

Design and Development of a Secure Biometric-Based Attendance Management System for Smart Educational Institutions

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Abstract:

The term 'biometric' refers to a measurable characteristic that is unique to an individual such as fingerprint, facial structure, the iris or a person's voice. This paper presents a fingerprint based biometric system that records the attendance of a person by using a hand-held fingerprint sensor. The experimental results suggest that many fraudulent issues can be overcome using the fingerprint-based attendance system and improve the reliability of attendance record

Introduction:

Biometrics is a Greek word and combination of two words Bio and Metrics. Bio mean life and Metrics mean the measure. Biometrics term normally refers to the study of people's biological characteristics. Now biometric technology is widely used for a single person identification and security. We can use biometrics finger scanning technique for the employee attendance management system. Now day's biometric time attendance system is becoming popular to manage attendance system. Biometric attendance system works quite efficiently and stop buddy punching. Like the traditional card swapping and pin passwords methods you don't need to bring card and remember passwords.

Fingerprint identification is one of the most well-known and common biometric identification systems. Because of their uniqueness & consistency over time, fingerprints have been used for identification over many years, more recently becoming automated due to advancement in computing capabilities. So, here the fingerprint identification technique was used for maintaining the attendance record. The record of the fingerprints of various students was maintained in a database. The communication between the PC and Module was done wirelessly over Bluetooth.

Basic Purpose of Biometric Attendance System:

- To maintain the perfect attendance.
- To make cheats impossible
- To avoid manipulation of attendance.
- To save time almost no energy required in carry out.
- To eliminate queueing for signing the for attendance.
- To improve security measures for accessing facilities.
- To improve user's focus on attendance as has been accompanying to rising issues today.

Intended Audience:

- The audience of this system will be:
- Students
- Faculty members
- Registration office
- This project will be managed by registration office, created and developed by the IT staff and other specialized people in the technology, such as programming, web design and others.

Product Scope:

The proposed system will manage the process of attendance that will be save in specific database. It will also let the user search and calculate daily attendance by month. Once the student place his/her thumb make on the scanner, it will directly save in database and generate message that will be send to their parents, it contains the time when their child arrives in their school. When the system detects an empty attendance, the system will automatically generate a message to the hand phone via SMS.

Overall Description:**Product Perspective:**

The product student management system, is an independent product and does not depend on any other product or system. The product will automate various tasks associated with handling student details and better organizing the stored information and optimum performance, thus helping the colleges to ensure smooth working of this purpose.

**Product Functions:**

The main feature of the Biometric Attendance Management System is that it keeps a record of all essentials details of each individual student or employee. At the end of a specified period this system creates a defaulters list as well as the non-defaulters list.

Attendance Percentage of each student and employee in every subject or field would be displayed in this list also; the system allows the professor or manager of the firm to view pertinent statistics on student's attendance record for the specified class. Finally, another feature of Biometric Attendance Management System is its flexibility and ease of use.

Operating Environment:

OE-1: The Attendance Management System shall function on the PC provided by the college. This entails the system to operate on the Windows CE platform.

OE-2: The Attendance Management System shall interface between Windows CE designated to store tendance records. The Software have not been established at this point.

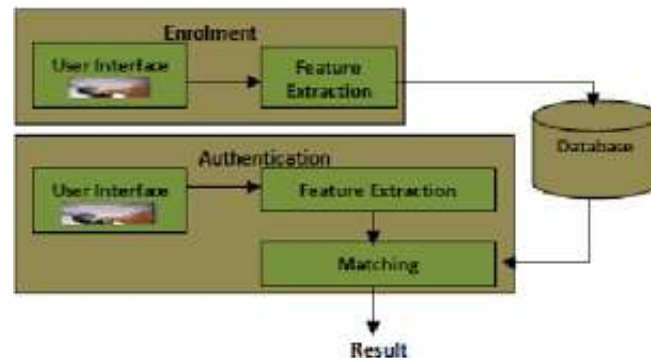
OE-3: The Attendance Management System will record all the essentials details of each particular student.

OE-4: Pentium 3.0 GHz or higher RAM must be 1 Gb or more and Hard Drive 10 GB or more

Design and Implementation Constraints:

1. Hardware and Processing Constraints

- **Memory Capacity:** Microcontrollers (e.g., ATmega328P or ESP32) have limited non-volatile storage. Storing hundreds or thousands of high-resolution biometric templates requires external EEPROM, SD cards, or cloud database integration. **Processing Power:** Feature extraction and template matching require significant CPU cycles. Complex algorithms—especially in facial recognition—can cause latency at the checkpoint if the hardware lacks adequate processing capabilities.
- **Network & Connectivity:** Standalone offline devices must sync with a central server over Wi-Fi, Ethernet, or cellular networks. If the connection drops, the system must cache data locally and reliably sync when the network is restored.



Assumptions and Dependencies:

The database mentioned within this Software Requirements Specification document is previously administered with the correct information needed by the Attendance Management System.

For attendance policies, since professors do not usually tabulate tardiness, it is assumed a student is either present or absent. The system also assumes that detail regarding each student would be made correctly.

Class data being used for setup and student recognition is dependent on information in a database administered outside of the capabilities of the Attendance Management System.

Statistics on student attendance is dependent on a professor's consistent utilization of the system for each class period.

External Interface Requirements:

User Interfaces:

The Attendance Management System shall provide details of students in the class to aid in taking roll.

These details can be clicked with a mouse in order to view a particular student's attendance record.

All modifications to the database will be done through a keyboard. Application will be accessed through a Browser Interface. The interface would be viewed best using 1024 x 768 and 800 x 600 pixels resolution setting.

The program will provide a page that produces current statistics on class attendance

Hardware Interfaces:

Server Side:

- Operating System: Windows 7/xp, Windows ME
- Processor: Pentium 3.0 GHz or higher
- RAM: 1 Gb or more
- Hard Drive: 10 GB or more

Client side:

- Operating System: Windows 7 or above, MAC or UNIX.
- Processor: Pentium III or 2.0 GHz or higher.
- RAM: 1 Gb or more

Software Interfaces:

Attendance Management System

This software will transmit the attendance of a class to a database on a machine via Internet.

The user will be allowed to modify attendance records at any time.

If the user forgets to transmit the information, the system will automatically send it for them at the end of the class.

Database

The Attendance Management System will communicate with the database to perform the following options:

To allow a user to enter attendance.

To allow a user to modify attendance.

To allow a user to query a system to gain statistics concerning individual and class attendance.



Communications Interfaces:

The security of a user must be consistent through the use of passwords.

The Attendance Management System will communicate to the database through Internet.

System Features:

○ Description and Priority

Provide a short description of the feature and indicate whether it is of High, Medium, or Low priority. You could also include specific priority component ratings, such as benefit, penalty, cost, and risk (each rated on a relative scale from a low of 1 to a high of 9)

○ Stimulus/Response Sequences

List the sequences of user actions and system responses that stimulate the behavior defined for this feature. These will correspond to the dialog elements associated with use case.

○ Functional Requirements Itemize the detailed functional requirements associated with this this feature. These are the software capabilities that must be present in order for the user to carry out the services provided by the feature, or to execute the use case. Include how the product should respond to anticipated error conditions or invalid inputs. Requirements should be concise, complete, unambiguous, verifiable, and necessary. Use "TBD" as a placeholder to indicate when necessary information is not vet available.

Other Nonfunctional Requirements:

- Performance Requirement
- Security Requirements
- Safety Requirements
- Software Quality Attributes

- Business Rules

Other Requirements:

- Software Requirement Specification
- Random Access Memory
- Operating system
- Databases
- Personal Home Page
- Structured Query Language
- Hyper Text Transfer Protocol

How Biometric Attendance System Works?:

Biometric finger print scanner system works very efficiently and quickly as you can read in below described steps. For identification process a biometric physiological finger Scanner works on two basic principles.

- **First, it takes an image of a finger**
- **Then finger scanner saves specific characteristics of every unique finger and saved in the form of biometric encrypt key.**
- **Actually, finger print scanner never saves images of a finger only series of binary code for verification purpose.**
- **No one can change the algorithm into an image so it is totally impossible to duplicate your finger prints so no need to worry about it.**
- **Secondly the biometric attendance system determines whether the pattern of ridges and valleys in this image matches the pattern of ridges and valleys in pre-scanned images.**
- **So now fingerprint scanner is operational and you can easily manage employee's**
- **attendance and every aspect related to time.**

Physiological:

Physiological biometric mean human characteristics, i.e. the shape and composition of the body. There are several ways to identify a human with the help of physiological biometric characteristics. The most commonly used physiological biometric identification can be done via face, fingerprints, hand geometry, retina, iris, signature, vein and voice.

Face:

Physiological face verification can be used for identification of a person. With this technique person is identified through its facial characteristics and pattern.

**Fingerprints:**

Finger print technique is also a part of physiological biometric. As we know that every human being fingerprints are different and unique from each other. So we can use this technique for biometric attendance system works. The accuracy rate of finger print scanning is very high and it is cheap technology. As compared to other physiological biometrics techniques like DNA, Iris and retina used for verification.



Hand Geometry:

In hand geometry technique identification process is done by measuring length of fingers, shape of the hands and palm geometry of a person.



Retina:

In physiological retina technique blood vessel at the back side of the eye is checked to match unique person retina. For this purpose low frequency beam is used to scan retina.



Signature:

For signature verification specific person name spelling, writing style, wordpattern are checked and match with the already record signature.



Vein:

For vein recognition pattern of vein on the back side of the hand or wrist is checked to identify authorized person only.

Voice:

The voice recognition technique can also be used for verification purpose. Each man voice tone, pitch and frequency always differ so this technique is not reliable. Because parody of any man is possible. Little change in voice because of cold or fever will stop and make it impossible to identify you.

Behavioral:

The behavioral biometric technique of a person includes characteristics like how he walks and scanners are used for it. Brain wave signaling and electronic Tattoos techniques are improved behavioral authentication techniques. We can use a behavioral biometric technique also for biometric attendance system works but equipment's and system installation is too much costly.

Objectives:**➤ Main Objectives:**

To develop a system that will help in automatic taking and tracking of staff attendance by using fingerprint.

➤ Specific Objectives:

- To collect and analyze the requirements of the proposed system.
- To design and implement circuit that will perform attendance taking process.
- To design implement supporting software module that will facilitate attendance tracking.
- Compare new system against the traditional system.
- Protect the proxy which is doing in daily base.

Tools:**Hardware Tools**

The major hardware part of the system is the fingerprint reader is following

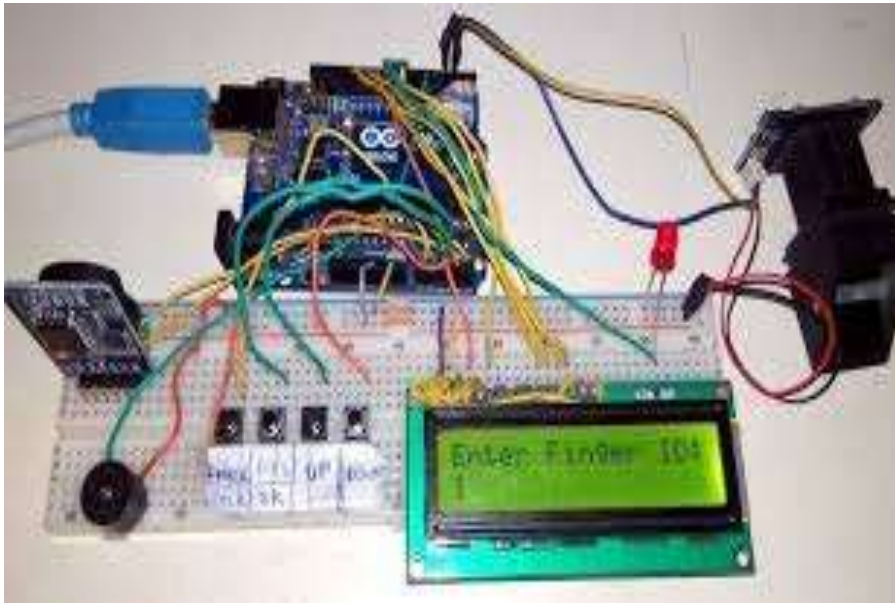
➤ Module R305

It is used to capture finger images, convert it to finger templates and save the templates for future matching.

➤ The Microcontroller ARDUINO UNO

It is a RISC microcontroller from ATMEL and it has 32MB of flash memory, 2KB of RAM and 1KB of EEPROM. The microcontroller works as a link between fingerprint reader and other system components including management server and database

- Main board contains RTC chip DS1307 to handle the date and Large EEPROM chip which is used to save the attend records.
- The chips MAX232 and SN75176 are used for communication with the management server.
- The 4 lines LCD which is used to display the academic numbers and status of device

**Software Tools**

The design methodology of the software part includes all applications that the fingerprint attendance system needs

- Microcontroller Code
- Software Design
- Web Portal Design
- MySQL (For Database Management)
- Python's GUI (Graphical User Interface) package- TKINTER

All applications that manage whole system depend on information of students and timetables of courses.



Technology Embedded System are used

Microcontroller Code:

- A microcontroller is a computer present in a single integrated circuit which is dedicated to perform one task and execute one specific application.
- It contains memory, programmable input/output peripherals as well a processor.
- Microcontrollers are mostly designed for embedded applications and are heavily used in automatically controlled electronic devices such as cellphones, cameras, microwave ovens, washing machines, etc.

Software Design:

- Software design is a process to transform user requirements into some suitable form, which helps the programmer in software coding and implementation
- Software design is the first step in SDLC (Software Design Life Cycle), which moves the concentration from problem domain to solution domain.
- It tries to specify how to fulfill the requirements mentioned in SRS.

Data Base (MySQL):

- MySQL is a relational database management system based on SQL - Structured Query Language.
- The application is used for a wide range of purposes, including data warehousing, e- commerce, and logging applications.
- The most common use for MySQL however, is for the purpose of a web database.
- It can be used to store anything from a single record of information to an entire inventory of available products for an online store

Phyton's GUI (Graphical user Interface):

Python offers multiple options for developing GUI (Graphical User Interface). Out of all the GUI methods, TkINTER is most commonly used method. It is a standard Python interface to the Tk GUI toolkit shipped with Python. Python with TkINTER outputs the fastest and easiest way to create the GUI applications. Creating a GUI using TkINTER is an easy task.

Intended Audience The audience of this system will be:

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Advantages of Using Biometric Attendance System Works:

There are so many advantages of using biometric attendance system works. Read below how biometric system can be beneficial for your organization and advantages of using it are:

- Installation system of biometric attendance system is easy.
- Biometric time attendance system works very quickly and its user interface is very friendly.
- Biometric attendance system stops buddy punching like cards or PIN passwords.
- Accuracy rate of the biometrics attendance system is very high.
- No one can fake or create replica your finger prints. Employees can miss or forget his/her attendance cards, but not the finger
- Employees don't need to remember long PIN, passwords and patterns.
- Attendance by biometric finger scanner is fast process it hardly take 1 to 5 seconds only
- Attendance by biometric scanner gives you always accurate data record.
- Biometric attendance system can easily reject an unauthorized person within no time.
- 11. Companies with the help of biometric attendance system can check worker clock in and clock out time.
- Attendance system can manage a number of employee attendance data efficiently.
- Biometric attendance system control over timing hours of employees.
- System helps you to control labor cost by reducing over payments.
- Festivals, holidays and leave management is cool and simple.
- 16. Biometric attendance system works take less than 5 seconds to recognize authorized person.

Disadvantages of Using Biometric Attendance System Works:

- Physical Traits are not Changeable: Most of the biometric modalities work with physical traits such as fingerprint, iris, palm vein, etc.
- Error Rate
- Cost
- Delay
- Complexity
- Unhygienic
- Scanning Difficulty
- Physical Disability
- Require integration and/or additional hardware
- Systems are not 100% accurate.
- Identity verification may take some time.

Conclusion:

- The system is developed with a proper market analysis and considering the perspective of small-scale industries and offices and educational sector.
- This can maintain attendance, enrollment as well as provides features which can be used for setting enrollers different rules (as a simple user, enroller and administration) and also generates several reports.
- This software has an advantage of maintain OFFLINE data, hence we take data attendance and enrollment with device and containing it with software application we can synchronize data.
- Fingerprint recognition is universally applied.
- In most cases, using biometric identification has proved to be more beneficial in long run.
- As more and more biometric systems are deployed, they are expected to become eve

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