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Non-contact Gesture Recognition Device Based on FDC2214

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Abstract

The capacitive sensing integrated module based on TI's FDC2214 applies STM32F103 series MCU as the control system, and uses STM32 to analyze and judge the data. The module combines LCD display, button selection module, voice broadcast and other modules to achieve a good human-computer interaction experience,and realize gesture recognition for guessing and punching. The software and hardware design of the device is feasible, and the gesture recognition is fast, accurate, anti-interference.

Keywords

FDC2214; gesture recognition; STM32; training mode; decision mode

I. Introduction

Gesture recognition is one of the new ways of human-computer interaction,which is becoming an increasingly important research topic, Gesture recognition technology is a new type of human-machine natural interaction control technology based on advanced sensing technology and computer pattern recognition technology. It can be divided into vision sensor-based gesture recognition and wearable sensor-based gesture recognition [1]. Gesture recognition focuses on tracking gesture actions and processing subsequent computer data. This article adopts TI's high-sensitivity capacitive sensor FDC2214 to collect data of different gestures, and the module performs judgments on different gestures through techniques such as training and learning, gesture recognition estimation algorithms, statistical sample features, and deep learning.

II. System design

The system design goal is to enable the device to complete the judgment and training of the "scratch" and "guess" gesture recognition games at the same time. The judgment of the guessing game here refers to the judgment of the gestures "stone", "scissors" and "cloth". The judgment of the boxing game refers to the gestures "1", "2", "3", "4" and "5". In the training mode, the gesture training of the guessing game and the boxing game can be performed for any person. After a limited number of trainings, the correct guessing game and the gesture judgment of the boxing game can be performed.

This system uses TI's FDC2214 chip and STM32 microcontroller to achieve effective judgment of gestures. One of the channels of the FDC2214 is connected to the copper clad plate to form a capacitance detecting circuit. When the hand is close to the sensing end,the capacitance at the sensing end has changed,which will lead to the change in the oscillation frequency of the LC circuit, reflecting the proximity of the gesture,Then the circuit connected with the single chip can realize the analysis and judgment of the data,and judge the gesture. The TFTLCD display is used to display the current mode as well as the tester's gestures. The system block diagram is shown in Fig.1. The system is mainly composed of three parts: the detection part, the control part, and the human-computer interaction part.

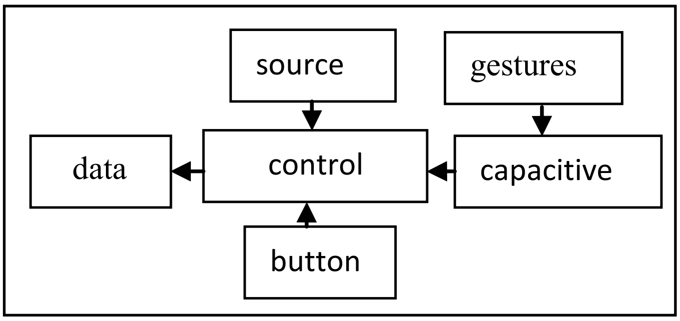

Fig.1: system block diagram

III. Hardware part design

1. Detection Part

The FDC2214 is a capacitance sensing sensor based on the principle of an LC resonant circuit. An inductor and a capacitor are connected to the input end of each detection channel of the chip to form an LC circuit. The measured capacitive sensing end is connected to the LC circuit, and an oscillation frequency is generated, and the measured capacitance value can be calculated according to the frequency value. By analyzing these data, the function of gesture proximity and recognition can be realized.As shown in Fig.2, the yellow part is called "the sensing plane of FDC2214". The plane is a conductor material. When the human hand approaches the conductor sensing plane, the sensing is performed. The capacitance of the terminal changes, which causes the oscillation frequency of the LC circuit to change, reflecting the proximity of the gesture and the determination of the gesture. The larger the area of the sensing plane, the smaller the distance between the gesture and the sensing plane，the greater the frequency of the sensing, the more sensitive the system will be. But at the same time, more noise may be introduced. Fig.3 is a graph showing the relationship between the area of the conductor plate and the sensing distance. A 200cm2 copper clad laminate is considered, which can enhance the sensitivity of the system and reduce the introduction of noise.

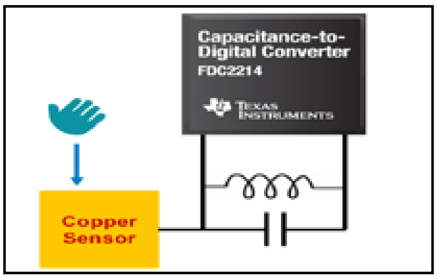

Fig. 2: Gesture sensing

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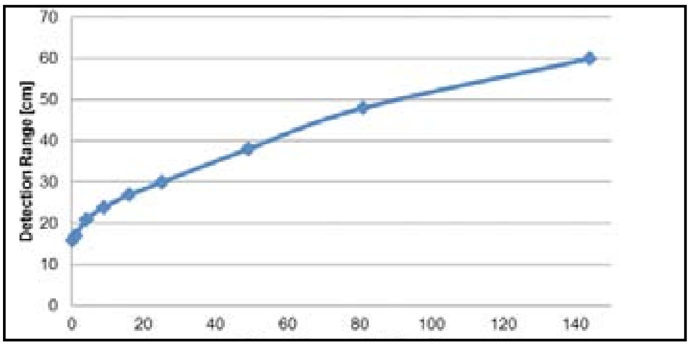

Fig.3: Dectection Rang vs.Square Sensor Size

The greater the distance between the hand and the hand-to-clad board, the worse the degree of induction and the unstable data detection, so the distance between the hand and the hand-to-clad board is 1.5 cm.

The FDC consists of a front-end resonant circuit driver and a multiplexer. It connects them to the core of the measured and digitized sensor frequency (fSENSOR) through the active channels. The core uses the reference frequency (fREF) to measure the sensor frequency.The reference frequency comes from the internal reference clock (oscillator) or an externally supplied clock. The digitized output of each channel is proportional to the ratio of fSENSOR/fREF. The I2C interface is used to support device configuration and transfer digitized frequency values to the host processor. The FDC can be placed in shutdown mode using the SD pin to conserve current. The INTB pin can be configured to notify the host system of changes in state. The FDC2214 sensor circuit is shown in Fig.4.

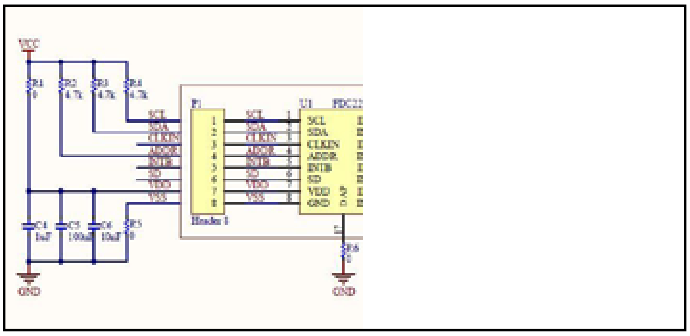

Fig. 4: FDC2214 sensor circuit diagram

2. Human-computer interaction part

Human-computer interaction part TFTLCD screen, independent buttons and other modules are used for display, mode interface selection, gesture changes, game decision results, and so on. A schematic diagram of the human-computer interaction part is shown in Fig.5.

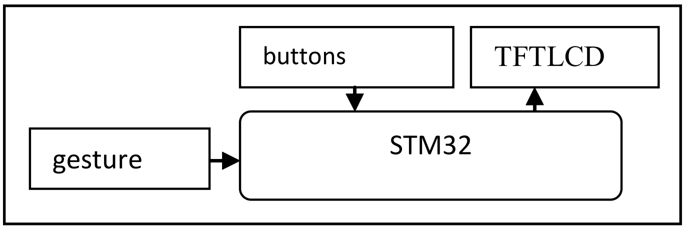

Fig.5: Schematic diagram of human-computer interaction

IV. System software design

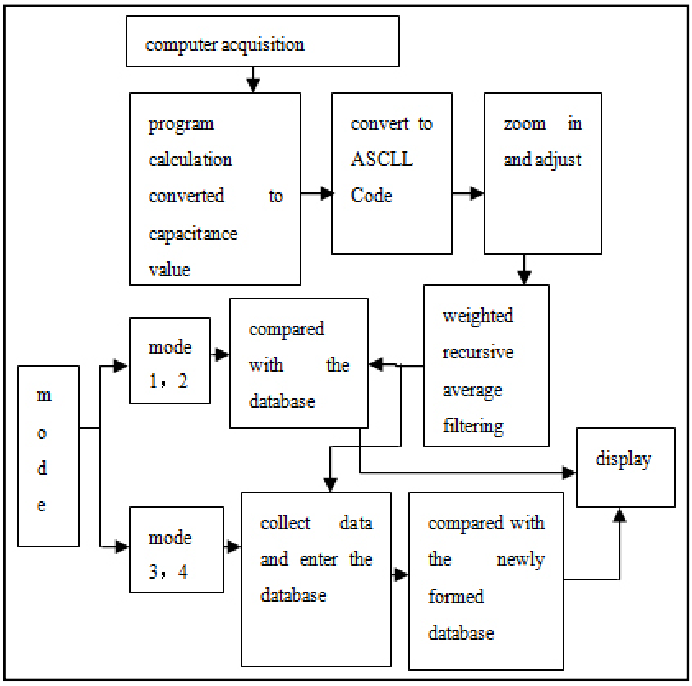

Fig.6: Software flow chart

The system software flow chart is shown in Fig.6. After the system is powered on, the mode selection is performed, and the decision mode 1, 2 or the training mode + the decision mode 3, 4 can be selected. In different modes, the MCU performs calculation, conversion, amplification and adjustment according to the collected data, and weighted recursive average filtering, and compares with the data of the database, and the judgment result is displayed.

V. Test plan and test results

1. Test plan

First, the judgment of the judgment mode is carried out, and the designated personnel successively perform the guessing and the punching and record the result. Then randomly select one person to collect the gesture information of the training mode. The tester first starts the guessing training data input and then goes to the judgment mode to judge the gesture of the tester. After the guessing is completed, the training mode of the punching is again entered, which is the same as the previous mode. Step, the tester is punched and judged, and the test is finished after the test is over.。

2. Test Results

The test results are shown in Table 1.

3. Analysis of test results

The system consists of STM32 single-chip microcomputer, FDC2214, copper clad laminate, acrylic plate, button and TFTLED display screen. At room temperature, the judgment result of the device is tested as expected, the fluctuation range of the collected value is not large, and the calculation rate of the processor can be Meet the time requirements limited by the title. The device can be basically eliminated by filtering or additional isolation, and the whole system state is relatively stable.

Table 1 :Test results

gesture frequency	mode	hammer	scissors	cloth	1	2	3	4	5
1	Judgment mode	149	71	211	45	75	135	184	211
	Training mode	155	75	210	43	76	133	188	221
2	Judgment mode	163	62	224	51	65	126	174	201
	Training mode	147	78	209	52	63	125	176	221
3	Judgment mode	158	69	204	47	78	139	189	201
	Training mode	139	65	221	46	77	124	180	216

Note: The number corresponding to each gesture is the converted set value

VI. Conclusion

After many tests, the design can achieve the desired goal, achieving non-contact gesture recognition, memory and decision function in the sensing area.(1) In the decision mode, when the distance between the sensing plane and the ground plane is 30 mm, and the distance between the sensing plane and the contact plane is 5 mm,Give gestures “stone”, “scissors” and “cloth” and give gestures “1”, “2”, “3”, “4” and “5”The judgment time is less than 1 s;(2) In the training mode, the gesture training of the guessing is performed on any tester, the number of trainings of each action is not more than 3 times, and the total training time is less than 1 minute; then the working mode is switched to the judgment mode, and the trained personnel are performed. Guessing judgment, the time of each judgment is less than 1 secondPerform gesture training for any tester, each training less than 3 times, the total training time is less than 2 minutes; then switch the working mode to the decision mode, and make a stroke decision for the trained personnel.The time for each judgment is less than 1 second.

References

[1]. Zhao Xiaochuan, Zhao Jipeng, Fan Bingyuan, Hao Lili. Review and Application Prospect of Gesture Recognition Technology[J]. Computer Engineering and Applications 294, 2017, 53(s2)

[2]. Wu Xia, Zhang Qi, Xu Yanxu. A review of the development of gesture recognition research [J]. Electronic Technology, 2013, 26(6): 171-174.

[3]. Chen Ting, Fan Shuo. Non-contact gesture recognition device based on FDC2214[J].Private technology 294, 2018 (10) 3-4.

*[4]. Huang Jian. Development of High Temperature Isolated Touch Module Based on Capacitance Sensing[J]. Aerospace Measurement Technolog*y, 2017, 37(5): 40-4.