intensive signal processing algorithms have been studied, including the Fast Fourier Transformation (FFT), Wavelet Transform, Autoregressive Models, and AR-ARX Damage Detection Pattern Recognition Method. To serve the large computation demand from these algorithms, while maximizing energy savings, a dual-core design method has been employed. These systems facilitate continuous data acquisition over a self-configuring multi-hop WSN, with high data rate and reliable communication requirements.

4.2.2 Heavy Industrial Monitoring

Sensors have already been widely used in industrial applications, such as the monitoring of automated assembly lines. Integrating wireless technology with these sensors enables condition based maintenance (CBM) to reduce downtime and enhance safety, with low installation and maintenance cost. Condition based maintenance can replace traditional high-cost, schedule driven, manual maintenance for various industrial entities, including power plants, oil pipelines, transportation systems and vehicles, engineering facilities, and industrial equipment. Industrial applications are unique in their requirement of highly reliable operation in harsh environments. For example, the electromagnetic radiation of machines may cause microcontroller malfunction or wireless communication interference. Also, the large variation in temperature and humidity demands reliable hardware components. Moreover, industrial applications often require the processing of large volumes of data with sophisticated signal processing algorithms. Thus, computation demand is usually high for these applications[1].

4.2.3 Military Applications

In the battlefield context, rapid deployment, self-organization, fault tolerance security of the network should be required. The sensor devices or nodes should provide following services:

- Monitoring friendly forces, equipment and ammunition
- Battlefield surveillance
- Reconnaissance of opposing forces
- Targeting
- Battle damage assessment
- Nuclear, biological and chemical attack detection reconnaissance.[3]

4. Conclusions

This paper gives a brief introduction about WSN with its components and classification and architecture, various aspects, energy consumption reasons and solutions for energy efficiency and applications of WSN. This is also useful to understand the battery consumption factors and saving energy in WSN. Different models of WSN were also explained in this paper.

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