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Embedded Design Research of Iris Information Acquisition System

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Abstract: In view of the limitation of traditional identification, it is easy to lose and copy keys, cards or ID cards, and it is easy to forget the password, so we designed an embedded application system based on the iris identification technology, which can realize the functions of gathering, inputting, and registering the iris information and identification. The hardware circuit was designed by using advanced RISC machines (ARM) embedded microprocessor as the core. The iris sensor was used to gather the iris information, and the development of software was accomplished with the embedded OS Windows CE. The system can be used on the company entrance guard system, customs security of airport and criminal identification. *Copyright © 2014 IFSA Publishing, S. L.*

Keywords: Iris identification, Advanced RISC machines (ARM), The OS of Windows CE, Embedded visual C + + (EVC).

1. Introduction

With the development of society, the importance of identity is increasingly apparent, and the traditional identification methods, due to its inherent limitations, can not meet the demands, and challenges are faced in safety performance, in the use of keys, cards, ID cards and other token way, there are easy to lose, theft and counterfeiting and other safety hazards. In the use of password mode, there is easy to forget and attack the problem, the more serious is that the identification of these traditional methods can not distinguish between the true owner and the impostors with object identity, while the body is used with itself physical characteristics, such as biometric identification technology, these problems can be avoided, these features have unique advantages in stability, permanence, uniqueness and security [1]. Compared with other biological characteristics, the iris is a more stable, more reliable physiological characteristics. Further, the iris is the external part of the eye, the iris-based identity authentication system may be non-contact for users. According to statistics, so far, iris recognition error rate is the lowest among all kinds of biometrics. Iris recognition has been widely applied in many fields, such as the company's daily attendance, criminal identity authentication, airport customs security, information security and other key areas.

This paper presents a sensor-based embedded iris information acquisition application system, it includes the front-end iris sensor acquisition system (lens, image sensor, image processing equipment) and terminal control system (mainly based on the ARM920T core Samsung S3C2410CPU, memory modules , LCD touch display module, power section, information acquisition and processing software), two parts are connected by RS232 interface. In iris

recognition, the existing back-end information collection management system is generally based on PC platform, it is not easy to move, information collection on-site and data analysis will be difficult. With maturity of hardware and software resources, the development has been rapid in the application of embedded system. Embedded system devices based on Windows CE usually have small size, light weight, low power consumption, network, powerful, user-friendly interface and good stability, the application system of iris sensor embedded information collection is designed in this paper, it is able to conduct on-site identity information collection and analysis of data entry.

2. Iris Recognition Principle

2.1. Iris Recognition Technology Overview

The human eye is composed of three parts of the sclera, iris and pupil, Iris is a disk-shaped membrane, it is located in front of the eye, as is showed in Fig. 1.

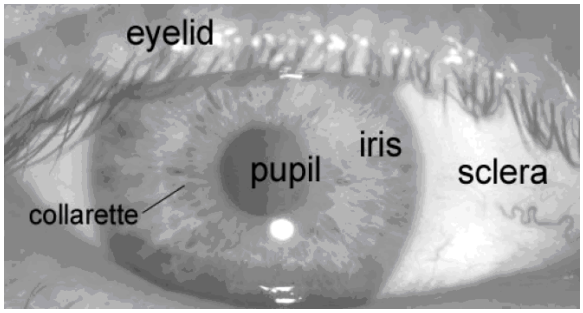

Fig. 1. Eye chart.

Sclera is the white part of the eye periphery, about 30 % of the total area, the black part of the eye center is the pupil, or about 5 %, iris is located between the sclera and the pupil, it contains the most abundant texture information, and it occupies 65 %, iris cutting diagram is showed in Fig. 2.

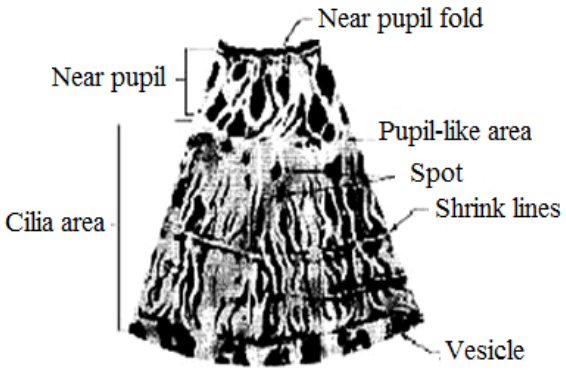

Fig. 2. Iris cutting diagram.

By the iris appearance, there are many pigmentations, crypts, folds, etc., it is one of the most unique structures in the human body [1]. The formation of the iris is determined by genetics, gene expression determines the form of the human iris, physiological characteristics, color and general appearance, and it is the surest sign of human biological identity, there are uniqueness, stability, acquisition, non-invasive, and other advantages. Iris recognition is to identify people through this biometric identity, in all biometric recognitive technologies, which includes fingerprint, the iris recognition is the most accurate one.

2.2. Iris Image Acquisition

The system uses a face / iris combined optical imaging apparatus, it comprises an imaging optical system, this system consists of an visible imaging optical system for the eye visual feedback, the near-infrared light imaging optical system for iris image, and the facial imaging optical system, which accesses information of the eye position location, the optical imaging means is provided with real-time closed-loop feedback control , and it is the image processing control unit. This device uses optical imaging methods, which include eye position tracking and positioning, as well as quick access to the highest quality iris images.

2.3. Iris Recognition Algorithms

In the iris image acquisition process, due to the presence of various uncertainties, there are a lot of changes in the captured images, such as that uneven lighting conditions can cause uneven distribution of iris image brightness, so in the previous feature extraction, these must be pretreated, the impact of various uncertainties is reduced, the entire pretreatment process is divided into the following three parts: iris localization, normalized, iris image enhancement [2], as is shown in Fig. 3.

2.3.1 Iris Location

Iris location is that the center and radius of the inside circle and the outside one are found in a eye iris image image, the iris is cut off, the iris inner circle is at the junction of the iris and the pupil, and the iris outer circle is at the junction of the iris and white sclera. The main positioning algorithms are Daunman circumference difference method, the Hough transform method which is adopted by Wildes, and gradient optimization algorithm [3]. The system uses Wildes gradient optimization algorithm [3], and compared with the previous two methods, the biggest difference is to simulate the pupil oval shapes, the iris image is better extracted.

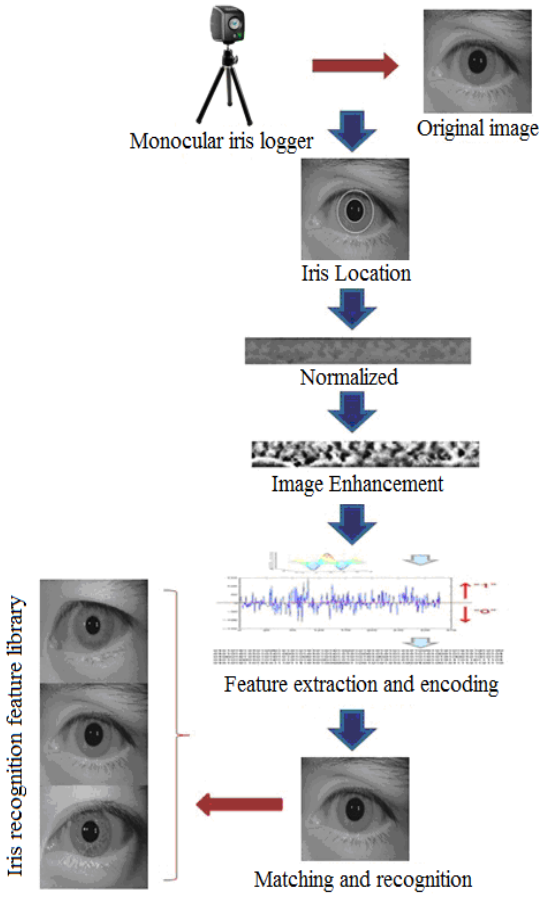

Fig. 3. Iris recognition flowchart.

2.3.2. Iris Image Normalization

Different people like different sizes of iris, even the same person at different times and environments, the iris size will change. This is mainly due to the pupil change with the illumination. Iris normalized purpose is to adjust the size of the iris region to a fixed size, to reduce the impact which is caused as the pupil scaling.

2.3.3. Image Enhancement

Because of the device, the light on the iris image is not distributed exactly and evenly, this will affect the texture analysis results. In order to improve recognition results, the iris image partial histogram equalization is done after the commencement, image enhancement is achieved [4], the impact of non-uniform illumination is reduced [5].

2.3.4. Iris Feature Extraction and Matching

By using Daunman 2-dimensional Gabor complex wavelet [6], it is better direction and frequency selective, iris image texture features are extracted, Hamming distance is used for feature matching [7]. As is Hamming distance:

$$HD = \frac{1}{N}\sum(codeA \otimes codeB) \qquad (1)$$

where N is the code length, *codeA* is the iris pattern A, *codeB* is the iris pattern B.

3. Composition and Works of Iris Information Acquisition and Application System

Iris information acquisition application system includes three parts of the sensor signal acquisition system, image processing system, and data analysis and transaction management system, as is shown in Fig. 4. Sensor signal acquisition system is responsible for locating and collection of the iris information. The image processing system is that the collected iris image is pre-processed and feature is extracted by high-performance digital signal processing (digital signal processing, DSP) chips [8, 9]. Data analysis and transaction management system is based on ARM9 embedded terminal, it is responsible for the link between the user iris feature information and its name and identification (identification, ID), and then they are stored in the database, and a user template is created, its information is storied, it is used for registration and user identification [10, 11].

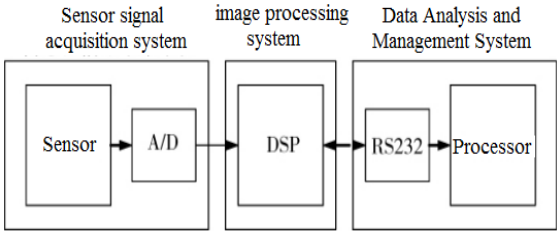

Fig. 4. Block diagram of system composition.

4. Iris Information Acquisition System Hardware Design

Left part of the figure are the time domain waveforms, the right part are the spectrogram, and the original voice, white noise (white), noisy speech and enhanced speech is respectively from the top to down. Calculating SNR SNRin = 5 dB before noisy speech enhancement, the filtered signal to noise ratio SNRout = 8.4 dB. After taking the white noise, the speech enhancement SRN efficiency.

Iris information acquisition system hardware includes iris acquisition module, iris recognition module, embedded core processor, memory unit, the user interface unit and communication interface unit.

4.1. CMOS Photoelectric Sensor

There are high integration, low power consumption, low cost, good image quality and other characteristics in the CMOS image sensor, OmniVision's OV7110 is chosen as image sensor in the system. OV7110 is a grayscale digital CMOS image sensor, which can achieve the resolution of 640 pixels × 480 pixels. Tests prove that the extent of the resolution can ensure a more complete view of the iris details, it is enough to be used as identification judgment, the iris pattern can be clearly seen in the eye. OV7610 and OV7110 parameter index is consistent with the functions, the only difference is that there is only the Y component in the output of OV7110 , i.e., only the gray scale values, while there are the U, V components in the output of OV7610, i.e., a color value. Because the iris information mainly lies in the different of iris texture, so there is the only gray collection.

4.2. Core Processor Choices

Since the system needs that iris image information is collected with timely response, and it is rapidly processed, and there need be a mass storage and convenient operation, user-friendly interface, the internet information is searched easy and fast, and it has good scalability. Therefore, the core processor requires powerful processing capabilities, rich interface, and it supports direct memory access (direct memory access, DMA) mode, there are better real-time and lower power consumption. Meanwhile, in order to simplify software development, processor be needed to have better support to the embedded operating system. Based on the above considerations, a dual-core processor is selected in the system, ADSP-BF533 type DSP is selected as an image processing module, a Samsung S3C2410 processor is selected in the embedded terminal part.

4.2.1. Iris Image Processing Module

Iris image processing section uses a type ADSP-BF533 DSP, the processor is a product of the Blackfin series, it is a new high-performance DSP. Its design needs to meet computing requirements and conditions of low-power design for today's embedded audio, video and communications applications, it is a new 16-bit embedded processor. It is the Micro Signal Architecture(micro signal architecture, MSA) which is jointly developed by the ADI and Intel, a 32-bit RISC instruction set and dual 16-bit multiply-accumulate (MAC) signal processing functions are combined with the usability of general-purpose microcontroller together.

4.2.2. Embedded Core Processors

Embedded core processor is S3C2410, S3C2410 microprocessor is a16/32 bit RISC processor with low power and highly integrated, it is designed and offered for the Samsung handheld devices, there is a 272-foot field-programmable gate array (field programmable gate array, FPGA) package, solutions are provided with a low-cost, low-power, high-performance small microcontroller for handheld devices and the general types of applications [8]. The maximum operating frequency is 203 MHz, while there is the memory management unit (MMU), so that the processor can easily run in Windows CE, Linux and other operating systems, and more complex information is processed. S3C2410A provides the following extensive internal equipment: separate 16 kByte instruction Cache and 16 kByte Data Cache, MMU virtual memory management, LCD (liquid crystal display, LCD) controller (supports STN & TFT), system boot of support NANDFlash, System Manager (chip select logic and SDRAM controller), 3-channel universal asynchronous receiver / transmitter unit (universal asynchronous receiver / transmitter, UART), 4-channel DMA, 4-channel pulse-width modulation (pulse width modulation, PWM) timer devices, I / O ports, RTC, 8-channel 10-bit analog-to-digital converter (analog to digital converter, ADC) and a touch screen interface, IIC-BUS Interface, IIS-BUS interface, USB host, USB device, SD Master Card & MMC card interface, 2-channel serial peripheral interface (serial peripheral interface, SPI) and internal PLL (phase locked loop, PLL) clock multiplier [2-17].

4.3. Embedded Peripheral Component

The floor mainly provides power support and interface extensions. Backplane DC is 5 V power supply, internal conversion 1.8 V is used for processor core, conversion 3.3 V is used for I/O interface circuitry.

Communication interface section includes serial port, Ethernet port and USB interfaces, the system is expanded with two serial ports, which are used to communication connection and system debugging for ARM MPU and iris recognition module. In network interface part, because there is no Ethernet S3C2410 internal control module, so a matching control chip is needed, it is Cirrus Logic's CS8900A chip, by using 10BASE-T interface, Ethernet sends and receives data. System expansion USB port is used for an external mouse, and it supports USB synchronization on WinCE. FLASH memory cell is K9F1208 type NandFlash, its capacity is 64 MByte, SDRAM is two HY57V561620, its capacity is 64 MByte. The user interface part is 3.5 inch thin film transistor type (thin film transistor, TFT) color LCD touch screen, 320 pixels × 240 pixels, it is directly connected to S3C2410 LCD controller. System hardware block diagram is shown in Fig. 5.

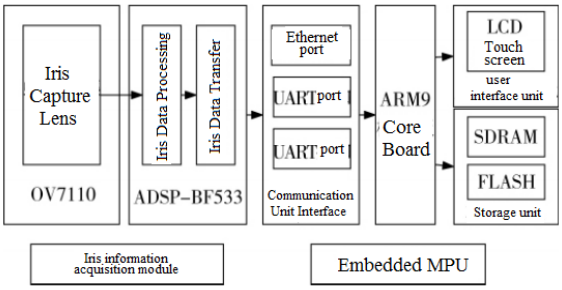

Fig. 5. Block diagram of hardware composition.

5. Iris Information Acquisition System Software Design

Software design work includes four parts, which are the choice of operating system and kernel customization and transplantation, Bootloader transplant, SPI driver design, application development.

5.1. Windows CE Operating System

Windows CE system is chosen as the underlying operating system. Windows CE is Microsoft's embedded and mobile computing platforms, it is an open, cutting 32 real-time embedded operating system, the operating system is used to electronic devices which like handheld computers, and compared with other desktop version of the Windows operating system, it has a good reliability, real-time high, the core characteristics of small size, there is only 8-32 MByte of ROM in a typical Windows CE devices, while the smallest Windows CE kernel is only 500 kByte. Windows CE is designed to be a highly modular operating system, it accommodates different types of smart devices, and it meets image size requirements for different operating system, Windows CE graphical user interface is very well.

5.2. Bootloader Transplant

Bootloader is the operating system kernel or a short running program before user application program runs. Through this program, you can initialize the hardware equipment, the memory space map is established, right environment is ready for the final call operating system kernel or user application program.

On S3C2410, Windows CE Bootloader is implemented into two, which are followed Nboot (nandflash bootloader) and Eboot (Ethernet bootloader), they were used to boot loader mode and download the operating system. Execution order of Boot Loader [9] is showed in Fig. 6.

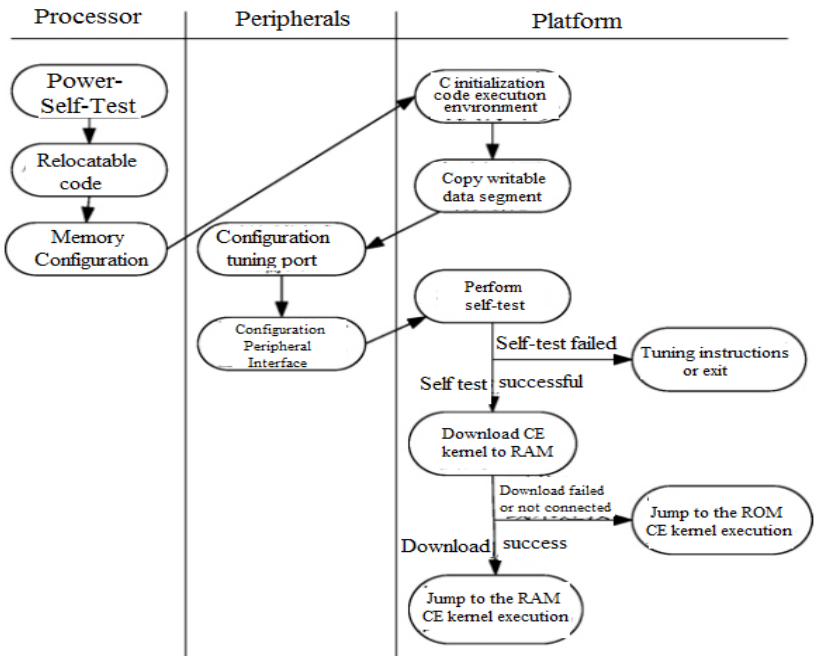

Fig. 6. Execution sequence chart of Boot Loader.

5.3. Windows CE Kernel Customization and System Migration

In Windows CE kernel customization and operating system migration, Platform Builder development tool is used, the appropriate hardware platform BSP (board support package, BSP) and hardware support are added, such as a USB mouse function, network drives, MFC controls, Chinese support. To modify the registry information

platform.reg, the appropriate network environment is changed, the same network segment is set with the PC, loading serial peripheral interface (serial peripheral interface, SPI) driver. After configuration, to export the software development kit (software development kit, SDK), the custom operating system is compiled. The resulting image file is downloaded to the target board via Ethernet.

5.4. SPI-driven Design

A driver is abstraction physical device or virtual device function software, drivers manage the operations of these devices, and equipment function is export to the operating system and applications. According to different of export interface drivers, windows CE driving can be divided into the native device driver (native device driver) and streaming driver (streams device driver). The machine device driver is integrated into the Windows CE platform device. Streaming driver is also known the install driver, the user-mode dynamic link library (dynamic link library, DLL) is dynamically loaded by the Device Manager (device. exe).

In Windows CE, the streaming device driver is responsible for the abstract file, the application will be able to provide application programming interfaces (application programming interface, API) (including readfile, writefile, IOcontrol, etc.) and to read and write for the system. When application program accesses the device by using API File, the request (Filesys. exe) filter through the file system is sent to the device. exe, device. exe calls streaming driver interface on request, to complete the interaction with the hardware.

5.5. Application Development

The software part of the system mainly completes the initial, data analysis and processing, PC display and operating functions. In development of master control program, eVC + + 4. 0 development tools are used, the C + + code is directly compiled to CPU instructions by eVC + + 4. 0, it uses win32 application programming interface (win32API) to access the Windows CE functionality , while it is to help development of graphical user interfaces (graphical user interface, GUI) and COM applications by using MFC (Microsoft foundation classes) or Active Template Library (active template library, ATL).

The serial port and baud rate is opened by CreateFile function. Baud rate, stop bits, parity bit is set, the received data is tested, and database information is compared, which is sent to the host computer through UART port, to read and writeserial port via ReadFile and WriteFile, and sound and light alarm is set on the input identification information, iris information is accessed, the user name and ID information registration, delete, and save function are achieved, the user identify is identified, finally, the serial port is closed through the Close-Handle function.

6. Conclusion and Outlook

This paper studies the iris information acquisition system, high-performance embedded microprocessor S3C2410 is used in the process, and ADSP-BF533-based DSP is applied in iris image processing applications, stable and powerful Windows CE operating system is used as the software platform. And we studied in the iris biometric identification technology and image sensor technology, the human iris information acquisition and identification process has been given, the various functions have been tested in the system, there are characteristics with simple, non-invasive to the body, portable, it can meet the needs of the company access control system, the airport customs security, criminal investigation, and information security and other fields.

Simultaneously, the system also has good scalability, and it can be connected to the national iris repository by extending the Ethernet interface, iris information is inquired, and the image information, which is acquired iris, timely is uploaded.

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