2021 IEEE 3rd International Conference on Communications, Information System and Computer Engineering (CISCE 2021)

Design of Wireless Smart Home Safety System Based on Visual Identity

Qiang Qi[1,a]
[1]School of ZTE Information, Xinyu University
Xinyu, Jiangxi, China
Email: [a]gogogotofighting@foxmail. com

Xiangyu Xie[2,b]
[2]School of New Energy Science and Engineering, Xinyu University
Xinyu, Jiangxi, China
Email: [b]xxy20000708@foxmail. com

Changhai Peng[1,c], Jufang Hu[1,*]
[1]School of ZTE Information, Xinyu University
Email: [c]pengchan4895@foxmail. com, [*]hujufang0790@foxmail. com

***Abstract*— Focusing on the problem that the elderly and the disabled live alone at home and miss the best rescue time in case of emergency, this paper describes a wireless smart home safety system based on visual identity. The system has the functions of monitoring, fire prevention, automatic speech recognition (ASR) , visual identity (VI) , temperature and humidity measurement, manual alarm, automatic alarm and so on. The VI function of this system is realized by establishing neural network model. When the user falls, the system camera recognizes the person who falls and automatically asks if he needs help. Also, on the basis of the original work, we use ZigBee protocol to make all the sensors wireless, expand the effective coverage of the system, making the installation more convenient.**

Keywords— IoT; VI; ASR; ZigBee; Neural network model

I. INTRODUCTION

With the development of electronic information, Internet of Things, embedded and other technologies[1], the automation and intelligence of various household electronic products are constantly increasing. With the development of electronic information, Internet of Things, embedded and other technologies, the automation and intelligence of various household electronic products are constantly increasing. Using wireless communication technology to control household appliances and simple mechanical devices has become an ideal choice for researchers to develop smart home system. In addition, the development of artificial intelligence technology has brought the prosperity of ASR and VI. Connecting the ASR module and VI module to the smart home system can greatly improve its intelligence. So as to bring users high-quality, intelligent, humanized, safe and convenient life experience[2].

Therefore, this project uses ZigBee protocol module to make wireless processing of sensors, monitors, relays, stepper motor drivers and other modules, this can reduce the damage of wiring to the aesthetic degree of interior decoration[3], and make the installation of the system more convenient.

In recent years, people pay more attention to the recognition of the fallen based on VI Technology[4][5][6]. Therefore, the neural network model is established to realize the function of VI. And the neural network model is established to realize the VI function of the monitor, which is used to identify the fallen person in the video and automatically ask if they need help.

978-0-7381-1215-2/21/$31.00 ©2021 IEEE

II. PROPOSED METHODOLOGY

The system block diagram of this wireless smart home system was shown in Fig. 1.

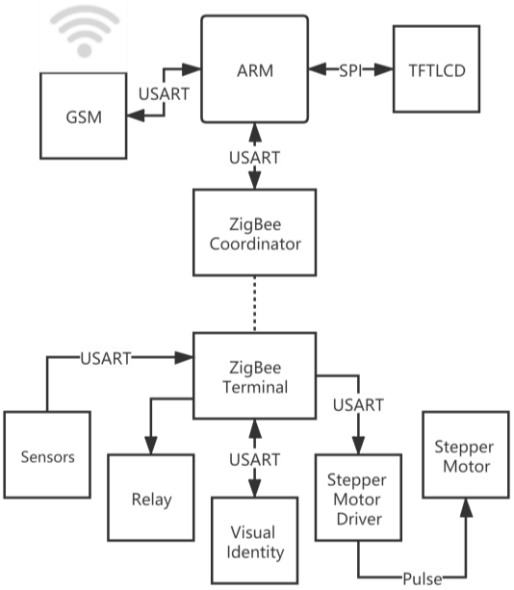

Figure 1. Block Diagram of This System

The wireless smart home system had three main functions: household appliances controling, environmental monitoring and indoor safety warning.

Through the wireless relays, the realization of the control of home appliances on or off. Also, to enabled stepper motor implement the control of the curtain.

Next, The function of Environmental monitoring was realized through OpenMV camera, which stores and provides monitoring video for a period of time. And to used sensor achieve indoor temperature, humidity and smoke detection.

Foremost, after processing the information by ARM, different alarm methods were adopted for three situations of abnormal temperature and humidity, someone tumble, fire disaster. According to the different degree of danger, through the GSM module to the preset receiver, such as: police, hospital, fire brigade call for help. Among them, whether someone fell

2021 International Conference on Communications, Information System and Computer Engineering (CISCE) | 978-1-6654-0352-8/21/$31.00 ©2021 IEEE | DOI: 10.1109/CISCE52179.2021.9445989

down was judged by OpenMV intelligent recognition. At the same time, users can also use voice commands to manually operate the system to ask for help. The voice interaction part of this function is realized by the ASR module.

III. SYSTEM HARDWARE AND SOFTWARE DESIGN

A. Hardware Requirements

On the basis of previous work, the ZigBee wireless communication IoT module was combined with MCU, cameras, sensors, stepper motors, relays and other hardware, to built multiple wireless hardwares which had different functions in our system.

Among them, the type of ZigBee wireless communication IoT module was ZB214A_PA. And its main control chip model was CC2530. In this project, this module was used to carry out wireless serial port communication between each functional module.

The MCU model was STM32F103, which role is to has communicated wirelessly with various sensors, relays, cameras, stepper motor drivers, etc.

The sensors used in this project were: ASR module (The type was LD3320), smoke detector module (The type was MQ-2), temperature and humidity sensor (The type was DHT11).

The camera used the OpenMV module, which has served two purposes. On the one hand, it has the monitoring capability of a normal surveillance camera. On the other hand, as a VI module, it can recognize in real time if someone has fallen in the image.

And relays were used to control the switching on and off of household appliances. In addition, the stepper motor drivers were used to control the stepper motor, so as to realized the function of controlling the curtain opening and closing. In addition, the TFTLCD display was used to visually display the temperature and humidity of the current environment.

B. Software Requirements

In this project, embedded C and Python, two programming languages were mainly used for software design. Thereinto, embedded C was mainly used for the programming of MCU and ZigBee wireless communication modules. Python, on the other hand, was mainly responsible for building neural network model, image processing and calling related C language libraries.

IV. EXPERIMENT AND RESULT ANALYSIS

The smart home system realized by this project was composed of multiple modules in the way of wireless connection, as shown in Fig. 2.

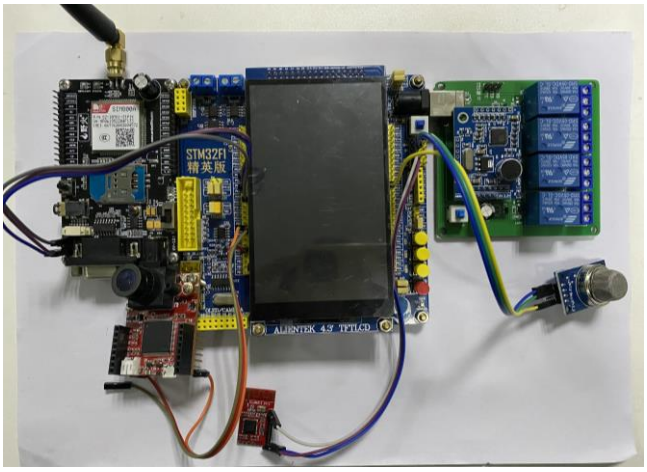

Figure 2. Hardware Implementation

This wireless smart home system could be apart from four parts according to function: wireless sensors system, VI & monitoring system, convenience system and alarm system.

A. Wireless sensors system

This part acts as the "eyes, ears and nose" of the smart home system, and was responsible for converting indoor analog signals such as temperature, humidity, smoke concentration and sound into digital signal. The signal was then wirelessly transmitted to the MCU via the ZigBee protocol. As shown in Fig. 3.

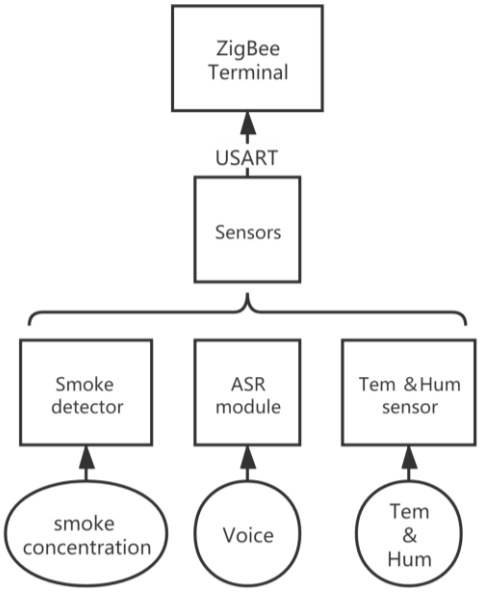

Figure 3. Block Diagram of Wireless Sensors System

In the meantime, all the sensors that made up the system were wireless, thus reducing the installation obstacles for users to a certain extent.

B. VI & monitoring system

In this project, we use Edge Impulse to build a neural network model, so as to realize the function of recognizing the fallen person in the image. Firstly, the image data of the fallen

person is uploaded to the Edge Impulse website and classified into two datasets with different tags. Next, select the percentage of training data and test data in the total amount of data. After that, we choose the model we want to build and carry out transfer learning. The image is processed by digital signal and RGB mode is selected. Next step, establish and generate data model features, and observe whether the data is representative and characteristic. In addition, we choose the number of training rounds and the minimum recognition success rate that we need to set up for the success of our model. In order to prevent the data training features from over fitting and avoid the inaccurate recognition of training model caused by too few training times. We set the number of training rounds to 20. Next, the trained model is tested with data. Finally, the trained model is tested and exported to generate the corresponding language library, as shown in Fig. 4.

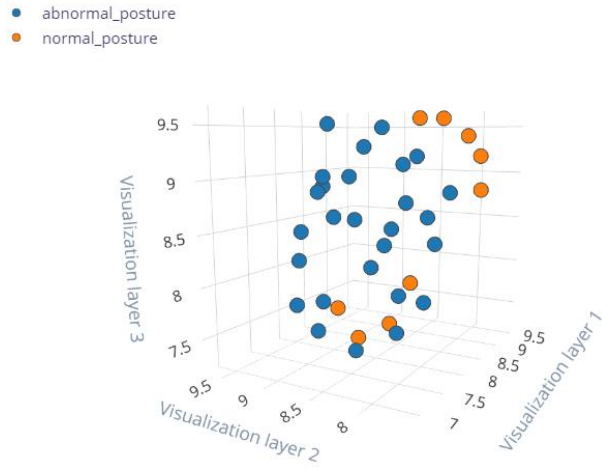

Figure 4. The Training Results of The Neural Network Model

After the export is complete, paste the generated model and code into the OpenMV module, open and run it. In this way, we acquire a monitor that can be used to identify people who have fallen. This part is the core of the VI & monitoring system.

In addition, all cameras connected to the system still retain their original function as monitors.

C. *Convenience system*

We designed convenience system for the convenience of users, especially the elderly and the disabled.

This system was used to control household appliances and simple mechanical devices. Through wireless relays to realize the real time opening and closing of home appliances. And enabled wireless stepping motors to control the mechanical part of the curtain. At the same time, the smoke concentration is detected through the smoke detector. While the smoke concentration exceeds the threshold, a shrill alarm is sounded. As shown in Fig. 5. And the temperature and humidity sensor is used to display indoor temperature and humidity information on the display.

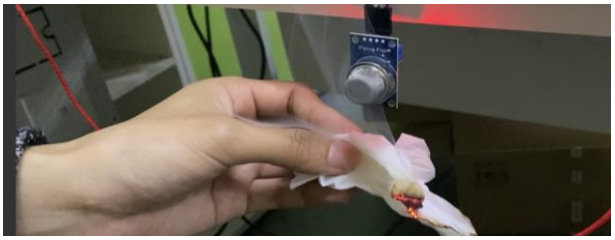

Figure 5. While The Smoke Concentration Exceeds The Threshold, The Smoke Detector Will Give An Alarm

More importantly, users could use voice commands to achieve the above functions. As shown in Fig. 6.

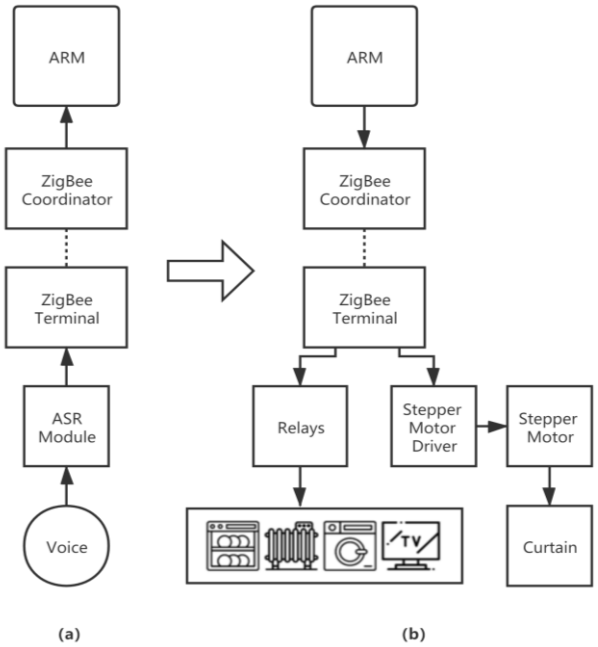

Figure 6. To Enabled Voice Commands to Realize the Functions of Convenience System (a) Issuing Voice Commands and (b) Starting

D. *Alarm system*

In this part of the project, we set up three ways to trigger the alarm. First of all, users wake up the system alarm through voice commands, just like using convenience system to operate household appliances; In addition, the system recognizes the fallen person through the camera and sends out voice inquiry. If the person who falls sends out a command that he needs help, or does not respond for a long time, the system will give an active alarm; In the third case, when it is not convenient to send voice commands, the user can use the emergency button to alarm actively.

Through GSM module, the scope of alarm includes police, hospital, firefighter and guardian. As shown in Fig. 7.

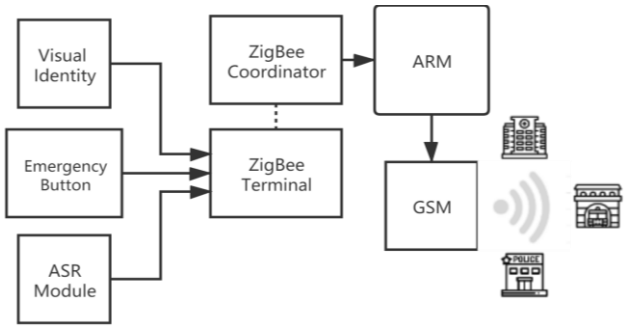

Figure 7. Block Diagram of Alarm System

V. CONCLUSIONS AND FUTURE WORKS

Design of wireless smart home safety system based on visual identity described in this project, which includes four system components: wireless sensors system, VI & monitoring system, convenience system and alarm system. In this design, VI technology based on neural network is applied, image data is collected by camera, neural network model is established and imported into OpenMV module.

On the basis of the previous work, the ZigBee protocol is used to realize the wireless and terminal of sensors, cameras, relays, stepper motors, etc, which enlarges the functional coverage area of the entire system. This makes the system easy to deploy and install in a modular manner and makes it easier to add new terminal equipment in the mid to late stages.

ACKNOWLEDGMENT

This research was partially supported by Science and Technology Research Project of Education Department of Jiangxi Province (GJJ181027), Innovation and Entrepreneurship Training Program for College Students in Jiangxi Province (202011508003, S202011508014), Innovation team Funding Project of Xinyu University (CT201901).

References

[1] Y. Pang and S. Jia, "Wireless smart home system based on Zigbee, " International Journal of Smart Home, vol. 10, no. 4, pp. 209-220, 2016.

[2] X. Mao, K. Li, Z. Zhang, and J. Liang, "Design and implementation of a new smart home control system based on internet of things, " in 2017 International Smart Cities Conference, ISC2 2017, September 14, 2017 - September 17, 2017, Wuxi, China, 2017, p. IEEE China Section; IEEE Power and Energy Society; IEEE Smart Cities Initiative: Institute of Electrical and Electronics Engineers Inc.

[3] K. Agarwal, A. Agarwal, and G. Misra, "Review and Performance Analysis on Wireless Smart Home and Home Automation using IoT, " in 2019 Third International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), 12-14 Dec. 2019, Piscataway, NJ, USA, 2019, pp. 629-33: IEEE.

[4] P. Gharti, "A study of fall detection monitoring system for elderly people through IOT and mobile based application devices in indoor environment, " in 2020 5th International Conference on Innovative Technologies in Intelligent Systems and Industrial Applications (CITISIA), 25-27 Nov. 2020, Piscataway, NJ, USA, 2020, p. 9 pp. : IEEE.

[5] S. Sowmyayani, V. Murugan, and J. Kavitha, "Fall Detection in Elderly Care System Based on Group of Pictures, " Vietnam Journal of Computer Science, vol. 08, no. 02, pp. 199-214, 05/ 2021.

[6] X. Yang, S. Tang, T. Guo, K. Huang, and J. Xu, "Design of indoor fall detection system for the elderly based on ZYNQ, " in 9th IEEE Joint International Information Technology and Artificial Intelligence Conference, ITAIC 2020, December 11, 2020 - December 13, 2020, Chongqing, China, 2020, pp. 1174-1178: Institute of Electrical and Electronics Engineers Inc.