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Research Article

Food Quality Monitor System Design Based on ARM11

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Abstract: In this study, the hardware and food control program were designed, the implementation of food control functions and control process were expounded. Results show that the food control system improves reliability and operability of the automatic control system, making maintenance and management more convenient and wide application value for engineering. The main function of the former is to collect food quality indicators, while that of the later is to analyze and process the indicators collected, display the corresponding results. To effectively prompt or alarm the user, the core control unit of the control terminal creates corresponding control commands and texts to the speech synthesis chip which will drive the loudspeaker to sound.

Keywords: ARM11, Food quality monitor system

INTRODUCTION

The food quality has a profound impact on people's work and life. Deterioration in the food quality has serious consequences: causing harm to human health, making people feel discomfort, affecting the work efficiency. Many countries have been concentrating on developing standards to improve the food quality and reduce the health risks of people.

As the food quality is so important, many researchers focused on the research of the it's monitoring system. A Food Environment Monitoring System (FEMS) for monitoring the concentrations of food pollutant gases and food quality indicators has been developed in compliance with IEEE1451.2 standard using the electrochemical sensors. A prototype of a Wireless Sensor Network (WSN) for monitoring the food quality of an arbitrary infrastructure environment is described (Sundell, 2004). The authors implement a Volatile Organic Compounds (VOC) food pollution monitoring system which sets up food wireless sensor network with the consideration of the cost, development complexity and the operation convenience to report value of VOC's concentration in indoor food environment. A simple and rapid monitoring system of food pollution is proposed by integrating a colorimetric detection method of formaldehyde and a function of image transmission of a mobile phone via IT network. A cost effective and user-friendly food quality monitoring system based on ZigBee wireless sensor network implemented with the TI CC2430 ZigBee chip is described. However, these literatures all monitor one indicator of the food quality. Based on this, we designed a system based on ARM11 to monitor indicators of the food quality: temperature, humidity and nutrition. In addition, the system can give the user prompt/alarm through TFT-LCD and loudspeaker (Kumar *et al*., 2011).

MATERIALS AND METHODS

Overall system design: Overall system design is shown in Fig. 1. The system includes two parts: acquisition terminal and control terminal. The major role of the acquisition terminal is to collect food quality indicators and send them to control terminal, whose main function is to analyze and process the indicators collected and display the corresponding results (Spachos *et al*., 2013).

The acquisition terminal contains three modules: sensors, microcontroller and wireless data transmission. Sensors convert the food quality indicators into analog electrical signals which are easily processed and transmit the signal to the microcontroller. The microcontroller properly processes each signal acquired by the sensor and then transmit them to the wireless data transmission module. The wireless data transmission sent the data through the wireless channel (Peng *et al*., 2013).

The control terminal includes a wireless data receiving module, central control unit, display module, serial communication unit, key circuit unit, voice prompt/alarm unit. Wireless data receiving module receives food quality data transmitted by the acquisition terminal through the wireless channel and then transmits it to the central control unit. The central control unit, core unit of the control terminal, processes the food quality data, displays the results by the display unit and provides the users corresponding prompt by the voice prompt/alarm unit (Sekine and Katori, 2009). Serial communication unit is mainly used for communication between the central control unit and PC

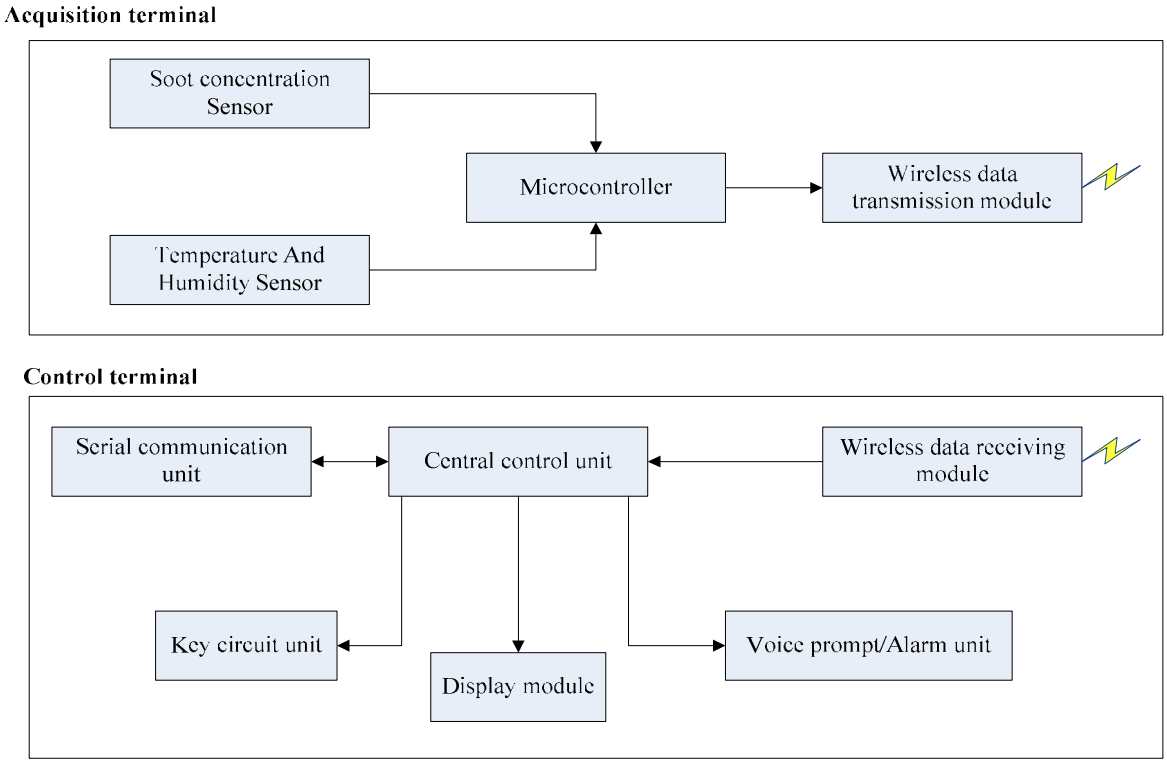

Fig. 1: The structure of the overall system

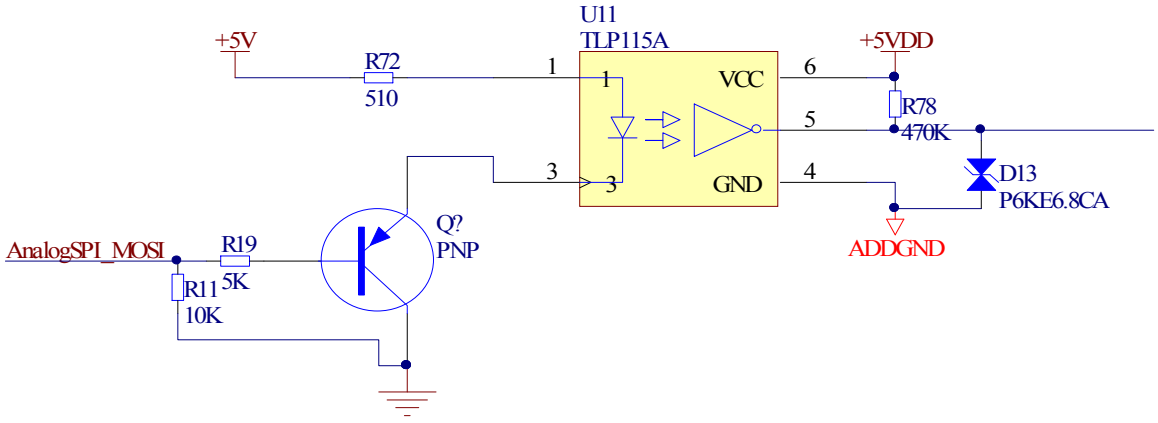

Fig. 2: Photoelectric isolating device

and it is convenient for the code testing. Key circuit unit is mainly used to control the central control unit to achieve corresponding functions.

System hardware design: The detailed hardware structures of the acquisition terminal and control terminal are shown in Fig. 2.

The design of the hardware circuit: In the process of the hardware circuit design needs to consider how the circuit anti-interference, how to protect when collecting current or voltage. In addition, the selection of main chip to meet can achieve real-time performance, high precision and the ability for dealing with data.

In the design of the hardware circuit, there are two key circuit, namely photoelectric isolating device and sampling circuit. Photoelectric isolating device as show in Fig. 2, R11 provides the bias voltage, pull up resistors R78 is, when the input 5v voltage, triode conduction for photoelectric isolating circuit. Photoelectric isolating device can increase the safety of the circuit, reduce the circuit interference and can simplify the design of the circuit (Tzen and Wey, 2011).

Fig. 3: Sampling circuit

Sampling circuit as shown in Fig. 3, one phase of the data sampling, V2P end connected to the ATT7022 chip, data from the outside by the sampling circuit transmission to the chip ATT7022 data calculation.

Sensor: In this study, three indicators of the food quality are focus: temperature, humidity, nutrition. These indicators are all measured by the wireless sensors. We choose sht75 to measure the temperature and humidity. It integrates the sensing element and the signal processing together and includes a capacitive humidity measuring elements, a temperature measuring elements, 14 bits ADC and serial interface circuit. The nutrition is measured by the MQ-2. It conductivity increases as the concentrations of nutrition index improves and can measure variety of nutrition components. Thus, it is a low-cost sensor with a variety of applications. The sensors measured the temperature, humidity and nutrition using the measuring elements and converted these food quality indicators into electrical signal. Then, the signal is transmitted to the microcontroller.

Wireless data transmission and receiving module: The nRF905 is selected as the wireless data transmission and receiving module. It mainly operates in 433, 868 and 915 MHz ISM band, respectively. The Chip includes frequency synthesizer, power amplifier, crystal oscillator and modulator function module. The output power and communication channels can be programmed. It is very suitable for low-power, low-cost system design.

The wireless data transmission module of the acquisition terminal receives the FOOD QUALITY data from the microcontroller and then sends it to the wireless data receiving module of the control terminal, which transmitted it to the central control unit.

Central control unit: The central control unit is the core unit of the control terminal. The Samsung S3C6410, a 32-bit ARM11 RISC microprocessor, is selected. It gives designers an unbeatable combination of 3D performance and low power in a cost-effective package. Along with its speed, 2D/3D multimedia capabilities and rich memory support, it offers the industry's broadest set of on-chip peripheral interfaces, including TFT-LCD 24-bit true-color controller, system manager for power management, 4-channel UART, 32-channel DMA, 4-channel timers and 12-bit ADC for touch-screen applications.

The central control unit sends the food quality data received by the wireless receiver module to the display module by the integrated TFT-LCD controller. Meanwhile, it analyzed the food quality to determine whether the current food quality has exceeded the set threshold. If exceeded, generates a control command and the text is generated and sent to the voice prompts / alarm unit. In addition, we can send the appropriate control commands to the central control unit through the key circuits.

Voice prompt/alarm unit: The voice prompts/alarm unit realizes the prompt function based on speech synthesis chip. We select SYN6288 as the speech synthesis chip. It is a high performance-to-price ratio, mid to high end chip. It is packaged in SSOP28L SMD and has simple hardware interface. And it is low power. It has the functions of text synthesis, intelligent text processing and analysis, digital volume control, words speed control and so on.

Comparing the received food quality data and set threshold, the central control unit transmits corresponding control commands and text to the speech synthesis chip SYN6288 by the UART interface. Then the speech synthesis chip SYN6288 synthesizes the control commands and text into speech signal, which is amplified by the power amplifier. At last, the amplified signal is transmitted to a loudspeaker which creates corresponding prompt or alarm sound.

RESULTS AND DISCUSSION

System software design: The software of the acquisition terminal is composed of three parts: food quality indicators acquisition and coding, food quality data processing and wireless data transmission.

Linux is used as the software operation platform of the central control unit ARM11. It is composed of Linux operation system and application program. The operation system includes device drivers, kernel and file system and the application program contains wireless data receiving, food quality data analysis, key control, LCD display and speech synthesis.

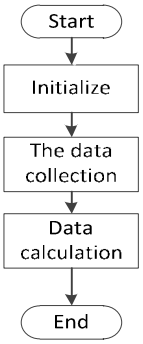

Fig. 4: The flow chart of ATT7022

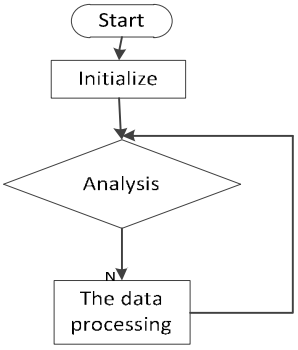

Fig. 5: The flow chart of STM32F103

Electricity acquisition is the process of software design data acquisition chip ATT7022 and a calculation is made of the collected data and then calculated the data transmission to the single chip microcomputer STM32F103 for data analysis, compared with the theoretical value, meet the requirements for the theory of the value of the output, if does not conform to, by single-chip microcomputer control circuit of correction and calculation and analysis of output data.

ATT7022 mainly for data calculation, flow chart shown in Fig. 4.

STM32F103 mainly analyze the calculation of the data, flow chart shown in Fig. 5.

CONCLUSION

In this study, we designed a system based on ARM11 to monitor the food quality including the temperature, humidity and nutrition. The system is composed by two independent parts. One called acquisition terminal is to collect the food quality indicators and the other named control terminal is to analyze and process the indicators collected, display the corresponding results. The detailed hardware and software structure of the system is given and each module is described.

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