Wireless sensor network

Nowadays, with the development of Micro-Electro-Mechanism System, On-chip System and low consumption embedded technology, there is a huge improvement in Wireless Sensor Network (WSN). Some researcher said that there will be a tremendous revolution in the area of communication in the next few years.

Wireless sensor network is based on ad hoc network a nd get some improvement as its special advantages. It can be used in particular environments in which is hard to use cable and power supply or somewhere that people cannot get in. For example, when a chemical explosion happens, it is very dangerous for the fireman to detect the situation closely, so it is significantly to use something to collect the important information and transmit these data back to the fire station. Another example is that the military need to investigate enemy’s rear area which is hard to detect by the radar. The wireless sensor network have the ability of self-adaption and do not need to be supported by other network. In the military example just mentioned before, the WSN nodes can be thrown to the rear area from the airplane when these nodes dropping on the ground, they can self-organize a network by themselves, each nodes can both act as coordinator and router. Each nodes using sensors to collect data and transmit these data to the sink node. The sink nodes send data to the internet and people can get these data remotely.

Embedded system

An embedded system is a computer system with real-time computing constrains used to control larger electrical or mechanical systems. For example, like MP3 player, GPS receiver, car brake system and so on are all the applications using embedded system to control. Embedded systems often use microcontrollers which include CPU, memory and peripherals. For all of the embedded systems, the ARM is most widely used 32-bit reduced instruction set architecture (RISC), and most of the communication devices use it. There are many companies have the ARM manufacture licenses like Apple, Atmel, Texas Instrument and so on. Wide range of processors available to meet conflicting goals of performance, cost and size.

Embedded system is used to control or monitor other machi nes. At first, it is only the mechanism link between the real time and the device. People write programs in it initially, and other devices are controlled by these programs. If we want to change the function of these devices, the only way to change them is to change the chips inside them. The classic aiming of the embedded system is to handle specific problems with embedded computing.

But now, with the development of internet technics, there is a new concept called ‘the internet of things’ became more and more popular. The internet of things (IoT) is the network linking with embedded objects and internet. Differ from the previous embedded systems, the objects can collect and exchange data. IoT can achieve the goal of intelligent identify, positioning, tracking, monitoring and managing. There are four layers in concept, sensing layer, network layer and application layer. The sensing layer, as the lowest layer, is used to collect information and transmit data to the sink node by wire or wireless, some novel technology like multisensory technology, RFID technology 2-D barcode technology are used in this layer. The network layer which include communication network and internet is used to manage the transferred data and with security method. The highest layer is the application layer, this layer is used to provide the human-computer interface designing. For example, A man can use personal device to control the electrical equipment in his house,

Performance metrics

1. Robustness

As WSN must face to various working environment, the strain capacity is needed indeed. In some tough conditions, the nodes may invalid or power off. The most remarkable difference between classic network and WSN is that the latter is highly limited. Because of the data transfer mechanism of WSN, every node can collect and transfer data. If information from remote distance transferred to the sink node, it may travel though many nodes. Once some nodes worked out, the data need to find another route to the sink nodes automatically. During the changing period, how to make sure that every information is complete is very important. By robustness protocol, the WSN system can have a better adaptability and hence have the survival ability in tough environment which is very important for the whole system.

1. Scalability

For common WSN system, the amount of the nodes is usually very huge. It is needed for the protocol that has the ability of scalability to make the network bigger and bigger [1]. In some area, we need to increase the nodes density when the ambient environment changes. A good WSN system should have a good routing protocol to balance the flexibility and extendibility at the same time.

1. Energy efficiency

WSN is made up of a lot low-cost and low-power wireless sensor nodes which are deployed in a particular area. Some of these area are difficult for human to reach. That is too say it is hard to change the battery for these nodes. So how to improve the energy efficiency is very important. Nowadays, there are three method to solve this problem. The first one is the optimize the data communication protocol through the network, as the WSN nodes need to form a private network automatically, each node must flood information to its neighbor to find the partner joined into a network. This step may waste a lot of energy for the detection. In addition, the nodes must transmit and collect data faithfully. So decreasing the energy cost during these process is very important. The second method is try to use a more efficiency batteries, but now it seems that the development of battery technology meet a bottleneck constraint. If the limitation of the battery make a big breakthrough, the use of WSN can will be broader. The third method is trying to gain energy from the surrounding environment, like solar energy, wind power and microwave power which could extend the nodes lifetime. But using this method may probably sacrifice the size of each nodes. For the above-mentioned three ways to increase the energy efficiency, optimize the transfer protocol is more feasible.

1. Security

Recently the security problem become more and more important. As the WSN have a high scalability which means that it could add or drop nodes easily. If there is a malicious attack try to join the network, the system will be very dangerous. The attacker can disguise as a nodes who wants to join the network. If the system can nor figure out, the fake node can steal the information or even it may destroy the whole system. So it is necessary to establish a security management protocol for the WSN. But unfortunately, establish a security method means that this may cost more energy during verification and identification. It is necessary to design a WSN security mechanism in an energy-save way.

1. Self-organization

The WSN should have the ability of the self-organization. It is important for WSN to self-organize whenever the situation changes [2]. When many nodes try to establish a network together, they should act as coordinator and sink automatically without any other hardware support.

1. Throughput

Throughput is a very important performance metric of WSN. It reflects the working efficiency directly in the transmission process. The higher the throughput, the bigger data rate it is. Due to the WSN operation principle, there is a huge confliction between energy limitation and data rate. In the IEEE 802.15.6 protocol stacks, the data link layer ensure the reliability for point to point and multi-point connection. In data link layer, the MAC sublayer is used to create network infrastructure and share communication resources. Throughput is highly depend on the MAC and connectivity. If they get failures, there will be a huge problem. Data collected by the sensor node transfer to the sink nodes to establish a connection between detection area and the outside internet communication. Because the sensor nodes and sink nodes are randomly formed, the signal strength through the different path are quite different. To reach the highest throughput target, we need to find out the best transmission route.

1. Average delay

Information transmit between different nodes. When the information reaches the sink node, it could be transmitted to the outside world. Every nodes obtain the information from its neighbor and send the information to its neighbor. It could spend a little time during the period for each nodes. If the number of nodes is significantly huge, that will cause a big delay. For a common WSN network, if we increase the WSN range, we will decrease the nodes density and then reduce the time delay. However, reference [3] shows that the average delay is relate to the throughput. The bigger transmission radius means that the lower throughput. So how to balance these two factor is very important.

1. Lubna K.A, Ali M.E and Aiyapaa.R.
2. Falko Dressler, *self-organization in sensor and actor networks*, John Wiley & Sons,2008
3. Hong-Ning Dai, *Throughput and Delay in Wireless Sensor Networks using Direction Antennas*, hnda@ie.cnhk.edu.hk.