

Design and Development of an effective and secure Fingerprint based Biometric Attendance Device (ESFB2A).

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ABSTRACT

This paper presents the design and construction of a fingerprint based biometrics attendance system. The model includes fingerprint model use for taking the fingerprint of each student and also a graphic LCD to display the registered students or none. Its process entails taking attendance of each student and it searches for it in the database to confirm if the student has registered or not. It marks attendance for the registered student and displays results not found for the unregistered student. It has a biometric data capturing database memory that stores about 200 students data (fingerprint, name, matric, sex, faculty, department, blood group etc.) it uses a USB computer keyboard as input and has a big 240×128 pixel graphic LCD as output. It has a Bluetooth or serial port to transfer attendance result to a phone or computer for printing. It includes password access for administrator to enroll students and to view the results.

(Keywords: fingerprint module, enrollment, database system, class attendance)

INTRODUCTION

This device is a very powerful and intelligent fingerprint attendance system used in school environments or classrooms that can register up to 200 students' details, biometrics, and bio-data (name department, matric number, gender, phone number, email address, marital status, blood group, name of next of kin, and phone number).

When a registered student attends a class he marks his attendance by placing his/her thumb on the reader. The systems captures the

fingerprint and search the database and displays the student data for a brief view to mark the student absent at the real time the attendance was taken. The lecture or exam details (course title, course code, lecturer name and venue) too will be captured so as to use it as a heading when sending the attendance result to a phone or PC using Bluetooth. It uses a well-organized database, easy user interface and accurate intelligence.

This study helps solve the old and traditional or manual way of taking attendance, normally passed around the classroom while the lecturer is conducting the lecture. There are numerous disadvantages of using such system. The attendance sheet is passed around the class; some students may accidentally or purposely sign another student's name. Another issue of having the attendance record in a hardcopy form is that a lecturer may lose the attendance sheet. As a consequence of that, lecturer can no longer trace the students overall attendance record throughout the particular period.

There are other management based attendance systems like the RFID based attendance system, voice recognition, GSM-GPRS attendance system and **face** recognition attendance system. But all of these have limitations; like the RFID, it works on the principle of taking attendance with the fingerprint acquisition and attendance module and sending the result through GSM as an SMS, the disadvantage of this is that the card can easily be lost or damage. The drawback about the RFID system is that student/students can easily give his/their card to fellow colleague for attendance taking.

The face recognition system works on the principle of using a computer application for

identifying or verifying a person from a digital image. One of the ways to do this is by comparing selected facial features from the image and a facial database. The drawback about face recognition is that many systems are less effective if facial expressions vary. Even a big smile can render the systems less effective.

And finally the voice recognition system is possible after making a digital model of an individual's voice that can serve as a stored profile or template of that voice print. Words and phrases are broken down into various kinds of frequency patterns that, taken together, describe someone's unique way of speaking. The templates are stored in databases for matching like other kinds of biometric data. The drawback about this type of attendance taking is that many challenges affect its accuracy. These include poor-quality voice samples; the variability in a speaker's voice due to illness, mood, changes over time.

This work fingerprint based biometric attendance system has a lot of advantages as follows:

- It has capacity for 200 or more students.
- It allows various lecturers of different courses to use it without mixing up their students.
- It gives room for printing of attendance at the end of each class for record keeping.

- It is fingerprint based; so no students can take attendance for another.
- It entails feature like; registering students, edit students data, delete students' data, edit time and date, view registered students, etc.
- It also uses password protection which will guide other lecturer from intruding into another lecturer's record.

Model Overview

This device provides the solution to the tradition way or manual way of taking attendance and also drastically reduce the inconveniency of the students signing attendance while lecture is going on through the use of fingerprint management software that is incorporated with the fingerprint device. For taking attendance, the students must have all been registered at the beginning of that semester and then for each lecture, the student place his/her thumb on the fingerprint module and the student matric no is sent to the database as having attended that particular class or lecture. Also the time each student registered is taken and report can be printed at the end of the class.

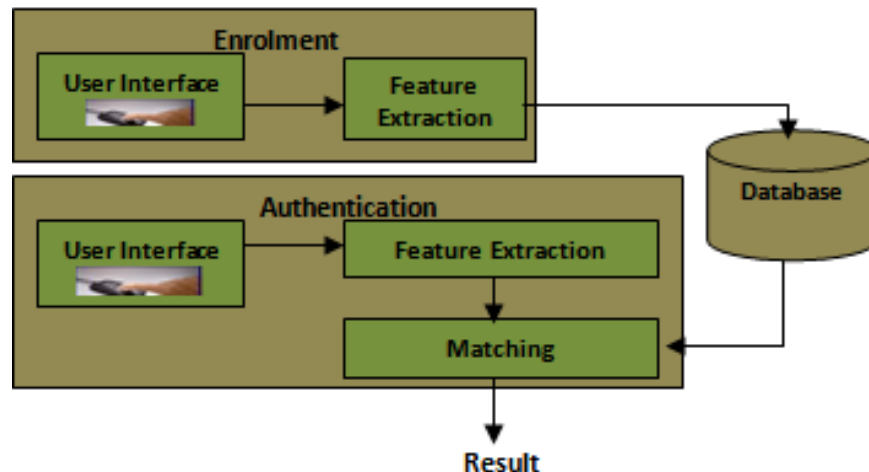


Figure 1: The General Architecture of a Biometric System.

System Hardware Design

The system hardware includes: fingerprint module, graphic LCD, microcontroller, external EEPROM and a keyboard input circuit.

Microcontroller pic18f452: This is the circuit that contains the main microcontroller which is PIC18f452 the heart of the whole project. It is responsible for: accepting data from the fingerprint reader, reading time information from the timer chip, getting input text from the keyboard decoder circuit, writing and reading data and information from the external EEPROM, then processing these data according to the software written for it and displaying information on a graphical LCD and also sending these information to a PC or any Bluetooth enabled device for permanent storage or printing. Figure 2 shows the image of microcontroller pic18f452



Figure 2: Microcontroller pic18f452.

Fingerprint Module: This circuit is responsible for reading fingerprint image information on the fingerprint reader. It communicates with the microcontroller; it accepts command to read the fingerprint, store it in a memory, compare the current image with one stored in the memory etc. it sends back the result to the microcontroller where it is further processed and make some decisions to mark attendance or to reject.



Figure 3: Image of fingerprint module

External EEPROM: This circuit is synonymous to an external memory card of a device. Due to the fact that the internal EEPROM of the PIC18f452 is 256 bytes which is not enough to store information that we need, an external EEPROM is employed to do the job. It has 65kB of memory space which is used to store up to 200 student data.

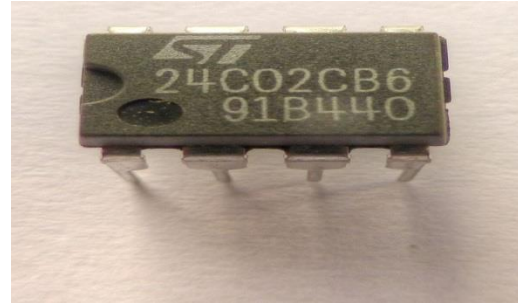


Figure 4: Internal EEPROM.

Graphic LCD: This is the main output device of the whole system. This is responsible for accepting display information from the main controller and displaying it accordingly. The display is used as a user interface to monitor the state of the system and to see what is happening at real-time. It allows the administrative user of the project to register student by displaying what is being typed.



Figure 5: Graphic LCD.

Keyboard Input Circuit: This circuit contains a PIC16f88 responsible for decoding keyboard scan codes and converting it to ASCII characters for main microcontroller. It is meant to ease the work of the microcontroller; reads the fingerprint module and send data to the graphic LCD simultaneously, so adding a keyboard to its list of process will make the whole job slower. The keyboard controller also

filters out some functions keys and other special keys that are not needed for this device; it is also responsible for sending signal to the keyboard tone buzzer anytime a valid key is pressed and also the caps lock and second function LED indicator.

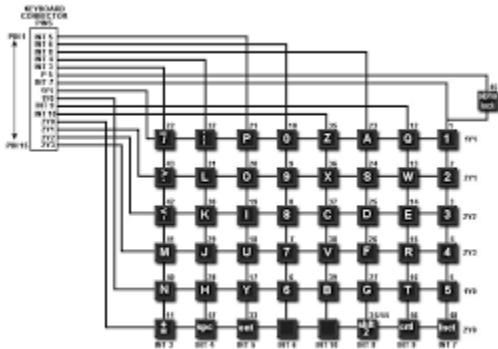


Figure 6: Keyboard Input Circuit.

METHODOLOGY AND FLOWCHART

Software: The software is like the machine in the heart pumping blood. The heart of the whole circuit is the. The programming language used to write the software is Embedded C or C language for embedded systems. The software algorithm and flow chart goes as follows.

Algorithm:

1. Start
2. Initialize ports, fingerprint, EEPROM, internal registers and LCD.
3. Get time from DS1307 displays it on LCD, check if there is a finger on the fingerprint module, check if button is pressed. If no finger, repeat 3, if finger is found go to 4, if button pressed, go to 7
4. Read student fingerprint from the fingerprint module.
5. Search database for a match if there is a match go to 6 else display "FINGERPRINT NOT FOUND" and go to 3.

6. Display student data and take attendance by setting the attendance flag to logic 1 and storing the time. The attendance is taken into a memory space allocated for the student. Go to 3.
7. Display "enter password". If correct password is entered go to 8 else go to 3.
8. Displays the menu to perform different function such as changing the password of the system, registration of student delete student data either one by one or all at once, edit the time and date settings, viewing list of registered student by only name and matric number or viewing full details of one student. He can also view or edit lecture details, view student attendance status, start a new class attendance, sending attendance result to a PC or a phone. If exit button is pressed go to 3.

See Figure 7 for Flowchart of Operations.

MODEL OPERATION, TESTING AND DISCUSSION

The enrolment and registration phase is an interface in which the administrator needs to log in and prepare capturing the bio-data of those using the device for the first time. The courses, lecturers name, time and venue are also registered at this phase. All data and information required for the proper recording of attendance are enrolled. For lecture to take place the lecturer has to edit the course and each student has to place his/her thumb on the fingerprint module; the fingerprint recognition unit compares the fingerprint features with those stored in the database. Once the fingerprint is found in the database, the microcontroller sends a signal to the fingerprint module and the fingerprint module takes the attendance.

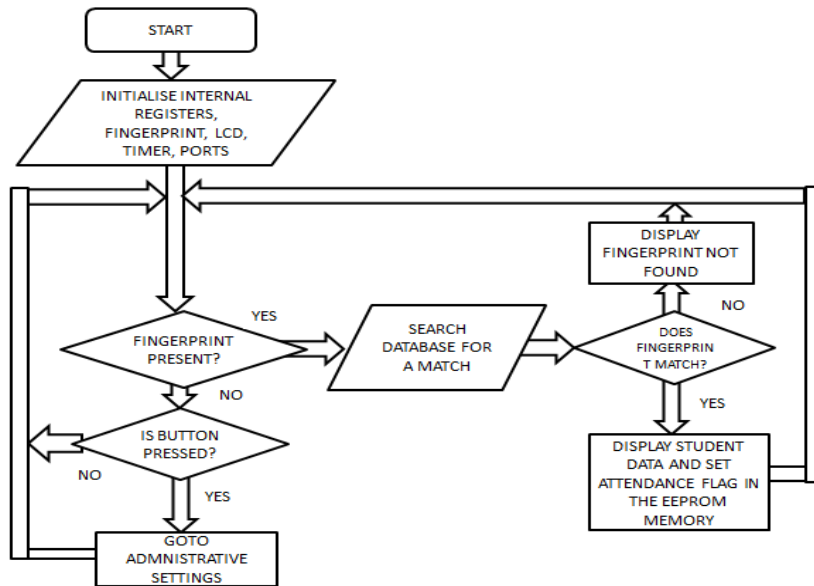


Figure 7: The Flowchart of Mode of Operation.



Figure 8: The Interface of the System.



Figure 9: Display when Attendance is Taken.

Figure 9 below shows attendance taken when the fingerprint of student is found in the database, also the login time is noted.

Figure 10 shows the case when a student or user place his/her fingerprint on the fingerprint module but attendance is not taken because he/she has not been registered.



Figure 10: Display when Attendance is Not Recorded.



Figure 11: The printout of the attendance taken at the end of the class.

Comparisons Among Manual Attendance, Biometrics, and the Fingerprint Based Biometric Attendance System

For the manual attendance system, the average execution time for fifteen students (15) is approximately 19.11 seconds as against the other biometric attendance which is 16.59 seconds. While the execution time it takes the fingerprint based biometric is 12.83 seconds for fifteen students. Table 1 shows the full comparisons between the manual attendance and the fingerprint based biometric attendance system.

Table 1: Comparison between Manual Attendance and Fingerprint Based Attendance System.

s/n	Formal manual method	Other type of biometric	Manual based method	Finger based system
1	22.78	13.81	60.30	13.08
2	12.82	13.43	60.30	11.19
3	19.65	14.12	60.33	10.62
4	11.38	13.63	60.33	09.97
5	12.65	12.49	60.46	10.35
6	16.24	12.72	54.06	12.90
7	14.66	13.35	55.07	10.10
8	15.23	14.01	59.15	09.99
9	15.03	14.21	60.14	10.16
10	16.31	14.31	60.12	12.13
11	14.97	13.85	59.09	11.14
12	15.16	14.32	57.01	11.16
13	15.18	15.11	53.02	12.13
14	16.92	14.32	54.04	11.16
15	17.61	14.89	60.14	09.03

The first column shows the various execution time for each student to mark his/her register and the average execution time is:

$$\sum \frac{\text{CLASS AVERAGE}}{N} = \frac{79.28}{5}$$

= 15.9 approximately 16s

The second column shows the various execution time for each student to take their attendance using other form of management attendance system. The result is shown below:

$$\sum \frac{\text{CLASS AVERAGE}}{N} = \frac{67.48}{5}$$

=13.5 approximately 14s

The third column shows contain the manual attendance taken based on various requirement for the students. The result is shown below:

$$\sum \frac{\text{CLASS AVERAGE}}{N} = \frac{301.72}{5}$$

= 60.3 approximately 60s

The fourth and last column denotes the result of the attendance taken with the fingerprint based biometric attendance system:

$$\sum \frac{\text{CLASS AVERAGE}}{N} = \frac{55.21}{5}$$

= 11.0s

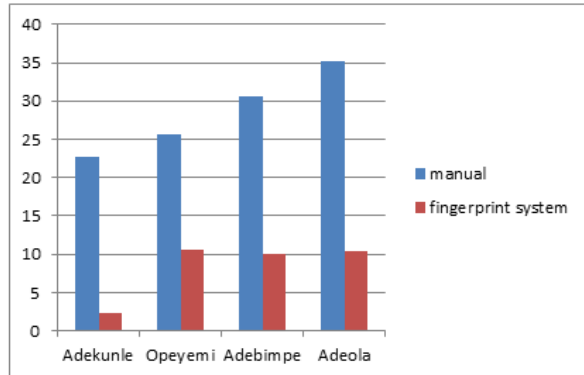


Figure 12: Differences in Time when Taking Attendance using Manual Method and Fingerprint Based Attendance System.

CONCLUSION

This system can be implemented in any organization where the use of attendance is necessary. It helps in reducing the workload and stress of inspecting each participant's attendance at the end of the semester, avoiding the case of a missing attendance and calculation errors when obtaining the total attendance. With this device the challenges faced by institutions and academic organization on attendance taking will be drastically reduced to the barest minimum.

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SUGGESTED CITATION

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