



Design of the intelligent voice electronic nose and its application in food quality detection

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ABSTRACT

Using Sunplus SCM SPCE061A as the control core, utilizing the method of combining hardware design with software design, a new type of intelligent voice electronic nose has been designed. The structure diagram of intelligent voice of electronic nose is introduced, the main unit circuits of the system and part of the software flow charts are given, and the selection of sensor is comprehensively expounded. Finally, the typical application of intelligent voice electronic nose in four kind's food quality detection of fish, vegetables, fruit and meat is analyzed in detail. Repeated tests show that the correct rate of the intelligent voice electronic nose for food quality detection is more than 97%, and it can make the correct classification of food, the intelligent voice electronic nose has the advantages of simple structure, convenient use, high intelligent degree, higher accuracy rate, so it is worthy being spread and applied.

Key words: Voice electronic nose; SPCE061A; Sensor; Food quality; Detection

INTRODUCTION

The quality of the food has been growing concern, in the process of food quality test, the methods of sensory organs, chemical analysis, mass spectrometry and chromatography are used frequently. But due to the influence of external conditions and the subjective factors, the sensory organs are susceptible to interference detection, chemical analysis methods, mass spectrometry and chromatography are quantitative, qualitative analysis, before the detection of food, food is needed to be separated and extracted, or even destructed, the analysis process takes time, uses great efforts and needs much money, they have poor real-time and they are not convenient to popularize and apply [1]. In view of the above shortcomings, combining with the sensor technology, control technology, artificial intelligence technology, a kind of intelligent voice electronic nose has been studied and designed. The intelligent voice electronic nose can simulate the smell organ of organisms, and then can effectively detect the food quality. The intelligent voice electronic nose can not only overcome the shortcomings of sense organ being easily affected by external conditions and subjective factors, but also solves the problem of pretreatment of chemical analysis methods and mass spectrometry detection method, it can be widely applied to the detection of food quality, environmental quality testing, medical, military and other fields.

HARDWARE DESIGN A SYSTEM

1. Block diagram of the system

The intelligent voice electronic nose is a use of electronic nose sensors can accurately and quickly analyze, identify the smell of gas and the corresponding information for voice broadcast an intelligent instrument, mainly by the power supply module, sensor module, controller, display module, voice playback module and key module consisting of six parts, and its block diagram is shown in Figure 1. Intelligent Voice electronic nose using a variety of sensors to obtain a response signal, and analyzed by the detection circuit and the controller of the sensor response signal, processing, analysis processing corresponding to the information after the display by the LCD screen, and the voice playback, and the relevant operating parameters can be button to set [2].

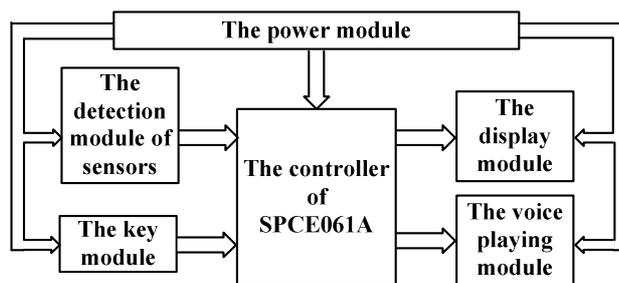


Fig.1 Block diagram of the system

2. The main unit circuit design

2.1 Power circuit

Using two rechargeable lithium batteries in series to obtain a DC voltage of about 7.4V, use W7805 were obtained +5V DC regulated voltage [3], to the sensor module, a key module, voice playback module, display module power supply; reuse integrated chip SPY0029 second stage regulator to get +3.3V DC voltage to the microcontroller SPCE061A processor power supply, the power circuit is shown in Figure 2.

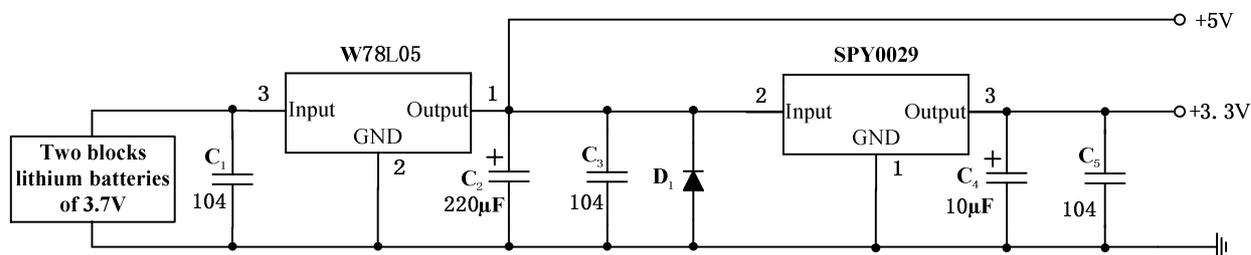


Fig.2 Power Circuit

2.2 Controller circuit

Sunplus uses SPCE061A control core, SPCE061A microcontroller is Sunplus Technology has launched a 16-bit microcontroller architecture, with a processing speed, low power consumption, ease of debugging, etc., is suitable for applications of digital signal one of the most economical choice of products [4]. The controller circuit mainly by SPCE061A its peripheral circuit, connected to other modules as shown in Figure 3.

2.3 Sensor circuit

Food in the deterioration process to some characteristic volatile gas, food spoilage process of volatile gases from the decomposition of food components, due to the extensive variety of food, basic food spoilage process of summarizing characteristic volatile gases category, according to the characteristics of demand for gas and food quality testing of food spoilage in the process of selecting the appropriate sensor volatile [5].

Due to the higher content of nitrogen species of fish, so fish, perishable foods, and accompanied by bad smell, usually volatile ammonia, hydrogen sulfide, ethyl mercaptan, trimethylamine, histamine and other gases in the process of metamorphic. Affected by moisture, vegetables easy microbial deteriorated, deterioration in the course of the main release alcohols, acids, ammonia, hydrogen sulfide and other volatile gases. Higher levels of carbohydrates in fruits, in the metamorphic process will produce alcohols and carboxylic acids, increases the release of carbon dioxide. Meanwhile, most of the fruit to mature during metamorphism, the content of ethylene will soar. With the extension of storage time, under the action of microorganisms, meat easily decomposed into ammonia, hydrogen sulfide, aldehydes, alcohols, ketones and other volatile gases. In summary, fish, vegetables, fruit and meat in the four major food deterioration processes are mainly produced nitrogenous, sulfur-containing and other VOCs volatile substances [6-8]. Taking into account the cost structure and usability problems, we use MQ-135, TGS-2620, MQ-3, MQ-136, MQ-137, MQ-138, TGS-2602 seven kinds of sensors for ammonia, sulfide, benzene homologues, alcohol, alcohols, aldehydes and ketones and other volatile gases were detected, thus completing the food quality testing, based on test results and is able to make reasonable food categories. After the detection result of the sensor voltage comparator LM393 convert analog signals to digital signals to facilitate processing microcontroller, the sensor detection circuit shown in Figure 4.

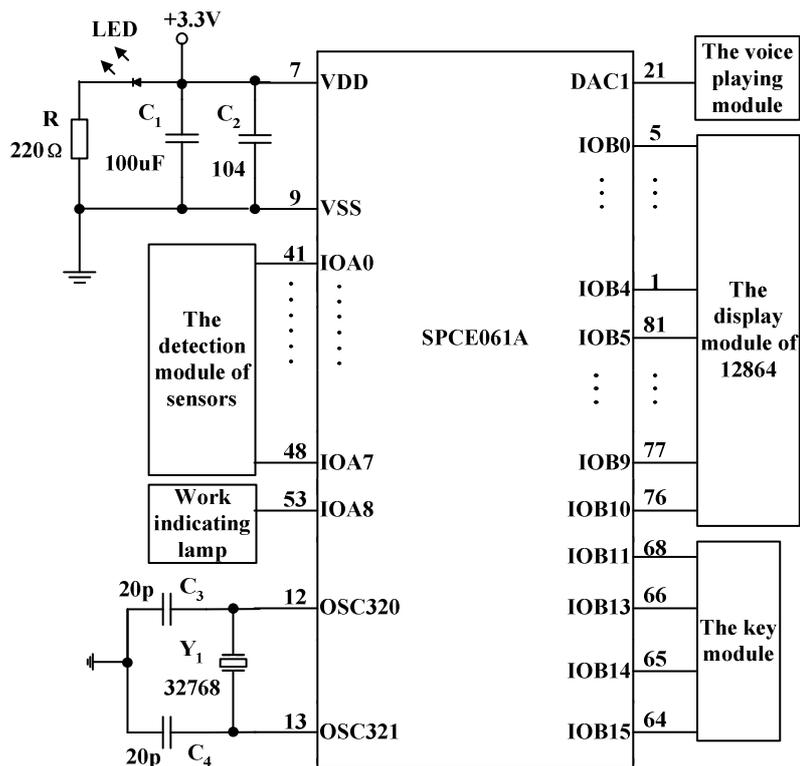


Fig.3 The controller circuit

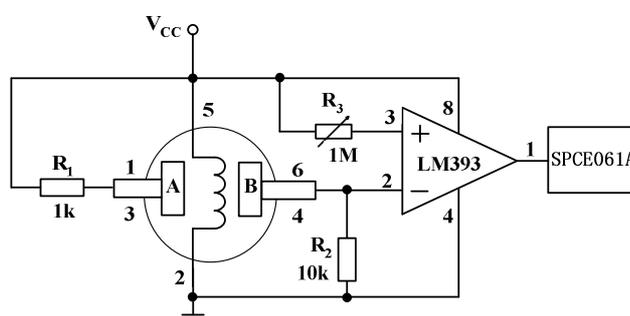


Fig.4 The sensor circuit

2.4 Display circuit

Using 128×64 characters dot matrix graphic type LCD module displays the appropriate information, the display module can display 8×4 lines 16×16 dot matrix characters, can be programmed to achieve a variety of display, display information than digital, 1602 LCD more display better. The interface circuit of 128×64 LCD is shown in Figure 5.

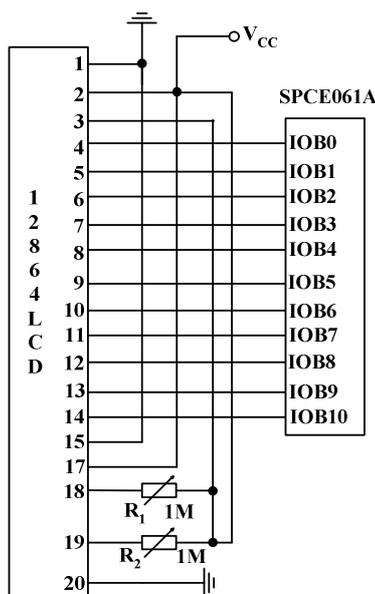


Fig.5 The interface circuit of 128x64 LCD

2.5 Voice playback circuit

Voice messages by voice decoder library functions need to play by the internal processor SPCE061A 10 DA converts the digitally encoded voice analog signals [9], and finally through the voice signal amplifier chip SPY0030 will play the voice signal after amplification, the voice playback circuit is shown in Figure 6.

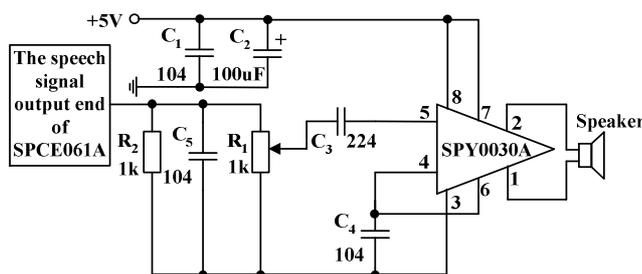


Fig.6 Voice playback circuit

2.6 Key circuit

For ease of use, we have optimized the design of a 4x4 matrix keyboard, and you can set the detection method, food quality standards and other relevant parameters through the matrix keyboard, the key circuit is shown in Figure 7.

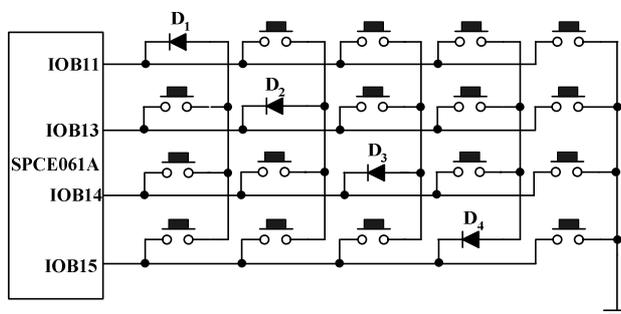


Fig.7 Key circuit

SYSTEM SOFTWARE DESIGN

C language with a simple and compact, flexible, rich set of operators and data types, flexible and practical advantages of expression [10], so intelligent voice control electronic nose software using C language programming, using C language to achieve a powerful microcontroller SPCE061A control functions in an orderly manner so that the entire work, the main program flow chart is shown in Figure 8.

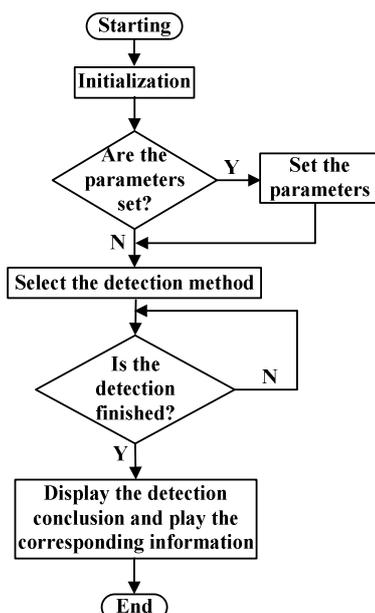


Fig.8 The main program flow chart

SYSTEM APPLICATION

Intelligent Voice electronic nose with our nose and mouth, to get food when sniffing distribute gas concentration value, comparing the gas concentration standard set of parameter values and testing, to evaluate the quality of food, into other food authenticity and voice play the appropriate information. The application of intelligent voice electronic nose it's fast, easy, and unique environmental advantages of evaluation methods in food quality analysis and testing has been widely. The intelligent voice applications were electronic nose for pork, sardines, tomatoes, apples and other foods were repeated testing, part of the measurement results are shown in Figure 9, Figure 10. Because the intelligent voice electronic nose is similar to the function of nose, so it can be used in odor identification, authenticity verification, process monitoring, environmental monitoring and other aspects.

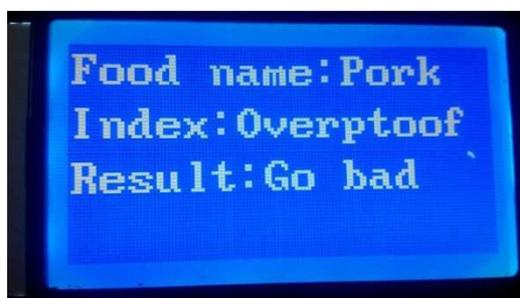


Fig.9 The detection result of pork

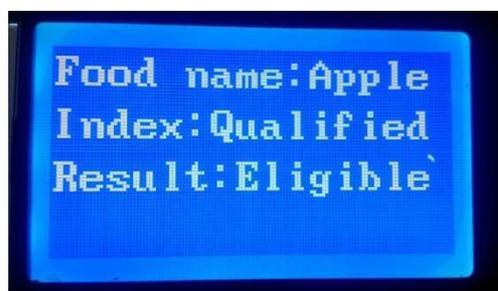


Fig.109 The detection result of apple

CONCLUSION

The intelligent voice electronic nose is a sensor technology, bionic technology, signal processing technology, SCM,

and other technology in one system, is an analog of human sensory organs, can food quality for fast, non-destructive and objective testing. Simulation results show that regardless of the trial from the price, or from the terms of use and feasibility considerations, intelligent voice electronic nose is a very good tool, it gives food quality testing and analysis provides new methods and ideas. With the increasing development of the technology is mature, intelligent voice electronic nose will be more extensive development.

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REFERENCES

- [1] Cheng, Zhou Zhi, Wang Xingping, *Journal of Hubei University for Nationalities*, 1(2014) 5-11.
- [2] Gardner J. W., Bartlett P. N. *Sensors and Actuators B: Chemical*, 1(1994), 210-211.
- [3] Sun Xiaozhi, Zhang Qimin, Basic analog electronic technology, Beijing, 2012, pp. 18-38.
- [4] Ran Weigang, Jing Xin, Liu Qiang, *Automation & Instrumentation*, 2(2014) 40-41.
- [5] Yu Youwen, Chang Jian, Cheng Jihong, The principle and engineering application of sensor, Xi'an, 2011, pp. 50-78.
- [6] Li Yuehua, Bao Jianqiang, Zhou Qiushu, *Science and Technology of Food Industry*, 19(2014) 284-288.
- [7] Concina L., Falasconi, M., Gobbi, E., et al. *Food Control*, 10(2009) 837-880.
- [8] Ghasemi-Vamamkhasti M., Mohtasebi S.S., Siadat, M., et al, *Sensors*, 9(2009) 6058-6083.
- [9] Qiu Shaofeng, The principle and application of Sunplus sixteen bit single-chip microcomputer, Xi'an, 2011, 66-72.
- [10] Zhao Jianling, 51 Series MCU development collections, Beijing, 2012, 226-332.