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A DESIGN AND IMPLEMENTATION OF A WIRELESS IRIS RECOGNITION ATTENDANCE MANAGEMENT SYSTEM

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Abstract. Iris recognition verification is one of the most reliable personal identification methods in biometrics.With the rapid development of iris recognition verification, a number of its applications have been proposed until now including time attendance system etc. In this paper, a wireless iris recognition attendance management system is designed and implemented using Daugman's algorithm [15].This system based biometrics and wireless technique solves the problem of spurious attendance and the trouble of laying the corresponding network. It can make the users' attendances more easily and effectively.

Keywords: Iris recognition verification; personal identification; biometrics; attendance management; wireless.

1. Introduction

While the move towards the digital era is being accelerated every hour, biometrics technologies have begun to affect people's daily life more and more. Biometrics technologies verify identity through characteristics such as fingerprints, faces, irises, retinal patterns, palm prints, voice, hand-written signatures, and so on. These techniques, which use physical data, are receiving attention as a personal authentication method that is more convenient than conventional methods such as a password or ID cards. Biometric personal authentication uses data taken from measurements. Such data are unique to the individual and remain so throughout one's life. This technology has been applied for controlling access to high-security facilities, but it is now being widespread developed in information systems such as network, e-commerce, and retail applications. In these technologies, iris recognition becomes the most mature and popular biometrics technology used in automatic personal identification.

In the beginning, the idea of using iris patterns for personal identification was originally proposed in 1936 by ophthalmologist Frank Burch. By the 1980's the idea had appeared in James Bond films, but it still remained science fiction and conjecture. In 1987 two other ophthalmologists, Aran Safir and Leonard Flom, patented this idea, and in 1989 they asked John Daugman to try to create actual algorithms for iris recognition. But now, this technology is also being used in several other applications such as access control for high security installations, credit card usage verification, and employee identification [1]. The reason for the popularity of iris recognition verifying is the uniqueness, stability, permanency and easily taking. Just for this, a number of iris recognition verification approaches have been proposed until now [2, 14]. This paper proposes a design and implementation of a wireless iris recognition attendance management system. This system is an application of the iris recognition verifying and RF wireless techniques and it is mainly used for employee identification. Through practices, this system is proved to be easy-to-use and efficient. This paper is organized as follows. Section 2 describes the technological requirements for this system design. Section 3 outlines the functions of this system briefly and describes the hardware and software design of the system. Section 4 introduces some key problems in the implementation of the system and finally Section 5 contains conclusions and future research plan.

1.1. Biometric Recognition

Today, biometric recognition is a common and reliable way to authenticate the identity of a living person based on physiological or behavioral characteristics. A physiological characteristic is relatively stable physical characteristics, such as fingerprint, iris pattern, facial feature, hand silhouette, etc. This kind of measurement is basically unchanging and unalterable without significant duress. A behavioral characteristic is more a reflection of an individual's

psychological makeup as signature, speech pattern, or how one type at a keyboard. The degree of intra-personal variation in a physical characteristic is smaller than a behavioral characteristic. For example, a signature is influenced by both controllable actions and less psychological factors, and speech pattern is influenced by current emotional state, whereas fingerprint template is independent. Nevertheless all physiology-based biometrics doesn't offer satisfactory recognition rates (false acceptance and/or false reject rates, respectively referenced as FAR and FRR). The automated personal identity authentication systems based on iris recognition are reputed to be the most reliable among all biometric methods: we consider that the probability of finding two people with identical iris pattern is almost zero [11]. That's why the iris recognition technology is becoming an important biometric solution for people identification in access control as networked access to computer application [12].

Compared to fingerprint, iris is protected from the external environment behind the cornea and the eyelid. No subject to deleterious effects of aging, the small-scale radial features of the iris remain stable and fixed from about one year of age throughout life.

A number of groups have explored iris recognition algorithms and some systems have already been implemented and put into commercial practice by companies such as Iridian Technologies, Inc., whose system is based on the use of Daugman's algorithm [4].

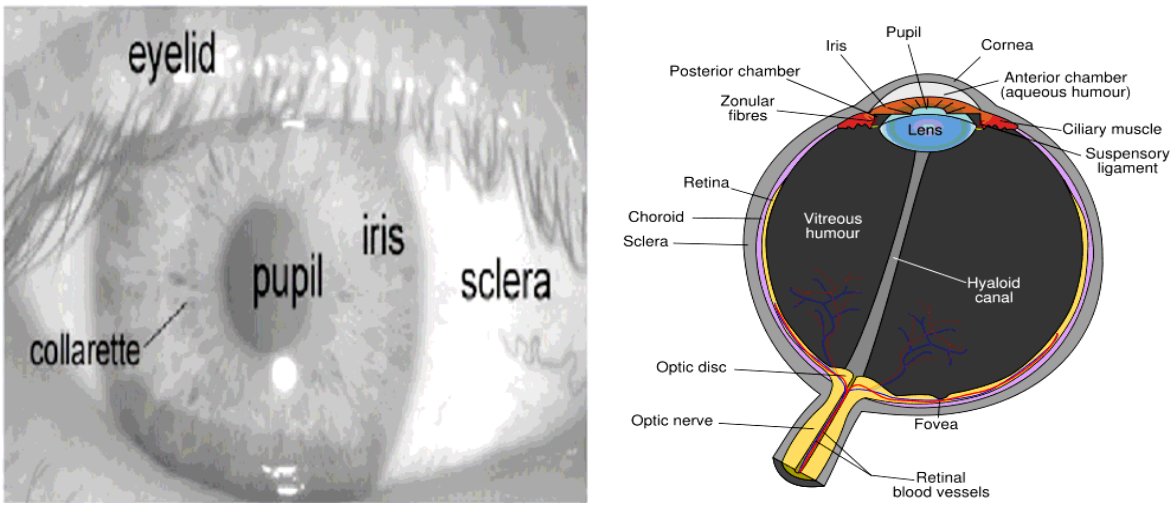

Figure 1. Anatomy of a frontal image of the eye [13]

A typical iris recognition system generally consists of the following basic modules:

I. image acquisition, iris location, and pre-processing,
II. iris texture feature extraction and signature encoding, and
III. iris signature matching for recognition or verification.

P.S.: The iris is a muscle within the eye that regulates the size of the pupil, controlling the amount of light that enters the eye. It is the colored portion of the eye with coloring based on the amount of melatonin pigment within the muscle.

2. Requirements for System Design

2.1. Authentication using iris recognition

Canonical and scientific modern company management system is the requirement for creating a cost-effective, rapid developing corporation. Attendance management is an important part of corporation management system. It can be in contact with salary of employee, work efficiency of corporation and even affects business image of company and staff morale. So the problem of reasonably, effectively and scientifically managing of staff attendances has become all companies facing issue. Traditional styles of attendance management include hand-written signatures, card bell, magnetic card, IC card and RF card attendance machines. These styles cannot avoid replacer checking out just because that people can be separated from cards.

The great advantage of the authentication using iris recognition is the irreplaceable nature. Through the analysis of the overall and local characteristics of iris recognition such as eyelid, sclera, pupil, we can extract enough detail data. Such data are unique to the individual and remain so throughout one's life [1]. We can use these data to identify or verify a person operating as follows: (1) a digital image of one person's eyes to be verified is captured;(2) a feature extracting algorithm is carried out;(3) minutiae are extracted and stored as a template for verifying later;(4) people to be verified place his eye on the iris recognition sensor so as to extracting the minutiae from the captured image; (5) a matching algorithm is applied to match the minutiae with the previously stored template [3-6]. The overall block diagram of the iris recognition verifying is shown in Figure 2.

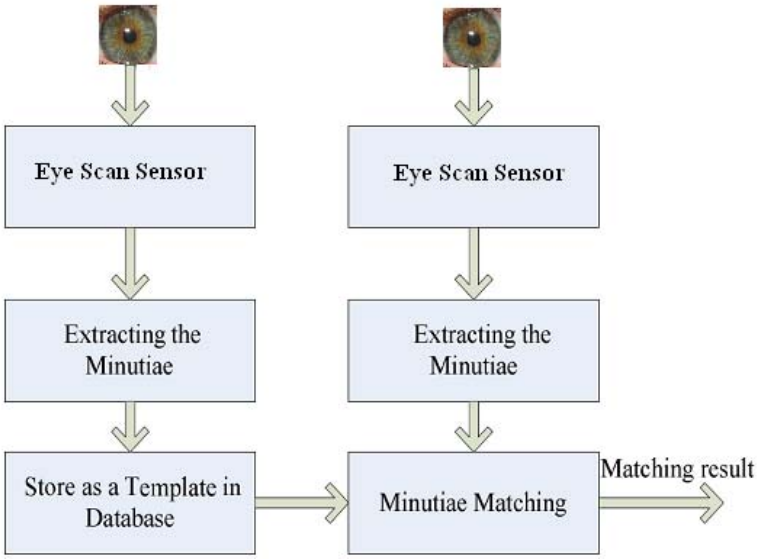

Figure 2. Iris recognition verifying process

2.2. Transmission Using Wireless Technique

There are mainly two kinds of iris recognition attendance management system on the market. One is on-line iris recognition attendance management system and the other is off-line iris recognition attendance management system. On-line system always needs to connect with a PC or workstation and all the iris recognition templates of people to be verified must be stored in a database in the PC or workstation. Thereby, matching iris recognition needs the support of the background PC. This kind of attendance management system is easy to paralyse in case of malfunctions of iris recognition attendance machines, transmission line or PC. Once several systems connect to form a network, burden of PC and the response time of the system will be added.

By contraries, an off-line iris recognition attendance management system can finish all the process including capturing the image of iris recognition, extracting minutiae, storing and matching. All the operating of matching iris recognition needs no support of PC and the burden of PC is lightened. The same systems can connect to form a 485 network and finally connect to the center PC of management system. So off-line systems are widely used in many occasions. The shortcomings of this system are that there must be a managing PC nearly and it is difficult to lay the transmission lines where topography is bad. With the development of wireless techniques such as RFID, GPS, Wi-Fi, Bluetooth etc, many companies manufacture wireless modules. So we can adopt the wireless techniques to solve the above-mentioned questions.

3. Functions and Composing of the System

Nowadays, bulk of automatic iris recognition system is constantly smaller. Complex iris recognition verifying algorithms can be solidified in a small embedded processing module. This module and iris recognition sensor as well as external control interface constitute embedded iris recognition verifying system. This wireless iris recognition attendance management system is designed and realized based on automatic iris recognition module and RF wireless module. The basic functions of this system include:

(1) Take the task of users' attendances;

(2) transmit the information of attendances to the managing PC;

(3) as a terminal of information, display useful information transmitted by PC on LCD.

3.1. Hardware Design

The hardware part of wireless iris recognition attendance management system is mostly made up of iris recognition verifying module, microcontroller, power module, wireless communication module, real-time clock module, keyboard module and LCD display module. Figure 3 shows the architecture of hardware design.

3.1.1. CPU and iris recognition

Iris recognition verifying module, microcontroller and RF wireless communication module are the core of the system. Hardware design is taking microcontroller (CPU) as center. We choose AT89C5122 as the microcontroller of the system which is a high-performance CMOS derivative of the 80C51 8 bit microcontrollers produced by Atmel Corporation. This chip not only has keyboard interrupt interface, UART, hardware watchdog and enough large RAM, Flash RAM, I/O ports but also has a self powered USB port. So it is fit for the embedded application systems well. Iris recognition verifying module is composed of iris recognition processing module and iris recognition sensor. In Figure 4, iris recognition processing module is showed in broken line frame.

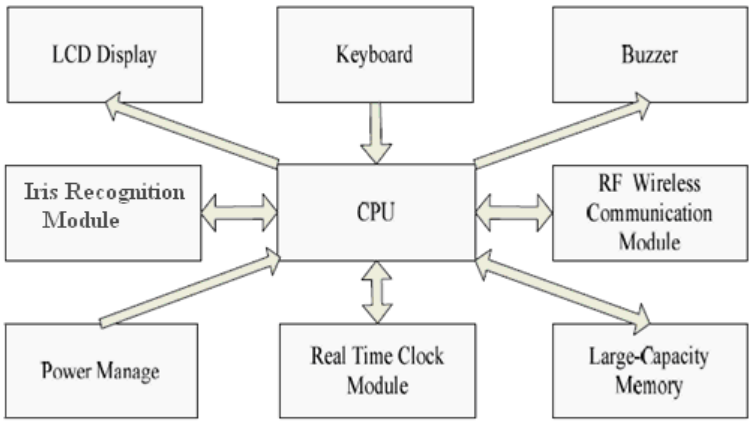

Figure 3. Architecture of hardware design

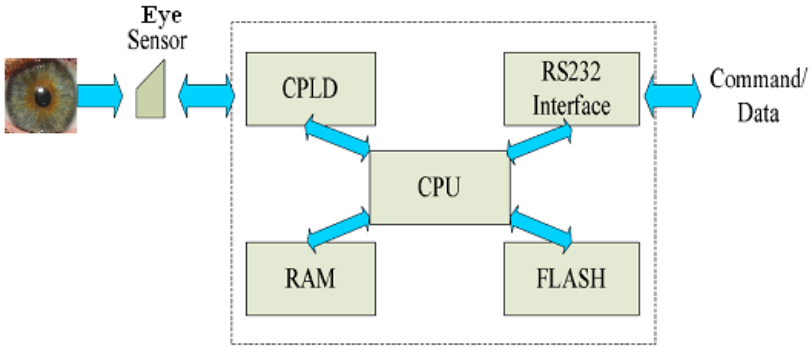

Figure 4. iris recognition processing module

Table 1. Format of communicating data packet

1(Byte)	1(Byte)	2(Byte)	2(Byte)	2(Byte)	2(Byte)	1(Byte)	1(Byte)
0	command	P1	P2	Lw-Extra Data	Lw-Extra Data	Error Code	Check Sum

Iris recognition processing module communicates with microcontroller module using RS232 interface in the form of transmitting and receiving data packet [7]. We define the format of 12 bytes data packet as in Table 1.

The Data packet is divided into two categories:

Command Packet and Response Packet. Command packet, which needs to be set command byte, p1 (parameter 1) and p2 (parameter 2) bytes, is transmitted to iris recognition verifying module by microcontroller. Iris recognition verifying module works under the command packet and responses the Response packet which has the same command byte but has the extra data in the seventh to tenth bytes and error code. Error code and check sum bytes can be used to check on the operations of iris recognition verifying module. There are basically five operations for iris recognition verifying module:

(1) Registering iris; (2) Modifying iris; (3) Deleting iris; (4) Verifying iris; (5) Identifying iris. For example, command packet and response packet of registering a user's iris are (table 2).

Table 2. Registering a user's iris recognition

I_R_REGISTER_START Command Packet							
0x00	0x50	ID	0	0	0	0x00	Chk
I_R_REGISTER_START Command Packet							
0x00	0x50	0	0	0	0	0x00	Chk
I_R_REGISTER_END Command Packet							
0x00	0x51	ID	0	0	0	0x00	Chk
I_R_REGISTER_END Response Packet							
0x00	0x51	0	0	0	0	0x00	Chk

3.1.2. Wireless Communication Module Design

As an embedded system, we need that wireless module has low power dissipation, longer transmission distance, better anti-disturbing capability and small package. We choose PTR2000+ [8] wireless module as wireless communication module which is based on nRF401 chip. This module is designed to operate in the 433MHz ISM (Industrial, Scientific and Medical) frequency band and it features Frequency Shift Keying (FSK) modulation and demodulation

capability [9]. It operates at bit rates up to 20k bit/s, effective transmission distance over 1000m and needs a few external components fully meeting the needs of the system. Data input pin (DI) and data output pin (DO) of PTR2000+ can be connected to TXD, RXD of UART of AT89C5122 directly. To control the PTR2000+ to receive or transmit, TXEN pin is connected to one I/O pin of AT89C5122. TXEN=1 selects transmit mode and TXEN=0 selects receive mode. CPU communicates information with PTR2000+ module by UART and controls PRT2000+ to transmit information such as attending records and system log. Also there is receiving terminal of PTR2000+ near the managing PC. The voltage converter IC (MAX232) is needed to convert TTL level to RS-232 electrical level when PTR2000+ is connected to the serial ports of PC. RST of COM can be connected to TXEN pin of PTR2000+ to switch its status of transmitting or receiving. So it realizes the function of wireless transmitting attendances information to a PC.

3.1.3. Man-Machine Interface and Other Hardware Design

Man-machine interface includes keyboard, buzzer and LCD display system. The former is used for people to input users' ID or commands, the function of the second is to give users a hint and the last is used to display the information of date, time, user ID, error code, and status and system log. Real-time clock in the iris recognition management system is the benchmark of attending records. We use DS1302 trickle charge timekeeping chip containing an RTC by Dallas Semiconductor Corporation. It not only can satisfy the accuracy of the time, but also continues to work by battery when power is low. There is also a mess storage memory (EEPROM) AT24C512 in this system which is used to store the records of attendances. These records are made to be copies of attending info which are transmitted to PC by wireless module. The USB port gives the managers of the system a way to download these records in case when data packets are lost in the wireless transmission.

3.2. Software Design

The software of wireless iris recognition attendance management system includes controlling software and managing software installed in managing PC or workstation.

3.2.1 Controlling Software Design

Controlling software in the system is mainly divided into four categories: iris verifying and identifying, managing iris of users, system setting, wireless communication managing. The simple flowchart of controlling software of the system is shown in Figure 5.

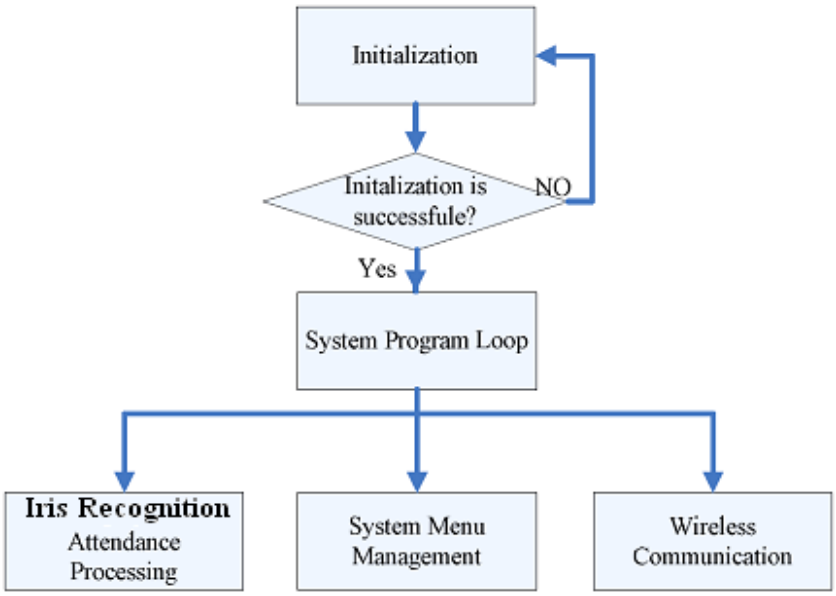

Figure 5. Flowchart of controlling software

System initialization including keyboard, LCD, serial port and PTR2000+ initial program is arranged firstly. Then system enters the program loop waiting for key down message and serial port interrupt.

Attendances operations and system menu setting operations are carried out in keyboard processing program by the way of users or manager press keys to send keyboard interrupt message to system program. Operations of registering, deleting, modifying irises are in the system setting menu. Only manager has the right to enter system-setting menu after verifying his/her iris recognition. System menu setting also includes time setting, bit rate of communication, styles of wireless communication and so on. All these programs are written in the C programming language.

3.2.2. Transmission Protocol Design

Uncertain outside factors may occurr in wireless transmission such as electromagnetic interference, power and noise interference. So we must supply a wireless transmission protocol which can do error correcting and detecting effectively. The first thing of the protocol is to identify noise and valid data. Often noise is raised with random bytes, so we can find some combinations of some fixed bytes to be the beginning of valid data packets.

After testing, we find that the combination of 0xFF, 0xFF and 0x00 has low frequency in noise and we make this combination as the beginning of data packets to be transmitted and received. A simple protocol is designed like this: [0xFF] [0xFF] [0x00] [Packet Type] [Data 0]… [Data n][Check Sum]. Packet type represents the data type of command or data. In this system, valid data transmitted by iris recognition attendance system include machine ID, users' ID, time of attending.

3.2.3. Design of Management Software on PC

Management software consists of communication interface DLL [10] and corresponding management setting program. Communication interface DLL charges the communication between wireless communication module and PC and management setting program is able to transmission data processing, information of stuff and shift managing, inquiry and print information of attendances.

4. Debugging and Implementation

In iris recognition verifying module debugging and implementation, we choose 300 irises as samples of iris recognition verifying testing. There are totally 1200 times of matching, and the verification rate is 98.3%, the rejection rate is 9.2%. In wireless transmission testing, we find that there is much noise in data transmission and the transmission distance cannot reach ideal distance. To solve these problems, we adopt some measures as follows:

(1) Add filter circuit to power to reduce power interferences;

(2) CPU and PTR2000+ have separate power supply and oscillator is set near CPU;

(3) PCB divides into some partitions such as strong, weak signals zone, digital and analog zone;

(4) In software, transmission uses short data packets and adds delay time at interval time.

Results show that the phenomenon of data packets losing rarely occurs. Data transmission is steady and reliable and transmission distance satisfies system needs. Wireless transmission solves the shortcoming of the system that there must be a managing PC nearly and it is difficult to lay the transmission lines where topography is bad. Attending people finish their attendances by pressing their iris recognition on sensor. This system can transmit users' attending records to managing PC in three modes: immediate, timing and response. It can be an intelligence terminal receiving information such as a meeting notice as well. To avoid the data packets lost, manager can check attending records with the downloaded data copies via USB port. The system accomplishes these functions well. The characters of the system are that single system not only completes its functions but also the same systems can form a network. Figure 6 shows that a network formed by four such systems is implemented.

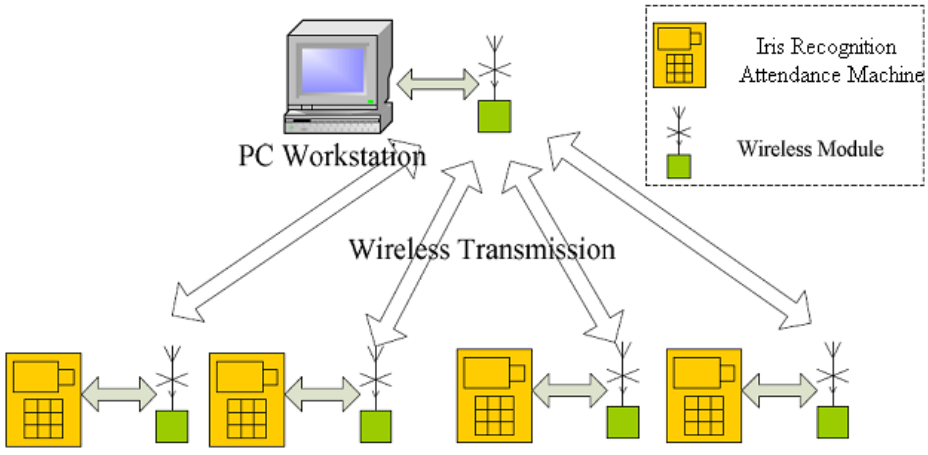

Figure 6. A network formed by four such systems

In such a network, PC receives data from each iris recognition attendance subsystem via wireless transmission channels and sends command to manage every subsystem uniformly. They communicate with each other according to different machine ID of data packets.

5. Conclusions and Future Work

This paper describes a techniques used in a iris recognition verifying system and wireless transmission as well as an implementation of such a system by means of a wireless iris recognition attendance management system. This system has the functions of iris

recognition verifying, checking on attendances independently, and wireless communication and so on. The performance of this system meets the needs of daily attendance management in various enterprises and institutions. It has good market prospects.

While the rapid development of chip and computer technologies, many new methods should be used in such system, e.g. RFID technology and other biometrics technologies like retinal verifying to enhance the reliability of recognition and adopt new wireless technologies like GPRS to solve the problem of the bad quality transmission channel and so on.

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