



Comprehensive Study of Applications of Wireless Sensor Network

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Abstract— *Sensor Networks were initially deployed for Military operations and surveillance but it emerged as a potential solution for various other fields like Environment sensing, Industrial sensing, Health and Home applications. Low cost small sensor nodes and robustness of the network allows the use of sensor network in various other fields. This paper studies the application areas of sensor network.*

Keywords— *Wireless Sensor Network, architecture, military applications, environment sensing, industrial sensing*

I. INTRODUCTION

There have been immense advancements in field of technology over the past years. Small size, low cost sensor networks have been developed which are capable of collecting, analyzing and transmitting information to a central processor node for further analysis and report generation. Wireless Sensor Network is a term for densely deployed sensor nodes which are capable of collecting real time information. These networks provide advantages over traditional sensing devices as they provide low cost network deployment and are fault tolerant and robust[1],[2].

A sensor network consists of large no of sensor nodes deployed in random topology(Figure 1). Sensor networks are deployed close to the phenomenon which is to be observed. Instead of sending collected data directly to processor node, sensor nodes uses its processing capabilities and transmit partially processed data to task manager node via satellite for further processing as shown in Figure 1. The communication power of transceiver is limited therefore information is communicated to Base station or Sink by multihop path [2].

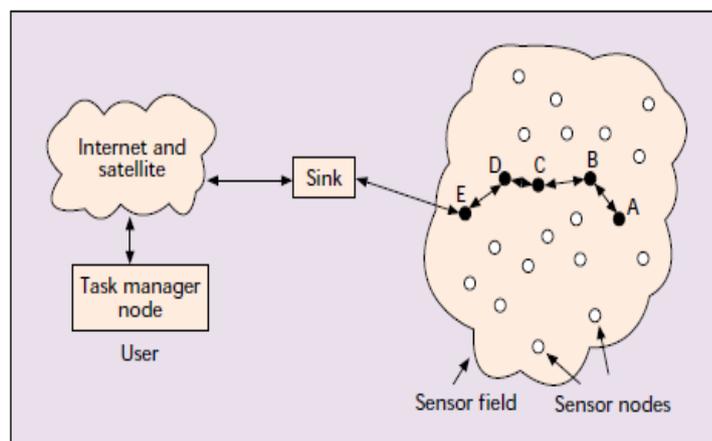


Figure 1 Sensor Node deployment and Communication Infrastructure

II. SENSOR NODE ARCHITECTURE

A Sensor node consists of following components (as shown in fig 2):

A. Power Unit

A sensor node consumes power for sensing, processing and transmitting data. A power source can be both a chargeable and non chargeable battery. For chargeable power source solar cells can be used. Power unit is an important component of sensor node as lifetime of node depends on lifetime of its battery[3].

B. Sensors

A sensor is a small hardware device which is capable of generating response to change in physical environment. Although sensors are of different type which are application specific but desired characteristics of a sensor node are small size and low power consumption[4].

C. ADC Convertor

Sensor node produces analog signals so ADC convertors are embedded to convert analog signals to digital signals. These digital signals now can be sent for further processing.

D. Storage and Processing Unit

Sensor nodes are designed for processing data before transmitting. A little processing is done at node level. For processing data, storage unit is required. Memory requirement is too application dependent. But usually flash memories are used because they are cost effective[2],[3].

E. Transceiver

Transceivers are needed for co-ordination with other nodes. To send and receive data transceiver is needed. To minimize energy consumptions transceivers are usually turned off rather remaining in idle mode because idle mode consumes almost same power as the transmitting mode.

For transmitting data in wireless sensor network RF (radio frequency), Infrared or optical communications (LASER) are possible choices

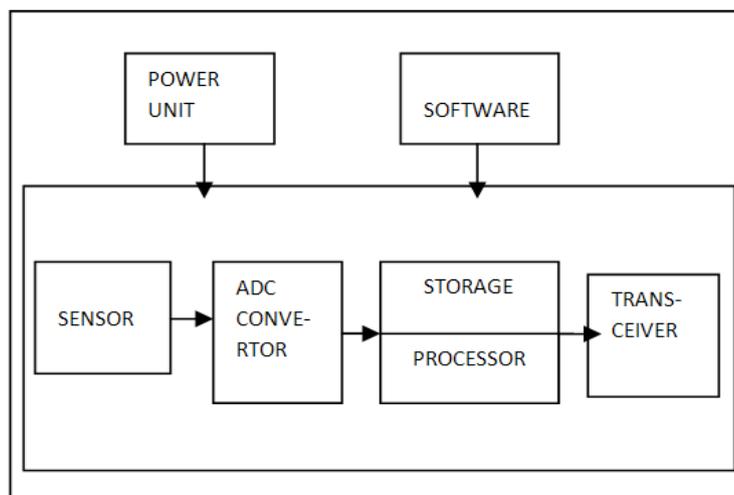


Figure 2 Sensor Node Architecture

III. APPLICATIONS OF SENSOR NETWORKS

Initially Sensor Network were developed for Military purposes like battlefield surveillance and intrusion detected as there was need of a network that is fault tolerant and robust. In military due to enemy attacks there is danger of potential physical damage[5]. But the flexibility of WSNs enabled researchers to look at WSN as a potential Application in various other fields. Current and possible application of WSN include areas like Military, Environment, Agriculture, Automobiles, Home applications and Industrial monitoring etc.

A. Military Applications

Sensor networks can provide variety of services to military and air force like information collection, battlefield surveillance, intrusion detection and attack detection. In this field of application sensor networks have quite an advantage over other networks because enemy attacks can damage or destroy some of the nodes but nodes failure in WSN doesn't affect the whole network. Possible uses of WSN in military are[7]:

- 1) *Intrusion detection:* Sensor network can be used as a 2-phase in Intrusion Detection System. Instead of using mines intrusion can be detected by establishing sensor network in that area. Mines are dangerous to civilians so instead sensor nodes sense the detection and alarm the army. The response to prevent intrusion is now decided by the military.
- 2) *Enemy Tracking and target classification:* Objects moving with significant metallic content can be detected using specially designed sensors. So enemies can be tracked and civilians are ignored. This system specially helps in detecting armed soldiers and vehicles.
- 3) *Battlefield surveillance:* Critical areas and borders can be closely monitored using sensor networks to obtain information about any enemy activity in that area. This provides quick gathering of information provides time for quick response.
- 4) *Battlefield damage assessment:* Sensor networks can be deployed after the battle or attacks to gather information of damage assessment.
- 5) *Detection of NBC attacks:* Sensor networks can be used as Nuclear, Biological and Chemical warning system. If any nuclear biological or chemical agents can be detected by sensors and embedded alert system can now send a warning

message. It provides the military critical response time to check the situation and prevent possible attacks which can save lives of many.[5],[6]

6) *Targeting system:* Sensors can be embedded in weapons. Exact information about the target like distance, angle can be collected and sent to the shooter. So sensors can be collaborated with the weapons for better target assessment.

B. Environmental Applications

Another major area of application of WSN is environmental monitoring. WSNs are deployed for habitat monitoring, flood detections, forest fire detection etc.

1) *Forest Fire detection:* Millions of sensor nodes can be deployed which use distributed sensing and collaborate with each other to provide information. So fire can be detected and exact location of fire origin can be provided before the fire is uncontrollable[9].

2) *Flood detection:* ALERT systems use sensors for rain, water level and weather. Information collected by these sensors can forecast the possible flood threats thus providing help for disaster management.

3) *Pollution Monitoring:* WSNs can be deployed for monitoring the level of pollution and warning generation. Air Pollution Monitoring Systems are deployed in cities like London and Brisbane to monitor the level of pollutants. These sensor networks look for amount of poisonous gases and these statistics are studied to analyze if pollution has increased and take actions to check pollution[9].

4) *Monitoring Wildlife Habitats:* WSNs can be deployed and are being deployed for wildlife research activities. These WSNs cover large area and provide useful information. By wildlife research behavior of Endangered species is studied which helps in preservation of these. Other activities studied with the help of sensors are-location, migration patterns of birds and other animals, food habits, hunting behavior, breeding and population. E.g. Great Duck Island, Maine[8]

It has several advantages over traditional methods of wildlife research like human investigator having camera recording activities, devices for tracking which were required to be attached on animal being tracked which can be damaged because for the animal it's a threat, a foreign element. So WSNs are attractive option over these. Advantages of WSNs over traditional methods are:

- Wide coverage
- Long monitoring periods
- No individual tracking
- Data available directly to researcher's location
- Land and Aquatic Coverage
- Continuous monitoring

5) *Other Disaster Management Applications:* WSNs can also be used for other disaster management like earthquake and landslide monitoring and disaster assessment.

C. Industrial Sensing

Commercial industry has long been interested in taking advantage of sensing as a means of lowering cost and improving machine performance and maintainability.

1) *Machine health monitoring:* Wireless sensor networks have been developed as a condition-based maintenance (CBM) solution for machinery. In wired systems, the cost of wiring limits the installation of enough sensors. Machine "health" is monitored through determination of vibration or wear and lubrication levels. WSNs enabled the insertion of sensors into regions that were inaccessible by humans like rotating machinery, hazardous or restricted areas[9].

2) *Monitoring Industrial Environment:* Wireless sensors are used for environmental condition monitoring in industries like monitoring the level of water in overflow tanks Nuclear Power plant and temperature inside refrigerators.

3) *Managing inventory control:* Each item in a warehouse may have a sensor node attached to it. The end users can find out the exact location of the item with the help of sensor and tally the number of items in the same category stored in the database.

4) *Interactive museums:* In the future, places like museums will become alive with the help of sensor networks. Children will be able to interact with objects in museums to learn more about them and the objects will be able to respond to their touch and speech with the help of sensors.

D. Health Applications

Sensor networks are also widely used in health care area. In some modern hospital sensor networks are constructed to monitor patient physiological data, to control the drug administration track and monitor patients and doctors and inside a hospital. They support fall detection, unconsciousness detection, vital sign monitoring and dietary/exercise monitoring[7]. WSNs are also used to form BAN(Body Area Network) which is placed close to body of patient and is used to monitor patient's heart beat rate and breath rate and movements[10].

E. Infrastructure Sensing

WSNs can be deployed as a part of infrastructure security. Critical buildings, monuments, stadiums can be protected from terrorist attacks using sensor networks. Sensors can alarm the user about potential threat using the same mechanism as enemy detection. Anyone with significant metal content can be detected as a possible threat and further action can be taken by the users who are handling the security of the event[9].

F. Smart Home applications

Sensor networks can be used for Home Automation application. Sensors can be configured with home appliances like Washing Machine, Air conditioners, vacuum cleaners and oven etc. This will make easy handling of these devices and now appliances can be accessed via Internet and can be controlled remotely[7].

G. Applications to Automobiles

Even sensors can be employed in vehicles which provide advance tracking mechanism for vehicles as well as tracking for theft vehicles by Police. Applications of WSN to vehicles are:

- 1) *Detecting and monitoring car thefts:* Sensor nodes are being deployed to detect and identify threats within a geographic region and report these threats to remote end users by the Internet for analysis.
- 2) *Vehicle tracking and detection:* Sensor nodes can be embedded in vehicle designs which is connected to WSN, the vehicle can be tracked with the help of sensor networks.
- 3) *Traffic Control:* Sensor networks have been used for vehicle traffic monitoring and control for quite a while. Most traffic intersections have either overhead or buried sensors to detect vehicles and control traffic lights. Furthermore, video cameras are frequently used to monitor road segments with heavy traffic, with the video sent to human operators at central locations[1].

H. Agriculture Applications

WSNs can be used for studying the local environment which is helpful in agriculture. Sensors are used to monitor the following conditions[11]:

- Temperature
- Humidity
- Soil moisture
- Wind speed and direction
- Rainfall
- Sunshine
- Level of CO₂

IV. CONCLUSIONS

Wireless Sensor Networks are emerging as a great way of data collection of monitoring. Its applications are not limited to Military Services but extend to vast area of human activities. The flexibility, fault tolerance, high sensing fidelity, low-cost and rapid deployment characteristics of sensor networks create many new and exciting application areas for remote sensing. In the future, this wide range of application areas will make sensor networks an integral part of our lives.

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