FINGERPRINT BASED ATTENDANCE MANAGEMENT SYSTEM

L.S. Ezema, C.K.A. Joe-Uzuegbu, J. N. Eneh and I. Amanze

Abstract - In many institutions and organizations, student and staff attendance is taken seriously as most management frown at absenteeism and sanction the individuals involved. Traditionally, the method of attendance taking used to be done manually using a physical register booklet. This method is prone to manipulation and impersonation. The attendance register could get damaged, stolen or lost. Therefore, several electronic techniques were developed to counter some notable flaws typical with the traditional method. These include clocking machine, RFID, biometrics, etc. While the clocking machine and RFID methods could not solve the problem of impersonation properly, some people fear the health effects of the use of biometrics like iris and facial scanner. Fingerprint scanning has been by far the more acceptable biometric system with the ability to eliminate all the trouble spots reported so far although computer support is always required. Therefore, this paper presents a fingerprint attendance system designed to also operate as a standalone and handheld system without the use of a computer, unlike other fingerprint attendance systems.

Keywords - fingerprint, identification, Attendance Database, Atmel 8052 (AT89S52) microcontroller
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1 INTRODUCTION

FINGERPRINT verification is one of the oldest known biometric techniques known but still the most widely used because of its simplicity and good records of accuracy. It is a well-known fact that every human being is born with a different pattern on their fingers and these features are used to identify and differentiate between two different persons.

The benefit of this application in an educational institute or organization cannot be overemphasized. The fingerprint recognition and verification technique has been adopted to replace the conventional method as it saves time and eliminates all the set-backs identified with the attendance register booklet. A fingerprint detecting device needs to be placed in each classroom or exam hall, and students would be required to swipe their finger across the sensor so as to indicate their presence in the class or exam. The student records are stored in the database for verification. The moment a student swipes a finger across the scanner, a check would be carried out for the student [1].

The attendance system is actualized using the Fingerprint technology and Embedded Systems. The Fingerprint technology serves as an identity proof to take the attendance of students. The device reads finger patterns from the fingerprint module and verifies this data with the already stored pattern in its database. If the details present in the database matches with the stored fingerprint, the system acknowledges the attendance. If the finger details do not match with the data stored in the database, an alarm system will be triggered to notify the security personnel to take further action. The system is designed in such a way that it can be used as a standalone device and can also be interfaced with a PC either to print out the attendance or to get more elaborate details of the people whose attendance is taken [1].

2 REVIEW OF RELATED WORK

Numbers of related literatures based on electronic device for student attendance record currently exist as reviewed below.
In [2], an embedded computer based lecture attendance management system was proposed. Although this was an improved system with electronic card reader serially interfaced to a personal computer, the demerit of such system is that someone can still take attendance for another person if given the person's electronic card. Authors in [3] used a wireless attendance management system that authenticates using the iris of the individual. This system uses an off-line iris recognition management system for image capturing, extracting precise details, storing and matching the captured image with one stored in the database. This system takes care of wrong clocking in or buddy-punching. Buddy punching is when one worker or student inappropriately clocks in for another. The only problem this type of biometric system has is that people usually have the fear that the Iris scanner, after sometimes might contribute to the damage of their eye and so tend not to embrace it. The authors in [4] designed and implemented a system that authenticates the user based on passwords. This system still could not eliminate impersonation since the password can be shared or tampered with. Passwords many times can be forgotten or the system hacked thereby preventing user's access to the system.

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In addition, we have other solutions such as RFID-based authenticiation system and GSM-GPRS based authentication system. There are issues with all these device-based solutions. The GSM-GPRS based systems use the location of class for attendance marking which is not dynamic. Thus, wrong attendance might be recorded if there is a change of venue. Problem with RFID [5] based authentication systems is that RFID cards can get lost, stolen, and it requires the installation of RFID detectors. RFID cards can also not eliminate impersonation.

This fingerprint authentication system, however, is a cost-effective and simplified means of identification. The fingerprint is distinctive to each individual. Even identical twins do not share the same fingerprint features, and it cannot be transferred, lost or forgotten like the password. It allows students to register for lectures with ease and eliminate errors that are associated with attendance registers because the system generates exports at the end of the semester. The advantage of this system is that it can work as a standalone system unlike other fingerprints identification systems already in existence.

3 FINGERPRINT AQUISITION PROCESS

A fingerprint [6] can be defined as an impression made by human finger because of the patterns created on the skin of our palms and fingers ever since birth. The marks or pattern on our finger will never undergo any change rather it becomes prominent with age. Figure 1 below shows a fingerprint image. For their permanence and unique nature, they have been used since long in criminal and forensic cases. Shown below, is a fingerprint pattern obtained from an optical sensor. The figure shows faint and dark lines emerging from a particular point and spiraling around it all over the finger.

Fig 1: A fingerprint image acquired by an optical sensor

The fingerprint acquisition process can be divided into three parts, there are:

1. The enrolment process
2. The verification process
3. The data collection process

3.1 Enrolment

The enrolment process is done once for each person. Each person would be required to register their fingerprint pattern by placing his thumb finger on the fingerprint scanner. The scanner takes the image of the finger and determines the unique characteristics of the fingerprint image. The fingerprint contains ridges and valleys which have different kinds of breaks and discontinuities. It is the various ridges and valleys that form the basis for the loops, arches, and swirls that are easily seen on fingertips. After the capturing of the ridge pattern of the fingerprint, a template is created, and the fingerprint is encrypted into series of numbers. These series of numbers will be different for each fingerprint pattern. After the process must have been completed, the fingerprint scanner sends the result of the encryption to a memory location or database. The process algorithm is shown in figure 2.

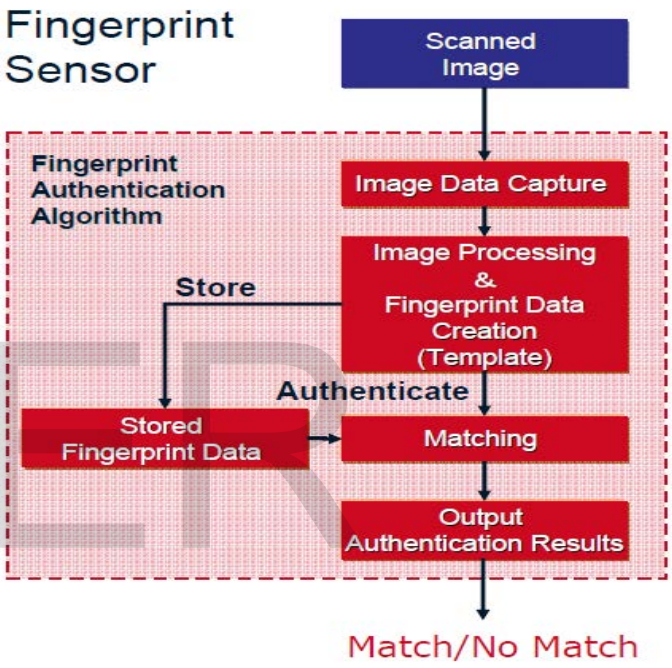


Fig. 2: Fingerprint sensor algorithm

3.2 Verification Process

The second process is the verification process. This is the most repeated process. It is a done each time the user wants to make use of the fingerprint controlled device. When he places his finger on the fingerprint scanner surface, the fingerprint would be processed by the fingerprint scanner. The fingerprint pattern that has been obtained would be compared against the stored enrolment template that is already stored in the database or memory location where the enrolment process was executed. When the fingerprint pattern passes the comparison process, it shows an acknowledgement in its display and grants the user access.

3.3 Data Collection Process

The last process that will be done is the data collection process. The data about the fingerprint device usage or record can be collected after a period of time and can be used as a form of

record to know the attendance of a person or to know the number of times a restricted.

4 SYSTEM OVERVIEW

The design of the project is done in two stages, the hardware part and software section. The software part is achieved using Visual Basic to design a program which would house the initial attendance database created in MS-excel, be used for the registration of each new user, and also accepting attendance record from the hardware for compilation with options of printing the updated record if required. The system block diagram and the system circuit diagram are shown in figure 3 and 4 respectively.

The hardware (device) comprises of the microcontroller, the fingerprint scanner, LCD display, real-time clock and serial communication that is housed separately in a portable box, and is used for verification and assigning of time to the registered user and sending the attendance data to the Visual Basic program on the computer.

The project was designed in such a manner that the hardware component can function independent of software component (VB.Net) and can be used to record attendance once the initial attendance database has been uploaded to its memory (EEPROM), thereby, working as a standalone system.

4.1 Description of the different Blocks

The power supply section (in figure 4b) of this circuit consists of a 230V from the mains supply which is stepped down by the transformer to 12V and is fed to a rectifier. The output is then fed to a filter to remove any a.c components present even after rectification. The voltage is regulated using a voltage regulator (LM7805 regulator) to 5V which supplies power to the rest of the circuit and also recharges the rechargeable battery. The LCD display displays the output of the two microcontrollers by the use of an octal latch which ensures that each of the microcontrollers sends data at different time interval. The port 1 of the microcontroller is connected to the latch and it is used for getting the data or information that is meant to be displayed to the user. This port is in open drain configuration and, as a result, pull up resistors should be provided for its normal operation.

The first microcontroller is connected to the fingerprint Module and communicates with it through a Serial port UART (Universal Asynchronous Transmitter and Receiver). The buttons (Sign In, Sign Out, Register, and Delete Finger) are also connected to the microcontroller. The controller ensures that each action being performed by the buttons is displayed on the LCD display.

The second microcontroller has the function of sending the data gotten from the fingerprint to the EEPROM, ensures that the Real Time Clock time is displayed and stored the moment a fingerprint is accepted. It also controls the displays of the LCD, by transmitting the character strings to be displayed on the LCD screen.

The two Microcontrollers are linked together through parallel connection using their parallel port. The EEPROM I2C 24C08 is a serial electrically erasable and programmable read-only memory. It is connected to the microcontroller through two pins SDA and SCL. This EEPROM is used to store the data relating to the details of the user and also the date and time the attendance was taken. The fingerprint module (SM630) device captures the fingerprint of the user and stores it in its memory. It operates at 57600 baud rate.

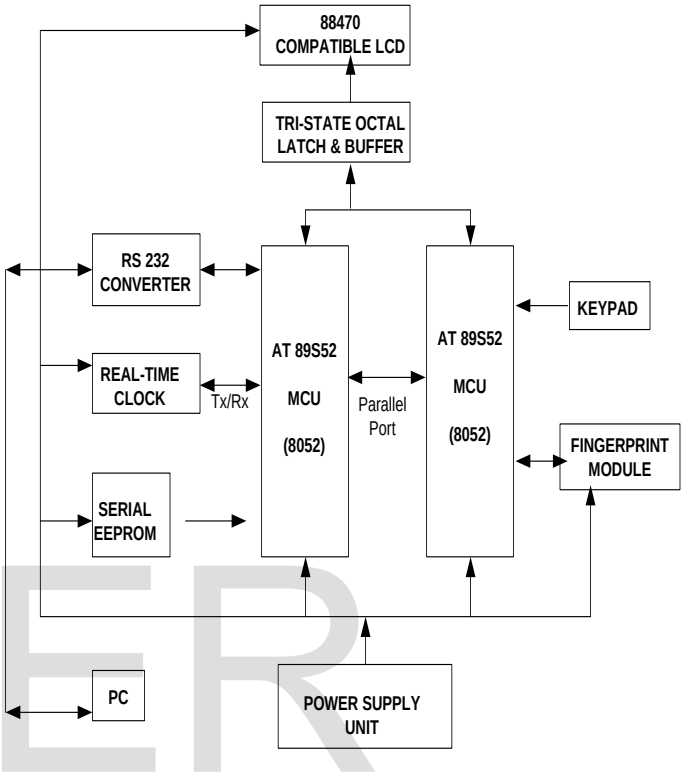


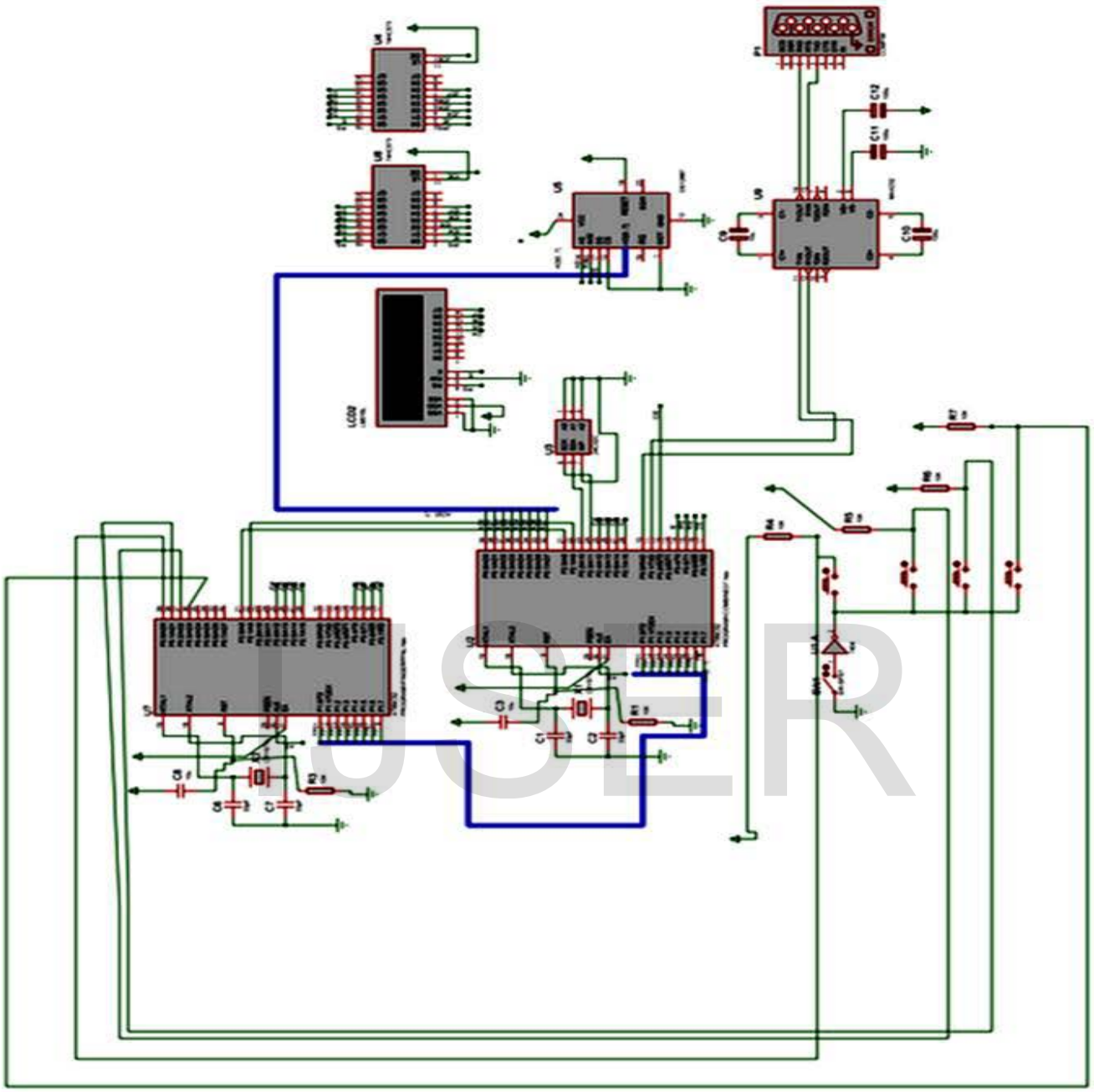
Fig 3: System block diagram

SM630 has 4 pins Vcc, gndTx and Rx.TheTx of SM630 is connected to a serial receive input of microcontroller which is nothing but P3.0 pin. Similarly, Rx of SM630 is connected to serial transmit pin of microcontroller P3.1. RS-232 which is a simple, universal and well-understood standard is applied in this project. It converts the active high condition of PC (-3 volt to -12 volt) to the active high condition of the microcontroller (+5 volt) and vice versa. Similarly, the active low condition of the microcontroller (0 volts) is transformed to the active low condition of the PC (+3volt to +12volt) and act as a perfect means of interfacing microcontroller and PC.MAX 232 is used in the serial communication to convert RTL to TTL.

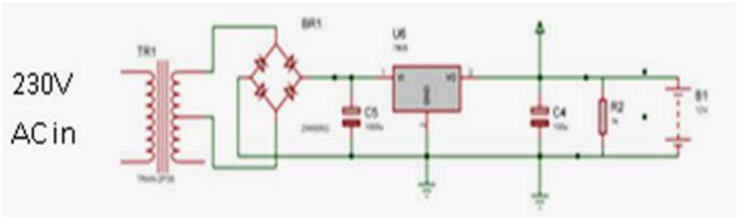
Hardware Considerations:

1. High data transmission rate or serial baud rate between the microcontrollers and PC.
2. The high clocking speed of the microcontroller.
3. Adequate data RAM and program FLASH memory available on the choice of microcontroller.
4. Fast response time in detecting and processing of fingerprints by fingerprint module
5. Accurate and updated time for keeping time of fingerprint detection

6. Highly stabilized and regulated the power supply of 5V DC.



(a)



(b)

Fig 4: (a) design circuit diagram, (b) circuit diagram of power supply

5 SOFTWARE DESIGN AND ANALYSIS

In the Software development process, the entire process is divided into two:

Firmware programming: This is the software developed using assembly language and burnt into the main microcontroller as firmware which coordinates the activities of all the other sub-modules making up this work. The program contains the instructions that send the data gotten from the fingerprint to the EEPROM, ensures that the Real Time Clock time is displayed and stored the moment a fingerprint is ac-

cepted. It also controls the displays of the LCD, by transmitting the character strings to be displayed on the LCD screen.

PC software: This is the software Package to be installed on the PC that is used for the initial registration of the attendance register users, sends and gets data from microcontroller via the PC serial port interface module, interpret the data gotten from the microcontroller and creates database. The software package is developed using Visual Basic Programming Language. Figure 4 and 5 shows the programme outlook and the flowchart for the programme.

The software implementation began with the writing of program codes according to the logic defined by the software design. The programs were developed using assembly language and VB.Net programming language. The assembly language was used to develop the firmware burnt into the microcontroller while the PC software interface was developed using visual basic.

Software specification

1. Easy to use and user-friendly
2. Well structured database
3. Password enabled to prevent unauthorized access

The program flowchart is a pictorial representation of the sequence of steps involved in carrying out a programming process. In other words, it is a diagrammatic representation of the program algorithm. The programme outlook and flowchart are shown in figure 5 and 6 respectively.

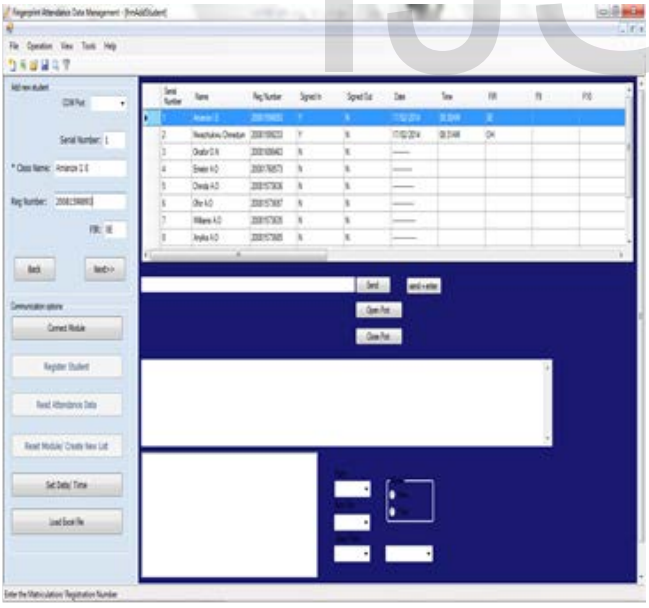


Fig 5: The programme outlook

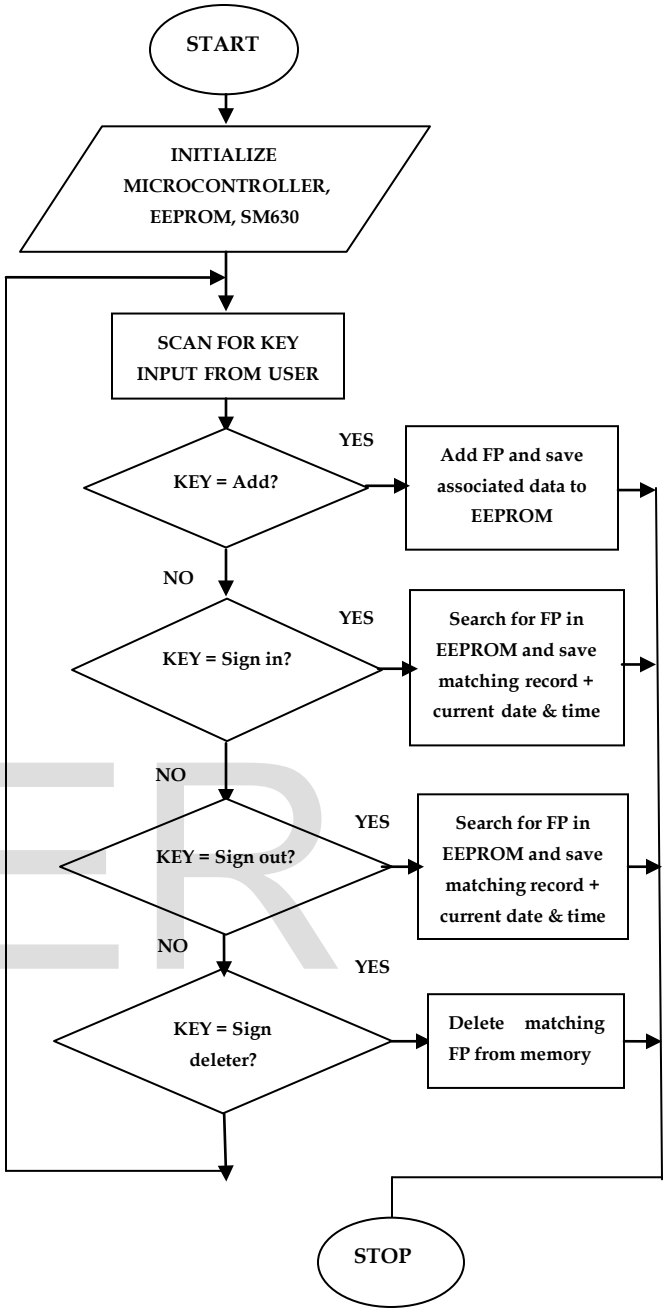


Figure 6: The programme flowchart

6 CONCLUSION AND FUTURE WORKS

This paper has successfully presented a reliable, secured, fast and efficient system replacing a manual and unreliable system. This system can be implemented in many institutions especially in the academic institutions for better result regarding the management of attendance. This system will save time, reduce the amount of work the administrator has to do and will replace the stationery material with an electronic device. Hence, a system with expected results has been developed but there is still room for improvement.

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The functionalities of the system can be further enhanced through the following recommendations:

1. The module could be remotely connected to a PC wirelessly (through the use of Bluetooth, Wi-Fi, WLAN) so the administrator can have access to the attendance data without physically interfacing the Module with PC.
2. The Module can be interfaced with a GSM Module to send SMS to the Security Personnel anytime an unregistered finger tries to sign-in or out or to parent notifying him/her of his/her child's attendance records.

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