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Analyzing the Components and Applications of Wire-less Sensor Network: A Concise Study

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Abstract

Wireless Sensor Networks (WSNs) consist of small nodes with identifying component by sensing, computation, and wireless communications infrastructure capabilities. The path searching means routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. Routing protocols in WSNs might differ depending on the application and network architecture. WSN provide several types of applications providing comfortable and smart-economic life. The easy molding, fault tolerance, high sensing fidelity, low price, and rapid deployment features of sensor networks create various new and thrilling application areas for remote sensing. In future, this wide range of application areas will make sensor networks an important part of our lives. However, understanding of sensor networks needs to satisfy the constraints presented by factors such as fault tolerance, scalability, cost, hardware, dynamic topology, environment, and power consumption.

Keywords: Topology, Wireless sensor network, Fault tolerance.

1 | Introduction

Wireless Sensor Network (WSN) refers to a collection of sensors for observing, monitoring and recording the physical conditions of the environment. Later, after observing and recording the behaviour of sensors, consolidating the collected data at a central location is the major task [1]. WSNs measure environmental like wind, humidity, temperature, pollution levels of sound, air and so on [2]. WSNs consist of position distributed and independent sensors to observe and monitor physical and environmental conditions [3]. They are helpful to collectively pass recorded data through network to a central location. Some networks are bi-directional as they both collecting data from distributed sensors and supporting control of sensor activity [4]. Spatially dispersed and dedicated networks help to collect different parameters with special sensors which are included in the WSN. Nowadays, such networks are used in many applications like industry, consumer applications. Few of the applications such as industrial process monitoring and control, machine health monitoring, and so on [5].

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2 | WSN Components

The main component of WSN is node. A sensor network generally consists of tens to hundreds or thousands of relatively small nodes, each equipped with one or more sensing devices. Each node is connected to one or more sensors [6]. Each such node normally has several parts: a radio transceiver with an inner antenna or connection to an exterior antenna, a microcontroller, an electric circuit for interfacing with the sensors and an energy source, basically a battery or an implanted form of energy collecting [7]. Size of a node can be from that of a brick to the size of grain of dust. The cost of sensor nodes is also variable [8]. They may range from a few to hundreds of dollars, based on the complexity of the individual sensor nodes. The potential of various properties such as energy and its consumption, memory, computational speed and communications bandwidth vary the size and cost of sensor nodes [9]. Hence, size and cost limitations on sensor nodes leads in corresponding constraints on resources. Thus, the use of specific sensor nodes with required quality of various properties depends on the application [10]. They are one or more components of the WSN with many more qualities like computation, energy conservation and communication to share recorded data [11]. They play a role of gateway between sensor nodes and the end user. These gateways are usually useful to forward recorded data from the WSN on to a central location [12]. Central locations are nothing but the servers. Other special components in WSN are routers. Routers specifically designed to compute, calculate and distribute the routing tables. Various components of WSN: 1) sensor node, 2) sensing unit, 3) sensor, and 4) ADC [13].

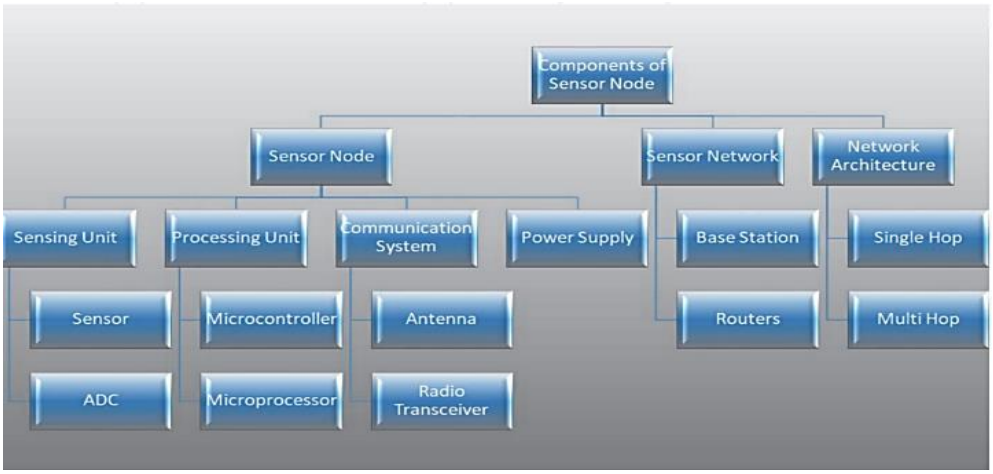

Fig. 1. Various components of sensor node.

1. Processing unit.
   I. Microcontroller.
   II. Microprocessor.
2. Communication system.
   I. Antenna.
   II. Radio transceiver.
3. Power supply.

2.1 | Sensor Node

A sensor node is a combination of different subunits and all they help to perform the functionality of the sensor node. The different units help to sense, record, monitor and analyse the data which is collected through physical conditions [14]. Sensor node comprises not only the sensing component but

Fan| Big. Data. Comp. Vis. 2(2) (2022) 101-106

also other important characteristics like processing of recorded data, communication with servers a storage units to store recorded data [15].

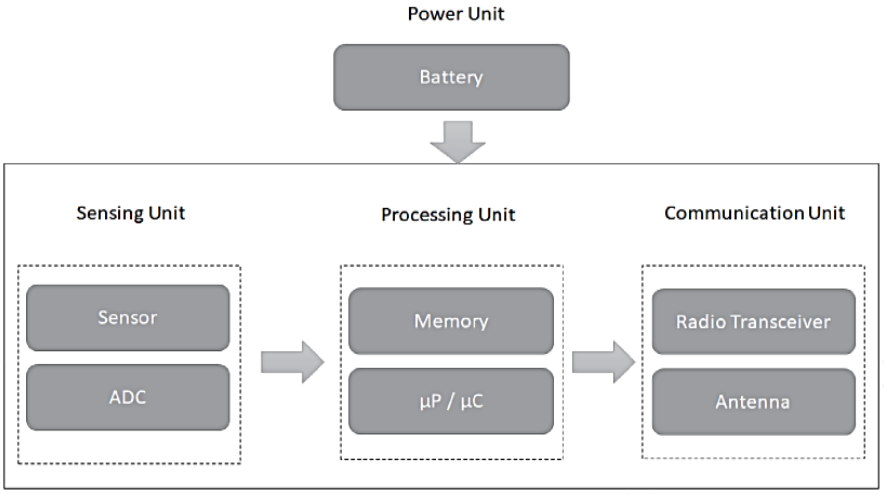

Fig. 2. Sensor node architecture.

With all these characteristics, components and enrichments, sensor node takes responsibility for data collection, data correlation, and fusion of data from other sensors with its own data and network analysis [16]. *Fig. 2* shows the sensor node is a combination of different units. They are, sensing unit, processing unit, communication unit and power unit. All of them have their own responsibility to sense data, process data and communicate sensed and processed data to servers [17]. Sensor collects the Analog data from the physical world and an ADC takes the responsibility of converting analog data to digital form. Another unit is the processing unit, which are usually a microprocessor and/or a microcontroller [18]. They perform intelligent data processing and manipulation [19]. The next unit is a communication unit consisting of a radio system and an antenna. Here, radio transceivers are used for data transmission and reception and antenna helps to transmit and receive the signals [20].

2.2 | Sensor Network

Sensor network consists of two components. They are namely Base Station (BS) and a router. BSs are just a central component that is used to collect data from distributed nodes. The BS acts as a gateway between other networks through the internet [21]. Once the BS receives the data from the sensor nodes, a BS performs some operations oBn collected data and sends that information to the user using the internet. As we know that the main tasks of a sensor node is to sense data and send it to the BS. Also, a routing path is essential [22]. And this responsibility is handled by a second component of the sensor network. It is a router. For finding the efficient routing path from the source node to the BS there are a lot of proposed routing protocols. The design of routing protocols for WSNs must consider the power and resource limitations of the network nodes, the time-varying quality of the wireless channel, and the possibility for packet loss and delay [23].

2.3 | Network Architecture

To observe the behaviour of sensors in sensor nodes, and to communicate with the BS, they must connect through networking. Here is the role of the second component of WSN. It is network architecture. To observe a physical environment, a large number of sensor nodes are arranged in a massive area. That's why the networking of these sensor nodes is equally important. There is communication not only between sensor nodes in a WSN but also with a BS. Here in network architecture, there is not only the communication between intermediate sensor nodes or between sensor nodes and BS, the BS also communicates with sensor nodes. The BS sends directions to the sensor nodes. The sensor node performs the task accordingly by working in co-operation with other sensor nodes in the network.

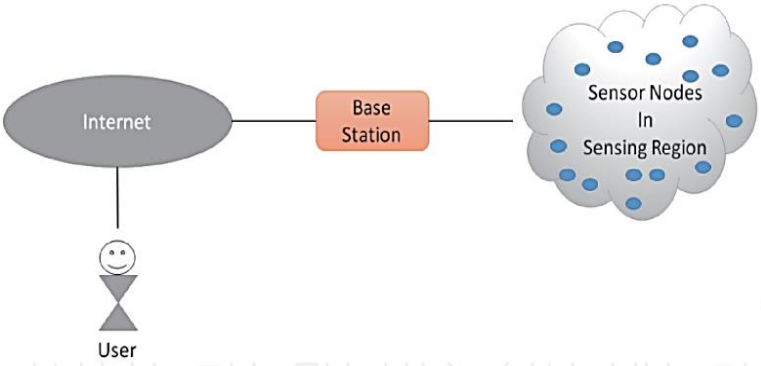

Fig. 3. Network architecture.

The network architecture has two main aspects. First one is single-hop network architecture and the other one is multi-hop network architecture. *Fig. 4* explains the concept of single-hop network architecture. In single hop network architecture, each sensor node is connected to the BS. And it allows long distance transmission as well. As it allows long distance transmission, obviously the energy consumption for communication will be significantly higher. Hence it affects the tasks of data collection and computation. The multi-hop network architecture is usually used for better power consumption. *Fig. 5* depicts the concept of multi-hop network architecture. Due to intermediate nodes in multi-hop network architecture, the load of one single link between the sensor node and the BS reduces. The he data is transmitted through one or more intermediate nodes. Hence, it is more efficient than that of single-hop network architecture. In flat architecture, the BS broadcast commands to all the sensor nodes but the sensor node with identical query will respond using its peer nodes via a multi-hop path. In hierarchical architecture, a group of sensor nodes are formed as a cluster and the sensor nodes transmit data to consistent cluster heads. The cluster heads can then communicate the data to the BS.

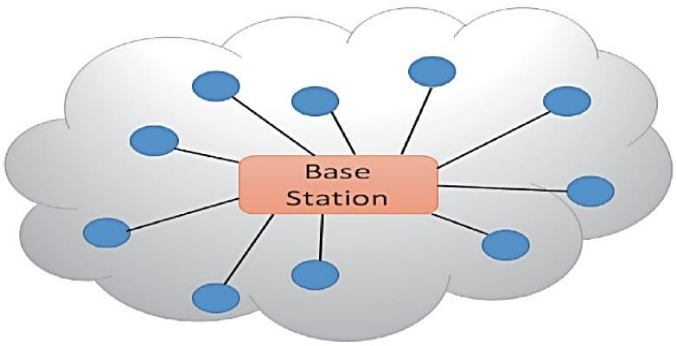

Fig. 4. Single-hop ntwork architecture.

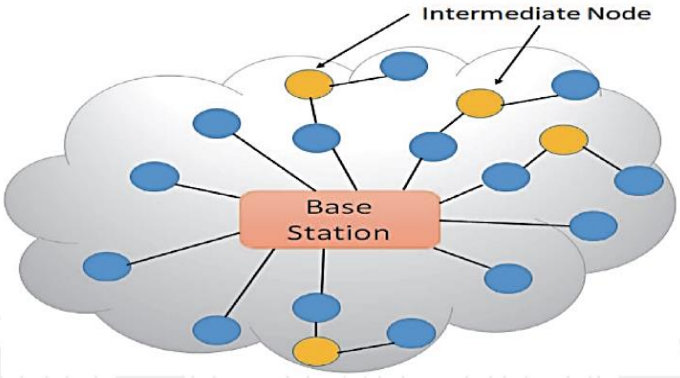

Fig. 5. Multi-hop network architecture.

3 | Characteristics of WSN

The important characteristics of a WSN include:

I. Power consumption limitations for sensor nodes.
II. Ability to cope with failures of nodes.
III. Mobility of nodes.
IV. Heterogeneity of nodes.
V. Homogeneity of nodes.
VI. Ability to deploy on a large scale.
VII. Capability to survive harsh environmental conditions.
VIII. Helps to use easily.

4 | Conclusion

Each sensor network node typically has many parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size and size can be a size of a grain of dust. Sensor collects the analog data from the physical world and an ADC converts this data to digital data. When a large number of sensor nodes are deployed in a large area to cooperatively monitor a physical environment, the networking of these sensor nodes is equally important.

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