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Gesture recognition smart home

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Gesture recognition smart home

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Abstract. Different from the traditional smart home control method, this article uses the PAJ7620U2 chip gesture recognition to add to the smart home system. PAJ7620U2 gesture recognition can recognize 9 different gestures. Based on this performance, a simulated smart home system based on gesture recognition is designed. It contains home intelligent electronic photo frames, audio and video entertainment modules, intelligent security monitoring, ZigBee wireless communication environment detection, and light control. The experimental results show that the system is simple to operate and powerful, and is integrated into the traditional smart home control method without gaps.

1. Introduction

Smart home originated in the 1980s and is the prototype of smart home, called Smart Home¹. In the 21st century, with the rapid development of the network and economy, technologies such as embedded and wireless sensing, and people's requirements for the home environment continue to increase, making smart homes widely concerned. Compared with ordinary homes, smart homes not only have the same functions as ordinary homes, but also more convenient and comfortable. In particular, smart homes that use gesture recognition can connect to home appliances with only a few gestures, and control home appliances, video entertainment, etc., is simpler and faster than devices such as mice and touch screens.

2. System related technology and overall design

The smart home system controls the home through gesture recognition and data collection for the home environment. The system is controlled by the development platform, which simulates home video and audio, and uses ZigBee technology to detect temperature and humidity.

2.1. Overall system design

This system is divided into four parts: operator gesture recognition acquisition part, development platform data processing part, data transmission part, and smart home controlled part.

Operator gesture recognition collection part: The operator makes the corresponding nine gestures within the range recognized by the gesture recognition device, and communicates the collected gesture information with the development platform through the LLC protocol.

Development platform data processing part: through reading and writing PAJ7620U2 driver to recognize and process the sent gesture data.

Data transmission part: Send the data processed by the development platform to the controlled home.

Controlled part of the smart home: execute the commands sent by the development platform.



2.2. *Embedded technology*

2.2.1. *Embedded System Framework.* Embedded system refers to a special-purpose computer system with applications as the center, computer technology as the basis, and software and hardware that can be tailored, and is suitable for application systems that have strict requirements on function, reliability, cost, and work volume. It generally consists of an embedded microprocessor (this time the arm A53 processor), peripheral hardware devices (paj9260, ZigBee, camera, etc.), an embedded operating system (Linux system), and application programs, which are used to control peripheral devices operating.

2.2.2. *ARM processor and architecture.* ARM can be said to be a general term for embedded microprocessors, or it can be considered to be the name of an embedded technology.

Arm processors have the characteristics of low power consumption, powerful 16-bit and 32-bit dual instruction sets, and many architectures. The current ARM architecture mainly includes: THUMB 16-bit instruction set (improved code density), DSP (arithmetic operation instruction set), Jazeller (allows direct execution of Java word code). ARM processors can be applied to a wide range of fields, such as wireless consumer electronics and image processing platforms, applications and storage, automation, industrial and network embedded real-time operating systems, and communication network security. This design uses ARM-A53 processor as the main control chip.

3. **Smart home hardware system**

The system hardware has the following components: PAJ7620U2 gesture recognition module, GEC-6818 embedded development platform equipped with linux system, platform simulation home audio and video module, home lighting module, ZigBee home environment monitoring module, security monitoring module.

3.1. *The module of PAJ7620U2 gesture recognition*

PAJ7620U2 is an optical array sensor launched by PixArt.inc. It has a built-in light source and ambient light suppression filter LED, lens and gesture sensor in a small cube module, which can be used in dark or low light environments. jobs. At the same time, the sensor human gesture recognition recognizes 9 different gesture types and output gesture interruptions and results. And it does not provide a proximity detection function, which can be used to detect the approach or departure of objects.

Features of PAJ7620U2 is:

IIC interface, support up to 400Khz communication rate.

Built-in 9 types of gestures (up, down, left, right, front, back, clockwise, counterclockwise, and swing), support output interruption.

Support the proximity detection function to detect the volume and brightness of the object.

The standby function consumes 15uA.

Anti-light interference.

PAJ7620U2 comes with LED driver, sensor sensing array, target information extraction array and gesture recognition array. When PAJ7620U2 works, it uses the internal LED driver to drive the infrared LED to emit infrared signals outward. When the sensor array detects an object within a valid distance, the target information extraction array will acquire the characteristic raw data of the detected target, and the acquired data will exist. At the same time, the gesture recognition array will recognize the raw data at the same time, and finally store the gesture result in the register. The user can process the raw data and the result of gesture recognition according to the I2C interface.

3.2. *Development Platform GEC-6818*

It is powered by Samsung cortex-A53 series high-performance processor S5P6818. As shown in Figure 1.



Figure 1 The GEC-6818 core board

The GEC-6818 experimental development platform includes a core board, an embedded development platform, and an experimental expansion motherboard. This system mainly uses a core board and an embedded development platform. The S5P-6818 core board is highly scalable, has up to 180PIN pins, and runs at speeds up to 1.4GHz. The core board has PMUAXP228 on board, with Coulomb's charge management, supports S5P4418 and S5P-6818 for normal operation, and integrates Gigabit Ethernet, which can be widely used in MID, POS, PDA, PND, smart home and other fields.

S5P-6818 uses 28nm production work, built-in high-performance octa-core ARM Cortex-A53 processing architecture. In terms of multimedia performance, it supports almost full-format video decoding. On the LCD controller, the chip has LVDS, RGB and MIPI three-channel display control interfaces. The display resolution can be up to 2048 * 1280 @ 60Hz.

3.3. Security monitoring module

Security surveillance uses V412 cameras to simulate indoor and outdoor surveillance. The camera is connected to the development platform module via USB. The security monitoring module is shown in Figure 2.

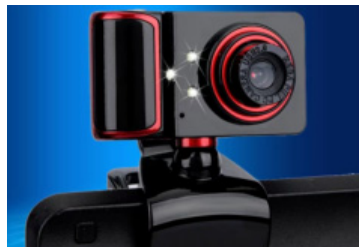


Figure 2 security monitoring module

3.4. Home theater

3.4.1. Home theater module. Home video simulation mainly uses the GEC-6818 development platform combined with madplay mplyer audio and video processing application tools to simulate home background music playback and movie video projection. madplay is mainly used for audio file decoding, such as mp3 files, wav files and other types of audio file processing. MPlayer is an open source multimedia player, released under the GNU General Public License. This software can be used in all major operating systems, such as Linux and other Unix-like operating systems, Microsoft's Windows system, and Apple Computer's Mac OS X system. MPlayer is based on a command line interface, and you can choose to install different graphical interfaces in each operating system². Because Linux is a command line operation mode, various operations on mplayer are implemented using commands. This time, it mainly uses its slave mode.

3.4.2. Temperature and humidity sensor and light control. This system uses a ZigBee module, which integrates temperature and humidity sensors and light control. The DHT11 digital temperature and humidity sensor is a temperature and humidity composite sensor with a calibrated digital signal output.

It applies special digital module acquisition technology and temperature and humidity sensing technology, which has extremely high reliability and stability. The sensor includes a resistive humidity sensing element and an NTC temperature measuring element, and is connected to a high-performance 8-bit microcontroller. As shown in Figure 3.



Figure 3 ZigBee environmental monitoring and light control module

4. Software design for smart home system

4.1. Gesture recognition and development platform

Drive shift value through gesture recognition module, Compile PAJ7620U2 driver code under Linux, and installed to the GEC-6818 development platform, Gesture recognition module through IIC communication protocol, Communicate with the development platform to pass gesture data to the development platform.

4.2. Temperature and humidity module design and lighting simulation of ZigBee

ZigBee's main control chip is cc2530, which is an 8-bit processor that Support serial communication and 2.4g wireless communication. The communication between ZigBee and 6818 of this system is mainly realized through the serial port. So the program should involve 6818 serial application and ZigBee serial application. First design the ZigBee temperature and humidity data acquisition code separately, Transfer to development board through usart, 6818 development board reads data from ZigBee corresponding serial port by using file io, At the same time 6818 received a light control gesture and Wrote data to the corresponding serial lighting control module of ZigBee through serial port, ZigBee reads serial data, obtains relevant instructions, and controls lighting

4.2.1. IAR Integrated Development Environment. C cross compiler of IAR Embedded Workbench (also known as EW) is a relatively complete, stable and easy to use professional embedded application development tool³, EW provides a unified interface to different microprocessors, and currently supports 35 types of 8-bit, 16-bit, and 32-bit ARM microprocessor structures⁴.

4.2.2. ZigBee device software implementation process. ZigBee's role is to enable the intelligent gateway to interact with other device nodes in the home's internal network. Through the transparent transmission mode, the server and the environmental monitoring end can communicate. On the embedded server side, ZigBee acts as a coordinator to communicate with the embedded server (6818 development board) through a serial port. At the home environment monitoring end, ZigBee, as a terminal node, communicates with the environment monitoring and lighting simulation end processors in the form of SPI bus. The communication between the coordinator and the terminal nodes requires networking. The formation and initialization of the network is implemented by the coordinator. The nodes created by the coordinator are mainly implemented by channel scanning, channel selection, and network signal setting. After the coordinator networking is completed, the terminal nodes will apply to join the network, and ZigBee communication can be performed only after joining the network results. In ZigBee communication, there are data reception, processing, and transmission, and there are three functions that are more important to achieve these functions:

Sampleapp_ProcessEvent () is an event processing function. When a registered event occurs, the main function will call this function to process the event (message, timer, custom event, etc.). After the judgment, the corresponding function is called for processing.

SampleApp_MessageMSGCB () is a data receiving function, mainly used to receive the data sent by the node. Once the command to receive data is received, this function will be called.

SampleApp_SendPehodicMessage () is a periodic data sending function that can send serial data to temperature and humidity monitoring and light control nodes.

4.3. Software design for home appliance simulation

Electronic photo frame module: It is mainly designed for embedded LCD screen applications, and the corresponding electronic images need to be displayed on the LCD screen. The main use is jpg format pictures, involving jpg image analysis algorithms, and image special effect switching display algorithms. Also pay attention to the io operation of electronic image files.

Music player module: It is mainly a practical madplay tool to parse audio files such as wav, mp3, The code is mainly designed for madplay application porting and its instruction operation mode. The control instruction application in the elf program is executed by the Linux system function system ().

Video playback module: Mainly use the mplayer tool, the type of video files to be played is mainly mp4, avi and other formats. Before officially writing the execution code, you need to transplant the mplayer tool to the development board, and then use the system function to control mplayer for video playback in the execution program. At the same time, we need to enable the slave mode and establish a communication channel on the development platform to ensure that mplayer can receive the instructions sent by the 6818 control terminal.

Security monitoring module: Collect camera data and display the collected jpg picture through two third-party libraries libapi_v4l2_arm.so and libjpeg.so.

5. Smart home system display and test

5.1. System operation interface

The data information of gesture recognition stores the detected gesture information in a register, and the development platform obtains the gesture information and makes corresponding judgments to control the smart home. As shown in Figure 4. It can be seen in the figure that it slides left and right and slides upward.

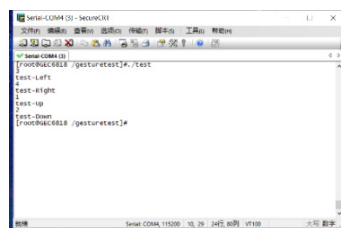


Figure 4 Gesture recognition test

5.2. Security monitoring test

The security monitoring test is to open the camera through the development platform and display it on the development platform, as shown in Figure 5. You can see the captured light image in the picture.

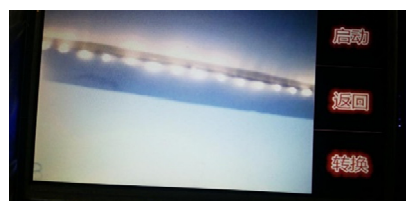


Figure 5 Security monitoring test

5.3. Home video simulation test

The test of the home audio and video module includes audio and video and electronic albums. After entering the main interface of the system, the home audio and video test is tested by gesture recognition instructions.

As shown in Figure 6, you can see the music playing, the play button is selected and paused, As shown in Figure 7, you can see that the button is in the playback state. As shown in Figure 8, you can see the electronic album, and there are previous, next, and back buttons.



Figure 6 Music player test



Figure 7 Audio player test



Figure 8 electronic album test

5.4. Environmental testing and lighting simulation

On the embedded server side, ZigBee acts as a coordinator to communicate with the embedded server (6818 development board) through a serial port. At the home environment monitoring end, ZigBee, as a terminal node, communicates with the environment monitoring and lighting simulation end processors in the form of SPI bus. Environmental detection is shown in Figure 9, and lighting simulation is shown in Figure 10.

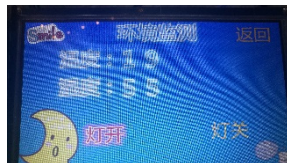


Figure 9 Environmental monitoring test



Figure 10 Lighting simulation test

6. Summary and outlook

This article designs a set of home audio and video control, security monitoring, and environmental detection systems through gesture recognition. The system uses the 6818 development platform of the Cortex-A53 system as the main control, adopts the gesture recognition of PAJ7620U2 as the detection, connects the USB camera for security monitoring, and the ZigBee integrated module collects temperature and humidity and simulates home lighting. The entire system uses linux driver, audio and video development, serial programming, ZigBee networking and other technologies. In recent years, the variety of smart homes has been diverse, but this technology is not complete enough to run a complete set of smart homes and is compatible with multiple technologies. With the rapid development of science and technology, the rise of artificial intelligence and big data will also slowly advance the smart home. By then, the human-computer interaction experience will be more comfortable, more complete, and more intelligent.

Acknowledgments

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