Research Article
Design of Food Temperature and Humidity Monitoring System based on Wireless Multimedia Sensor Network

Zheng-Bing Zheng
School of Physics and Telecommunication Engineering, Shaanxi University of Technology,
Hanzhong 723001, Shaanxi, China

Abstract: This study takes wireless multimedia sensor network as the breakthrough point, by means of the interpretation of the characteristics of wireless sensor network, analyzed the structure of food temperature and humidity monitoring system and analyzed the configuration of hardware and software of the monitoring system, moreover, it puts forward the relevant strategies of extending the working life of the food temperature and humidity monitoring network.

Keywords: Design of food temperature, humidity monitoring system

INTRODUCTION

As human beings entered the twenty-first century, information has become a strong driving force to promote the development of international society and the global economy. Information science has become one of the most active fields. The storage, transmission, generation, acquisition, processing and application of information are the six parts of modern information science, among them, the acquisition of information is one of the important links in information technology industry chain. Wireless Sensor Network (WSN) integrated with Micro-Electric-Mechanical system (MEM), modern network and wireless communication technology, circuit and sensor technology, as well as embedded computing technology, etc., which is composed by a large number of cheap micro sensor nodes deployed in the monitoring area, forming a multi-hop self-organizing network system by means of the wireless communication method, which purpose is to collect, perception, acquire and process the information of the monitored object within the network coverage are and then send to the observer. With the help of wireless sensor network, it can introduce the information with rich images, audio, video and other medias into the food monitoring activities based on the wireless sensors network, so as to realize the food temperature and humidity monitoring with fine-grained and accurate information (Megerian *et al*., 2005).

MATERIALS AND METHODS

The overview of wireless multimedia sensor network: Wireless multimedia sensor network is a multimedia node (equipped with camera, microphone and so on) with computation, storage and communication capabilities, which can sense the network through the distributed self-organized sensing network, with the abilities to collect, perception, acquire, process and transmit the multimedia information in the network coverage area in the forms of audio, video, static images, numerical data, etc., (Cortes *et al*., 2004).

The characteristics of wireless sensor network:
It can enhance the ability of node and network: Since it is with multimedia information processing ability including audio, video, image and other forms, the capacity of node and network can be significantly enhanced (acquisition, processing, storage, receiving and dispatching, energy supply, etc.) At the same time, it can enhance bandwidth resources accordingly.

The perceived media is rich, with a variety of heterogeneous data coexistence: A variety of wireless multimedia sensor networks are often coexisted with audio, video, images, numerical, text and controlling data signal; in addition, the data format is diverse with heterogeneity, such as single numerical data and video streaming information can commonly serve the multimedia monitoring tasks.

The processing task is complex: The collecting data format is single in the traditional sensor network with less information, simple processing, which only needs to add, subtract, multiply, divide, sum up and fusion processing for averaging; while audio, video, images and others in WMSNs have large amount of data, rich information, complex format, which need to be compressed, recognized and combined with many other
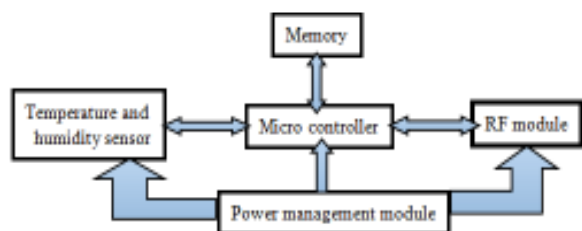
Fig. 1: The structure of sensor nodes

complex processing, so as to meet various needs of application.

Architecture of food temperature and humidity monitoring system: The hardware part of temperature and humidity on-line monitoring system based on wireless sensor network technology is mainly composed by temperature and humidity sensor nodes and control consoles. It can transmit to the control center in the way of wireless multi-hop transmission (Li *et al*., 2003). The software of system mainly consists of automatic monitoring, data storage and query, data analysis, as well as temperature and humidity overrun warning module, etc. The operation of monitoring software is easy to be operated with high degree of intelligence (Meguerdichian *et al*., 2001a).

When the system works, the nodes of sensors are based on the instruction of sink nodes, as well as the acquisition of temperature and humidity, which can be sent. At the same time, the nodes of main group can regularly send the temperature and humidity data in the way of wireless multi-hop routing to the sink node, which can be sent to the monitoring center through a wired network transmission by the sink nodes and complete the function of analyzing and processing data as well as the other functions in the control center.

The design of sensor node: The hardware of food temperature and humidity online monitoring system is mainly composed of the design of the wireless temperature and humidity sensor nodes. Moreover, the main group nodes use family algorithm and automatically generate the family, which have the same structure and function with common sensor nodes (Meguerdichian *et al*., 2001b). Each node is mainly composed of power supply management module, temperature and humidity sensor, microprocessor, memory, as well as RF module and some other functional modules. The structure of a typical sensor nodes is shown in Fig. 1.

The power management module can provide necessary energy to another functional unit needed by the normal energy. Temperature and humidity sensor can be used for sensing and acquiring the information of food temperature and humidity. The microprocessor components are partly responsible for the coordination work of all nodes such as dealing with the information of sensors necessarily, having preservation, controlling the sensors and the operating mode of power, etc. The RF module is responsible for the communication with

the other sensor nodes. According to the layout environment of the sensor nodes, the sensor nodes are powered by battery, which at the same time can be of convenience for installing, maintaining and prolonging the service time. Thus it must meet the requirements that sensor nodes should be small in size, the system should adopt low power design, which should ensure the system with high reliability and stability.

The sensor module: This system uses digital temperature and humidity sensor SHT21, which has a complete calibration with digital output, high adjustable resolution, low power and excellent long-term stability, etc. SHT21 is equipped by a new design with CMOSens chip, an improved capacitive humidity sensor and a standard band-gap temperature sensor, whose performance has been greatly improved and even beyond the reliability level of the previous generation of sensor SHT1X and SHT7X. At the same time, in the clip, it also stored electronic identification code (it can input the command and read the identification code, which can be convenient for the localization of the nodes.

RF module: The radio frequency unit is the key part of the sensor network, which is used to complete the digital signal modulation and demodulation, it is the largest part for the energy consumption. In order to ensure the sensor networks with more prolonged network life in the limited situation of battery energy, the radio frequency unit can use clips with low power mode in a variety modes. This system uses NRF24le1 of RF module, which is the latest wireless and ultra low technology adopted by the NORDIC Company. In a tiny package of power dissipation, it can be included NRF24l01 wireless transceiver with 2.4 GHz, the enhanced 51FLASH microprocessor, monolithic FLASH chips with rich peripherals and interface etc., which is a perfect combination between the comprehensive performance and cost.

The hardware design of sink node: The sink node is a special point in wireless sensor networks, which is located in the upper layer of the sensor nodes and responsible for data transmitting as well as protocol conversion. It needs to have a large amount of storage with high throughput as well as calculation processing and some other functions, which can use RS-232 to have access to the controlling center. The system mainly includes micro-controller, memory, serial communication and wireless communication as well as some other modules. The micro controller is the core, which can realize the function of allocating and scheduling the resources of the system.

Design of system software: The software of temperature and humidity on-line monitoring system is
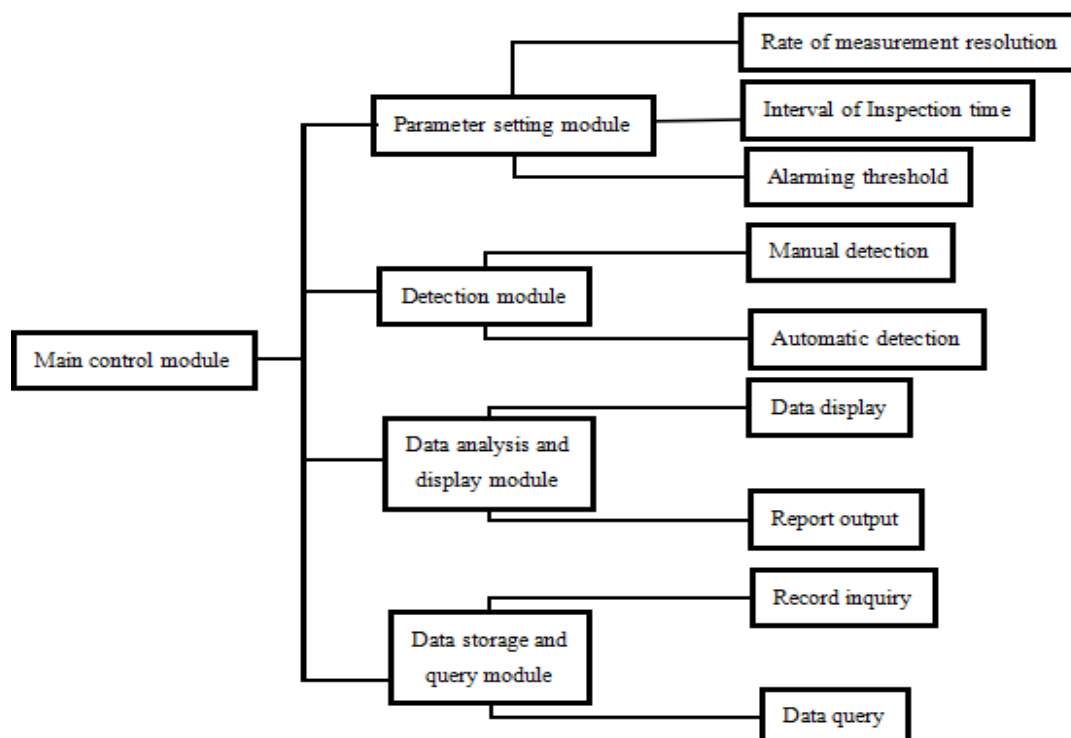
Fig. 2: Diagram of system software component

based on the development of VC language, which can realize the acquisition, storage and analysis of the data. The diagram of the software composition of the system is shown in Fig. 2.

Parameter setting module: Before carrying on the examination, first of all, it should set parameters, including the parameter setting of the temperature and humidity sensor measurement resolution rate, the setting of inspection interval, as well as the setting of the alarming threshold.

The detection module: The mode of operation can be divided into automatic mode and manual mode. Automatic cycling mode can automatically complete all cycle monitoring of detection points, real-time display, storage, alarm, among them, time interval can be set randomly in parameter setting. The manual mode is used for the centralized monitoring for a local regional node.

Data analysis and display module: The software can deal with the acquired data and display data and analysis results in the display window. In the parametric setting, according to the experience, it can set an alarming threshold, during the process of monitoring, if the nodes are abnormal, the software will automatically alarm.

Data storage and query modules: Real-time system can save the original data automatically, including the

number of nodes, acquisition time and so on, which can realize the system data management mode of combining database management method with the multilevel file management method together. To facilitate the management personnel with the work of observing the changes of temperature and humidity condition of each point in the base, the monitoring system can provide the function of query.

RESULTS AND DISCUSSION

The strategy to prolong the working life of food temperature and humidity monitoring network: Due to the miniaturization of wireless sensor nodes, nodes are usually powered by batteries, thus the energy is limited, moreover, because the physical constraints of the regional distribution of the nodes is more difficulty than replacing the batteries, thus, the limitation of the sensor node's battery energy is one of the most critical constraints for the design of the entire sensor network, which directly determines the working life of the net. The energy consumption module of the sensor nodes include sensor module, processor module and wireless communication module, most of the energy is consumed in wireless communications. In order to reduce the energy consumption of nodes and prolong the working life of nodes, in addition to using low-power chip design for the hardware, designing simple and efficient mac and routing protocol is the key to saving energy.

In mac layer, the main measures to reduce the energy consumption of the nodes is to reduce the collisions of data transmission, avoiding the re-transmission, at the same time, making the nodes into sleep state when it is appropriate. In this system, it can take mac protocol with the non average slot energy efficient elections. This protocol belongs to the scheduling protocol, getting the referenced idea from the design of DE-mac protocol, using the periodic monitoring and dormancy mechanism, which can reduce the idle listening, avoid channel conflicts, adopting the minimum energy node election mechanism within the family, so as to balance the network energy effectively. Once the whole network energy consumption is slow, it can embody the protocol performance well, which can effectively extend the service life of the network. And the routing protocol for the wireless sensor network can play a role of monitoring the changes of topology, establishing, maintaining and removing the routing between nodes, which can ensure the information accurately, efficiently as well as timely delivery.

CONCLUSION

At present, wireless multimedia sensor network is a hot issue both at home and abroad, which has a broad prospect for application. Through years of research, people's inherent understanding with the characteristics of sensor networks has been gradually deep. However, in order to realize the practicality of the sensor network, it needs to solve many problems. In addition, with the diversification of the types of the sensor network and the expansion of the scale of the network, the design and application of the network also needs to take the balance and scalability into account.

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