



Research on embedded access control security system and face recognition system



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ABSTRACT

Aiming at an access control security system, the paper provides overall architecture of the security system and illustrates system functions and system software; lists structural diagrams of system hardware and illustrates functions of Ethernet interface circuit, GPIO interface circuit, RS485 bus interface circuit and GPRS module circuit; describes theories and wiring of security detectors such as vibration detector, infrared detector, smoke detector and combustible gas detector; gives detailed description of GPIO drive program design, lists a flow chart of the security signal collection program and designs a monitoring interface of security signals by QT; realizes control of video functions and video camera rotation, and lists a flow chart of video collection program; controls the pan-tilt camera by PELCO protocol, and realizes alarming by the GPRS module; establishes a Web server, designs a user registration page, a user login interface and a security monitoring page in order to realize remote access to the security server; analyzes design of cookie and front-end design programs of view monitoring web pages; lists a flow chart of remote video monitoring program, and illustrates CGI key codes of remote control of pan-tilt camera; designs a face identification program based on the embedded system, analyzes the face detection algorithm and the face identification algorithm, and realizes program design of PCA algorithm.

1. Introduction

With continuous development of computer and communication technologies, great improvements in chip manufacture technologies and rise of Internet industry, high-tech intelligent equipment has gradually entered people's life, while traditional security protection measures cannot satisfy people's demands any longer. In the current society, social population mobility is very high and most people work outside, so that home security appears to be more important. Most common intelligent security products take a single chip microcomputer as the control core. Due to resource limitation and weak processing capability, the single chip microcomputer can hardly satisfy people's demands. Hence, it is urgently necessary to find a highly reliable and more intelligent security system in the society.

Tie and Guan proposed an automatic and robust method to detect human faces from video sequences that combine feature extraction and face detection based on local normalization, Gabor wavelets transform and AdaBoost algorithm. The key step and the main contribution of this work is the incorporation of a normalization technique based on local histograms with optimal adaptive correlation (OAC) technique used to alleviate a common problem in conventional face detection methods [1]. Patil and Kapur presented a dynamic internet protocol (IP) based

ARM9 embedded Webserver (EWS) for data acquisition in scale down version Linux [2]. Pai and Chang presented a novel facial expression recognition scheme based on the extension theory. The facial region is detected and segmented with the feature invariant approaches. Additionally, the proposed algorithm is implemented by the XScale PXA270 embedded system, so various facial expressions can be recognized in real time [3]. Venetianer and Deng discussed some of the major challenges involved and conducted a case study for addressing the problem. One of the key concepts is to handle boundary conditions by fuzzy evaluation [4].

Elmiligi introduced new classification of embedded systems attacks using a novel multi-dimensional representation, explored the possible threats to embedded systems, and proposed a new procedure to evaluate and improve the security of embedded systems during various phases of product development [5]. The approach presented by Karmore is used to test safety critical features of the embedded system. The inputs and outputs are trained, validated and tested via ANN [6]. Sveda discussed a safety and security-driven approach of the embedded system design for an industrial class of Internet-based applications [7]. Cheng used the "embedded technology" as the core; ZigBee and GPRS wireless communication technology were integrated [8]. Collotta and Pau proposed a fuzzy logic based mechanism that determines the

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sleeping time of field devices in a home automation environment based on Bluetooth Low Energy [9]. It has been stated (Fang et al.) that the human activity recognition performance of neural network with application of the BP algorithm has been evaluated and compared with other probabilistic algorithms: Naïve Bayes (NB) classifier and Hidden Markov Model (HMM). The results show that different feature datasets yield different activity recognition accuracies. Due to use of unsuitable feature datasets, the computational would be more complex and the activity recognition accuracy would be lower [10]. Vaslin described a complete off-chip memory security solution for embedded systems. Security core is based on a one-time pad (OTP) encryption circuit and a CRC-based integrity checking module [11].

In combination with embedded type technologies, network technologies and computer technologies, the paper puts forward a more reliable, intelligent and efficient embedded access control security system. PXA270 is taken as the processor chip; a USB camera with good pixel is adopted; and a Linux operation system, a QT library and an OpenCV computer vision library are transplanted on the PXA270 main console. In this way, the paper designs the program of embedded face identification system. The paper also analyzes a face detection algorithm AdaBoost and program realization of the algorithm, and researches feasibility and program realization of PCA principal component algorithm. Face data information is collected by the camera, and obtained data is processed. To control a remote camera, the Web server needs to call the CGI program to control the external application. The completed web pages include video monitoring web page, user registered web page, user login page and environmental monitoring web page.

2. Overall architecture of security system

2.1. Overall architecture

The hardware platform takes a PXA270 chip as the core, while NAND FLASH, SDRAM, network card, USB interface, serial ports and other devices are disposed peripherally. Software part comprises a system platform layer and an application layer. The system platform layer mainly comprises a system guide program Bootloader, an embedded Linux kernel, a root file system and relevant device drive programs; the application layer mainly comprises multiple sensor collection programs, an embedded Web server and a CGI script program. The research contains two core parts. The first part is the access control face identification module, wherein access control system hardware is realized through connection of a PXA270 master controller and a USB camera, and software is realized through programming of an identification algorithm. The other part is gateway design of the security system, wherein a gateway is established on the embedded Linux system. The gateway depends on the system platform, belongs to application layer software and supports access of external networks. Because of the gateway design, remote users can access the security server. Meanwhile, the gateway can locally collect signals of the security sensor, can monitor videos and can also control a GPRS module to send alarm short messages. The overall structure diagram of the system is shown in Fig. 1.

2.2. Realization of system functions

An access control security system integrates an access control system and a security system. The access control system controls entering into a living room. The security system is responsible for problems related to living environment security. When abnormal situations take place in the environment, an alarm shall be sent out and the user shall be informed in time. The system is equipped with a local alarm mode, a remote alarm mode, an access control system and an emergency button alarm mode. According to the local alarm mode, an alarm device can be triggered to send out an alarm when abnormal situations

take place in the security environment. Such mode can realize alarming and frighten lawbreakers. According to the remote alarm mode, a controller controls the GPRS module to send a short message to a user when abnormal situations take place in the environment, while the user can check the security environment remotely via a mobile phone or PC after receiving the alarm short message. By the access control system, the user can limit permissions and allow conditions for entering into a living room. At first, PCA dimension reduction processing is carried out to the face image of a legal user, and data is stored in the system; when the user enters the living room, face data is connected by the camera. After being processed by PCA dimension reduction, the face data is compared with the data stored in the system. In case of successful matching, the person is deemed as a legal user, and the access control lock is opened. According to the emergency button alarm mode, the user can send an alarm by pressing the emergency button when encountering emergent accidents or dangers.

The face data information is collected by the camera. It includes camera driven transplanting, image acquisition based on function interface provided by V4L, face detection with AdaBoost detection algorithm, and face recognition based on use of the PCA principal component analysis algorithm. The implementation of the GPIO driver and the acquisition of sensor signals are designed. The security system acquisition program calls the underlying driver to complete acquisition of security signals.

The monitoring interface design of security signals is completed with QT. The video camera is controlled by a pan-tilt camera and the multi angle monitoring is obtained. The RS-485 bus is designed to control the rotating program of the security camera, and the original video data is acquired. In the embedded Linux system, GoAhead server is built; CGI is used to realize data interaction, remote video surveillance, and remote monitoring of security environment. The CGI program dynamically deals with the visitors' requests, such as saving the user's input information, controlling the security camera, and returning the related data according to the user information.

2.3. Design of system software

The overall software part comprises Bootloader, a Linux kernel, a root file system and application layer software successively from the bottom layer to the top layer. Bootloader is mainly used to initialize hardware equipment and guide starting of the kernel. Linux kernel is clipped according to actual demands and shall be kept as concise as possible in order to ensure smooth system running. The root file system is established by BusyBox and stores a lot of configuration files and file system information. A sensor collection module shall collect sensor data. A master controller acquires data of each sensor. Data processing software processes and analyzes the data acquired by the controller and determines whether the alarming is necessary. As for user terminal software, a control operation interface is designed through connection of an LCD with touch screen to the master controller, sensor information is disposed on the interface, and control buttons can be operated. A system alarm module is realized by a GPRS module. While collecting changes in security signals, PXA270 may control the GPRS module to send an alarm short message to a remote user. Design of camera video collection and camera control program is realized. In establishment of an embedded Web server and design of a dynamic web page, the embedded security system is built into a server, wherein the user is allowed to check a security state of the server remotely by a PC or a mobile phone.

In order to realize remote access security server and monitor security state, web program needs to be designed. The monitoring web page is written in the HTML language. In order to add dynamic functionality to the web, the system uses the Javascript language. When users want to control pan-tilt camera through remote networks, the Web server needs to be invoked by the related CGI program.

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