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Lecture: (3)

Introduction about Wireless Networks Sensors

Subject: Wireless Sensor Network
Level: Third
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1. Introduction to Wireless Sensor Networks

Sensors link the physical with the digital world by capturing and revealing real-world. Phenomena and converting these into a form that can be processed, stored, and acted upon. Integrated into numerous devices, machines, and environments, sensors provide a tremendous societal benefit.

Wireless sensor networks (WSNs) are interconnected sensor nodes that communicate wirelessly to collect data about the surrounding environment. Nodes are generally low power and distributed in an ad hoc, decentralized fashion. (See Fig 2.1).

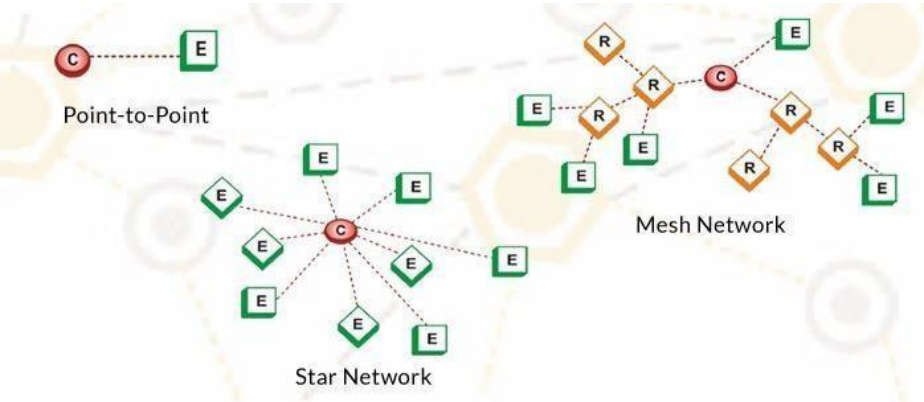

Figure 2.1. Wireless Sensor Network

2. Sensing and Sensors

Sensing is a technique used to gather information about a physical object or process, including the occurrence of events (i.e., changes in state such as a drop in temperature or pressure). An object performing such a sensing task is called a sensor. For example, the human body is equipped with sensors that are able to capture optical information from the environment (eyes), acoustic information such as sounds (ears), and smells (nose). Figure 2.2 shows an example of the steps performed in a sensing (or data acquisition) task.

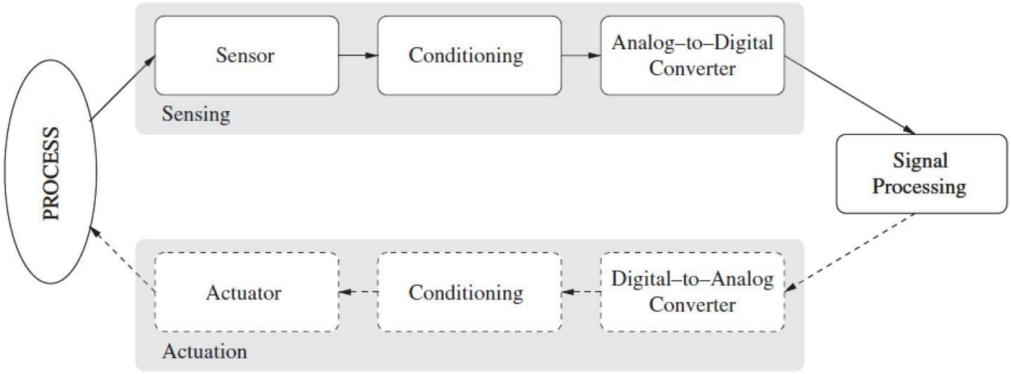

Figure 2.2. Data acquisition and actuation.

These are examples of remote sensors, that is, they do not need to touch the monitored object to gather information. From a technical perspective, a sensor is a device that translates parameters or events in the physical world into signals that can be measured and analyzed.

Many wireless sensor networks also include actuators which allow them to directly control the physical world. For example, an actuator can be a valve controlling the flow of hot water, a motor that opens or closes a door or window, or a pump that controls the amount of fuel injected into an engine. Such a *wireless sensor and actuator network* (WSAN) takes commands from the processing device (controller) and transforms these commands into input signals for the actuator, which then interacts with a physical process, there by forming a closed control loop.

3. Sensor Classifications

Which sensors should be chosen for an application depends on the physical property to be monitored, for example, such properties include temperature, pressure, light, or humidity. Table 2.1 summarizes some common physical properties, including examples of sensing technologies that are used to capture them.

Table 2.1. Classification and examples of sensors

Type	Examples
Temperature	Thermistors, thermocouples
Pressure	Pressure gauges, barometers, ionization gauges
Optical	Photodiodes, phototransistors, infrared sensors, CCD sensors
Acoustic	Piezoelectric resonators, microphones
Mechanical	Strain gauges, tactile sensors, capacitive diaphragms, piezoresistive cells
Motion, vibration	Accelerometers, gyroscopes, photo sensors
Flow	Anemometers, mass air flow sensors
Position	GPS, ultrasound-based sensors, infrared-based sensors, inclinometers
Electromagnetic	Hall-effect sensors, magnetometers
Chemical	pH sensors, electrochemical sensors, infrared gas sensors
Humidity	Capacitive and resistive sensors, hygrometers, MEMS-based humidity sensors
Radiation	Ionization detectors, Geiger–Mueller counters

While many sensors connect to controllers and processing stations directly (e.g., using local area networks), an increasing number of sensors communicate the collected data wirelessly to a centralized processing station. This is important since many network applications require hundreds or thousands of sensor nodes, often deployed in remote and in accessible areas. Therefore, a wireless sensor has not only a sensing component, but also onboard processing, communication, and storage capabilities. With these enhancements, a sensor node is often not only responsible for data collection, but also for in-network analysis, correlation, and fusion of its own sensor data and data from other sensor nodes. When many sensors cooperatively monitor large physical environments, they form a wireless sensor network (WSN). Sensor nodes communicate not only with each other but also with a base station (BS) using their wireless radios, allowing them to disseminate their sensor data to remote processing, visualization, analysis, and storage systems. (See Fig 2.3).

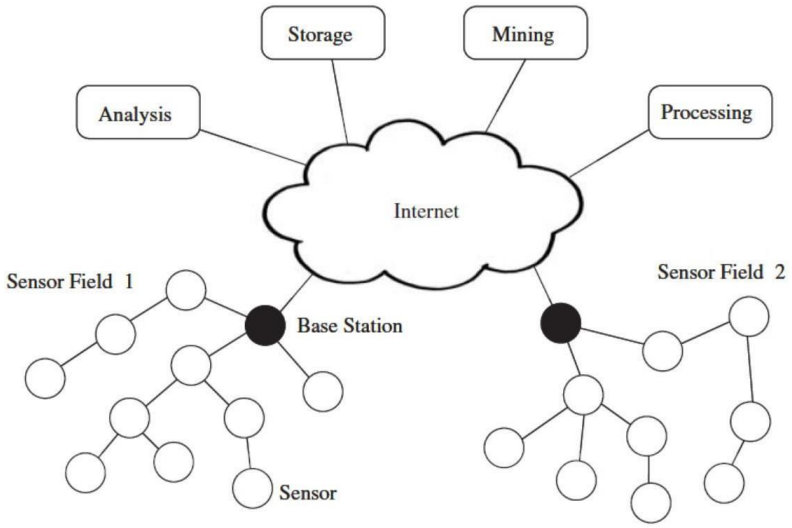

Figure 2.3. WSN.

Finally, some devices may have access to additional supporting technologies, for example, Global Positioning System (GPS) receivers, allowing them to accurately determine their position. However, such systems often consume too much energy to be feasible for low-cost and low-power sensor nodes.

4. How WSN Works?

WSNs are collection of nodes, and these nodes are individual small computers. These tiny devices work cooperatively to form centralized network systems. There are some requirements for nodes to be used in these networks such as efficiency, multi-functionality and being wireless.

Moreover, each node in any network has a predefined goal. For example, if it is aimed to collect information about microclimates across all sections of any forest, these nodes are placed in different trees in the forest to form a network. In this network, they should have a centralized and synchronized structure for communicating and data sharing. The sensor nodes are placed in a connected

network according to a certain topology such as linear, star and mesh. Nodes of the network in any topology have a limited broadcast range which is generally 30 meters. In WSNs, data collection and data transfer are accomplished in 4 steps:

a) Collecting the data,
b) Processing the data,
c) Packaging the data and
d) Transferring the data.

5. WSN node Structure

A sensor node is made up of four basic components such as sensing unit, processing unit, transceiver unit and a power unit (See Fig. 2.4). It also has application dependent additional components such as a location finding system, a power generator, and a mobilizer.

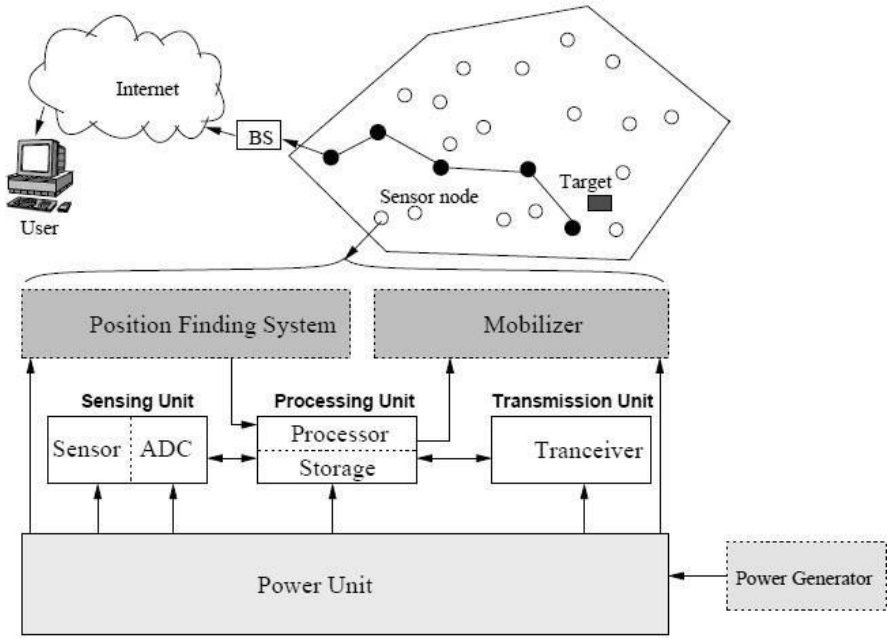

Figure 2.4. Sensor node components.

- ***Sensing Unit***: It is usually composed of two subunits: sensors and Analog- to-Digital convertors (ADC's). Analog signals produced by sensors based on observed phenomenon are converted to digital signals by ADC, and then fed into processing unit.
- ***Processing Unit:*** It manages the procedures that make the sensor node collaborate with other nodes to carry out assigned sensing tasks. It is generally associated with a small storage unit.
- ***Transceiver:*** It connects the node to the network.
- ***Power Unit:*** Since wireless sensor networks focus more on power conservation than 'Quality of Service (QoS)', it is one of the most important components of a sensing node. Power units may be supported by power scavenging units such as solar cells. A sensor node can only be equipped with limited power source. (<0.5 Ah, 1.2 V)
- ***Location finding system:*** It is commonly required because most of the sensor network routing techniques and sensing tasks require knowledge of location with high accuracy.
- ***Mobilizer:*** It may sometimes be needed to move sensor nodes when it is required to carry out assigned.

6. Advantages and Disadvantages of WSNs

a) Advantages: Since WSNs use wireless communication instead of hard wiring, they do not need complex infrastructure. Owing to wireless structure, WSNs become cheaper. They spend less energy since devices are usually in sleep to conserve energy. Furthermore, WSNs are compatible with external devices and new plug-ins. This feature increases their usage areas and their

functionality.

b) **Disadvantages:** WSNs have comparatively low speed of communications, limited memory space and narrow bandwidth. They are battery dependent. Since they have limited power sources, they are designed to consume less operating energy. But consumption of less energy can cause avoidance of taking essential security precautions. Since there are some security leaks that can occur due to energy saving policies, WSNs may be attacked by malicious attackers. Moreover, WSNs are affected by surroundings such as walls and far distance etc.


THANK YOU!