New Application of Children's Sign Language Enlightenment Based on Data Glove

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Abstract. In order to enhance the learning interest of deaf-mute children as beginners in sign language and promote the balance of educational reform, we have developed a new application which based on data gloves, to be the enlightenment for children learning sign language. The application mainly includes three parts: data acquisition and conversion, wireless communication, and cartoon interactive application. The application, taking STM32 development board as the control core, is integrated with multiple sensor function modules including Wi-Fi wireless communication, three-axis gyroscope, bending resistor and others, therefore, it can realize the gesture recognition and data transmission. After repeated testing, the system has high accuracy in gesture recognition, not only data transmission is reliable but also the application response timely. Deaf-mute children can use the cartoonish application to get sign language examination questions and to answer by wearing data gloves, and then the system will give a star rating comprehensively based on whether the answer is correct, on whether the cue is clicked in answering question and on other aspects, so as to realize the interaction with the PC program and let deaf-mute children contact and learn sign language in games. The design concept of the application has received favorable response from Qingdao school for the deaf, which has a certain practical and promoted value.

1. Introduction

Language is the most important communication tool for human beings, which is closely related to thinking and is the direct manifestation of thought, so is the sign language, which is the first language of the deaf-mutes, a tool for communication and their thought [1]. Research suggests that 0-12 years old is the best period of language learning and there is plenty of nice teaching software assisting sound children study, while the way for deaf-mute children to learn sign language is relatively single. Usually teachers demonstrate personally in class and children learn sign language picture books on their own after class. Although hearing and speech disorder aggravates the difficulty of mental and intellectual development of deaf-mute children, it has a positive impact on their development of visual perception so that their visual advantage is very obvious. In the related tests, the observation ability of deaf-mute children is more sensitive and their visual motion ability is stronger compared to healthy children[2].Besides, deaf-mute children are more competent than those normal children in terms of identifying and distinguishing important features of different objects according to their vision, and the visual memory of color and pattern. Therefore, in addition to using language communication, increasing the stimulus of nonverbal materials in the process of education for deaf-mute children can...
give play to the advantages of visual memory to get more information [3], which is also our idea and original intention of designing the new application of children’s sign language enlightenment based on data glove. The proposed application of this article is a kind of Internet of things application. It puts forward the new application of the enlightening sign language teaching according with children's psychology, interest and motivation. Compared with traditional teaching method of sign language, this application is more enlightening for children who have just begun to access sign language, help them understand sign language and stimulate their interest in learning sign language.

The first part of the article describes the overall design and implementation of the application. It mainly introduces function of the application, design and implementation of the model. The second part gives an overview of centre control, communication module and data acquisition module. The third part introduces design ideas of system software, testing methods of hardware and software, and makes an example analysis to some debugging results. The fourth part summarizes design ideas and design method of the application.

2. The overall design and realization of application

2.1. The function profile of application

By wireless communication, sensor technology, embedded system and other significant technology, we develop a children's sign language enlightenment application that accords with children's curiosity and has prominent visual communication effect. Its main functions are as follows:

- Application realize gestural recognition through detecting tortuosity of the bending resistor and changes of palm displacement.
- Contrast whether gesture is accord with the requirements of application and judge whether gestural answer is right.
- Based on the comprehensive evaluation of the answer situation, the application will give star rating to realize Inspired teaching.
- Sign language teaching mode which can through passing levels stimulates the enthusiasm of deaf-mute children to learn sign language.

2.2. The design of application module and realization of function.

The design of application integrates STM32F103VET6, Wi-Fi module and other digital sensor inspection module in order to realize above function, which are shown in the figure 1. We use Visual Studio developing Interactive cartoon application and realizing sign language enlightenment of deaf-mute children.

![Figure 1. System Architecture](image_url)
The bending resistor takes charge of collecting tortuosity of figures and its resistance decreases with the increase of tortuosity. Three-axis gyroscopes takes charge of collecting changes of palm displacement and then the recognition of gestures can be realized by the above two modules. Considering sign language is a dynamic language and children are more active, so application integrates serial port connect to Wi-Fi module to realize wireless transmission of data, which provides more comfortable use experience for deaf-mute children. In addition, wireless transmission provides conditions for applications to be ported to mobile devices such as mobile phones and tablets [4], so the use of APP can make sign language learning more convenient and fast.

2.3. Instruction of application module

2.3.1. Central control module and Communication module. Application selects STM32F103VET6 which is high performance and low power consumption as Central control module of SCM selects Wi-Fi module to realize communication with PC.

The Wi-Fi module of application is ESP8266 series chip. With its high integration, low power consumption and ease of use, the chip has gained recognition in the Internet of things field and it is the best choice to realize remote control which is based on Wi-Fi [5]. ESP8266 supports soft AP mode, Station mode and soft AP + Station coexistence mode. Application selects soft AP mode which regards ESP8266 as a Wi-Fi hotspot.

The fundamental process of ESP8266 realize wireless control: Firstly, PC joins up ESP8266’s hotspot by Wi-Fi and builds Socket links through the application. Secondly, the instructions of the starting data detection were sent to the ESP8266 chip via Wi-Fi. The chip converts the Wi-Fi signal into a serial signal and sends it to the MCU via serial communication. Thirdly, the MCU begins processing the acquired instruction and data. Finally, MCU sends the data back to the application in real time via the ESP8266 chip, so application realize the data interconnection between STM32 development board and PC. The integral control process is shown in the figure 2.

![Figure 2. System Communication Frame](image)

2.3.2. Data acquisition module. Application select bending resistor as acquisition module of figure condition and output of bending resistor as analog signal. So MCU need use ADC to collect data. The change of palm displacement is detected by the three-axis gyroscope MPU6050. The module’s interior integrates AD, so we simply use the protocol configuration to read the data. Selection of system front-end data acquisition module is shown in the table 1. The data glove is shown in the figure 3.
Table 1. Selection of Data Acquisition Sensor Module

| Module                        | Model   |
|-------------------------------|---------|
| Bending resistance module     | RFP     |
| Three-axis gyroscopes module  | MPU6050 |

Figure 3. Data glove

3. Software design of application
The application mainly uses Keil uVision5, computer and DAP simulator as the development tool.

Programming on STM32 development board with Keil uVision5 and programming on Bending resistance, three-axis gyroscope according to the agreement.

We adopted C# language in cartoon interactive application. Using the controls provided by Visual Studio makes application forms to sets up interactive interface which appeals to children’s psychology. Through Wi-Fi to receiving the information coming from hardware and achieve the data connection. And then judge gestures to make further instructions.

4. Application test
The application test divided into STM32 development board test part and PC application test part.

For the STM32 development board test, testing the design of the power is the first step, then testing whether it can successfully start Wi-Fi, ADC module is the second step when providing power supply for development board. Thirdly, testing whether bending resistance and three-axis gyroscope can successfully collect data and return to PC through Wi-Fi.

For the PC application test, start with the development board started correctly. Get sign language examination questions from PC first and then wear data glove made up of bending resistance and three-axis gyroscope to answer the question. The glove will get the bending combination of each finger in order to achieve the capture of sign language action. PC receiving data through Wi-Fi and judge the answer right or not, if right, you can enter the next level, or you can click point to see the correct answer.

5. Summary
The article outlines a design method of new application of children’s sign language enlightenment based on Internet of things, expounds the design idea of the application and the realization way of key functional modules. The application integrates the sensor technology, embedded technology and wireless communication technology and other important technologies. Tests have proven that the
application which according with children’s psychology, interest, motivation and other characteristics can achieve an effective gesture recognition, and give star rating to children’s answer. This achieves the desired design effect. With the development of technology, intellectualization and modernization are the trends of future society. Currently, sign language teaching limited to traditional class sign language teaching. The development of the application improves this situation. This application with preferable interactive performance is easy to use and can enhance the learning interest of deaf-mute child. Moreover, it makes sign language teaching emission its brilliance. Not only bring multiple reading experience but also bring stimulate of fresh vision to children.[6] The 19th session of national congress of the communist party of China pointed out that do a good job of special education. Efforts will be made to give every child access to fair and quality education. This consistent with our design philosophy and meets the development trend of society which beneficial to product promotion.

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