KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CSE 3200: System Development Project

PROJECT TITLE

"Fingerprint Based Biometric Attendance Management System"

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Abstract

Fingerprint recognition is the most popular method in the biometric era due to its accuracy and uniqueness. Manually documenting and maintaining attendance on a sheet by queuing up in front of the class is a complicated and time-killing method. In this paper, we have proposed a biometric attendance management system that takes the attendance of the students and maintains the records in an educational institution in a real-time environment.The system consists of three stages- 'enrollment', 'attendance' & 'data storage'. The process of fingers' enrollment and attendance reporting is performed using the fingerprint module. Using the SD Card module, student's attendance details are stored in a file. The system prevents the tendency of giving proxy which has become a bad trend nowadays.

Contents

1 Introduction

Attendance is a symbolic representation that occurs at various places such as educational institutions, organizations, hospitals, etc. to indicate a person's presence during the day's start & end. In every educational institution, the authority keeps track of the attendance details of their students for various purposes. They record it manually. For example, the lecturers provide a printed sheet so that the students can ensure their attendance by their signatures. But many students give the proxy for their friends who are absent by imitating their signatures. To avoid this issue, many teachers prefer to call out the students' names or rolls during class time. But that is a very time-consuming approach. Most of the universities in Bangladesh have a procedure not to allow their students to attend the examination if their attendance is less than or equal to 60%. Therefore there is a need for a system that would eliminate all of these troubleshoots.

A biometric system would provide the required solution. Physical attributes like fingerprints, iris, face, hair color, hand geometry, and behavioral features like signatures, accent on tone and speech, etc. make a person different from others. A fingerprint based attendance system is better than the manual system based on research [1] and also it has more advantages over other biometric technologies [2]. Kamaraju et al. [3] developed a wireless fingerprint system using Arduino. The system was at risk to intruders because the process shared the same database and there were no security issues. In the field of biometrics, fingerprints are one of the basic forms used to recognize individuals and individuality among all the biological characteristics. It never changes throughout one's entire lifetime.

The main purpose of this paper is to design a system to help the authority with the maintenance of attendance. All the students will have to enroll their fingers against their IDs for giving attendance in a lecture. The students will be considered as present or late present relies on their fingers' placed time on the fingerprint module. For further purposes, attendance details will be stored in a text file and the file is extracted into an excel file for performing some calculations.
The objectives of our work are as follows.

- To design fingerprint based bio-metric attendance system.
- To enroll fingers of the students for the system.
- To take attendance of the students.
- To calculate average attendance of a student from the attendance sheet at the end of the semester.

The overall system is a reliable and secured system. It is easy to use. It cannot be forged easily. From manually marking the attendance in attendance registers to using bio-metric systems, the overall system has been improved significantly.

1.1 Motivation

In every educational institutions, the authority keeps track of the attendance of all students. But the attendance system is poor. The system can easily be manipulated. For example, a teacher has to pass a printed sheet to record the attendance of the students. A student needs to fill the sheet with his/her signature. In this case, some of the students can imitate their friends' signatures even though they are absent. To avoid this issue, many teachers are to call out the students' name or roll during the class time. But this approach is very time consuming. To solve these issues, we have planned to introduce a system that is 'Fingerprint based Bio-metric Attendance System' which will be helpful for our education system.

2 Related Works

There are a lot of related works on the attendance system to control student attendance efficiently. The related works are described shortly as follows.

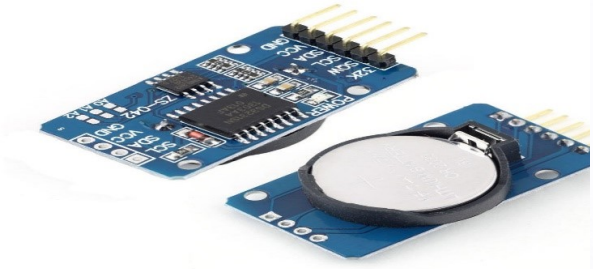
Kadry et al. [4] proposed a wireless system that takes student attendance using iris recognition. But the iris scanner is five times higher in cost compared to fingerprint scanning. It requires a lot of memory for the data to be stored and later accessed. The system may often face difficulties because of being iris small. Arulogun et al. [5] designed an attendance system based on RFID. In this case, students must carry their RFID cards. RFID cards may be lost or damaged and so students may have to suffer. The facial recognition-based system was introduced in [6]. But it requires costly equipment, also did not provide the required accuracy because facial expressions are not the same at all times. The face recognition system has also difficulties with data processing and storing. Zainal et al. [7] discussed the fingerprint attendance system. But they didn't clear the rules for marking the attendance.

3 Equipment

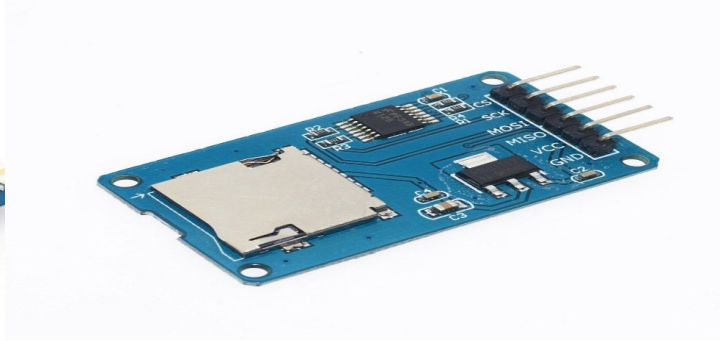
The following requirements are needed to complete the work.

(a) Arduino Mega.

(b) R307 Fingerprint Module.

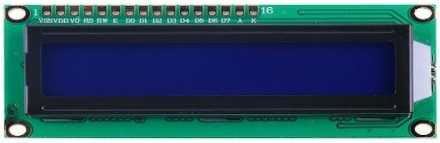


(c) DS3231 Real Time Clock Module.



(d) SD CARD Module.

(e) 4*4 Keypad.



(f) 16*2 LCD Display.

Figure 3.1: Equipment

We also used potentiometer, card reader & microSD card, bread board, and connecting wires.

4 Project Description

This proposed system introduces a new automatic attendance management system which integrates fingerprint authentication into the process of attendance management for the students. It consists of 3 processes – 1) Fingerprint Enrollment. 2) Taking Attendance 3) Data storage . We have used Fingerprint module to identify a true person by taking his/her finger input in the system. Here we have used 4*4 keypad for setting class date & time and also handling enrolment & attendance processes. RTC module is used for obtaining the current time & date for the fingerprint reader. It can record the exact time when a student attends the class.

In the enrollment stage, all the students have to register their fingers against their id numbers. So when the students want to enroll their fingers, they have to press key 'B' and then lcd asks for the ID where they want to store their fingers. With the help of key 'C' & 'D' they can select their IDs and then have to press '#' to proceed with selected ID. Then LCD shows some messages like place finger, remove finger, place same finger again. Maintaining all these steps, fingerprint of the student is captured and its unique features called minutiae points are extracted and is converted into a template and stored by the selected ID into the internal memory of fingerprint module i.e. fingerprint database.

After completing the enrollment process, the students are permitted to give their attendance. Now the students want to give attendance, they have to press key 'A'. Then LCD asks for placing finger on the fingerprint module. Then the fingerprint is captured again and the extracted features compared with the template in the database to determine a match before attendance is made. If the fingerprint is not matched lcd shows a message 'Finger not found' and if matched, the system will check if matching (student check in time) is made within the first 15 minutes of the class time. If so, the student will be considered as present otherwise it will be a late attendance for him/her. We have used key '*' for back operation.

Fig. 4.1 represents the flow of the attendance phase. Here, s is the student check-in time and t is the class starting time with additional 15 minutes.

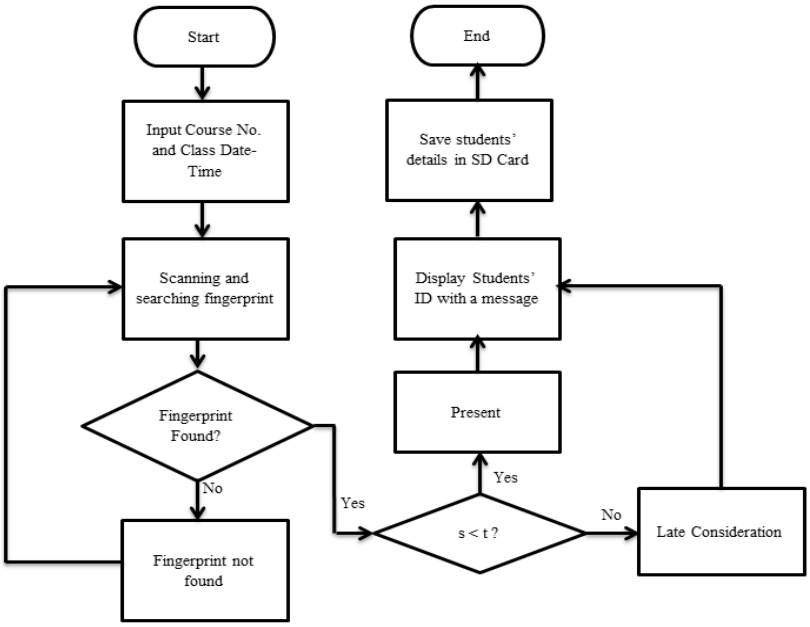


Figure 4.1: Flowchart of the system.

For data storage, we have used SD card module as interface between SD card and the micro-controller Arduino. It consists of an SD card which is the type of storage used to store the student's record. Attendance details will be saved in a file (.txt) of the SD card for further purpose. Then we have extracted the data from .txt file to an excel sheet. From the excel sheet, we have calculated the percentage of total attendance of every student.

5 Methodology

The architecture of the system integrates micro-controller, monitor, and communication interfaces with the Fingerprint module. This integration speeds up development while maintaining flexibility in design and simplifies testing. The block diagram of the system is shown in Fig. 5.3.

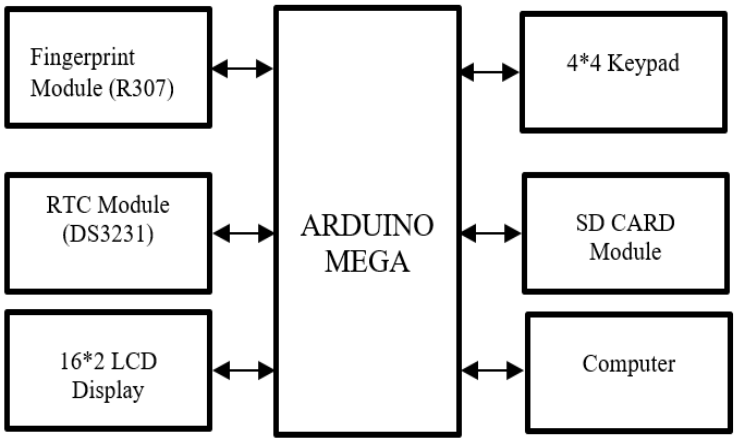


Figure 5.1: Block diagram of the system.

The proposed methodology works with several stages. These stages are discussed briefly.

5.1 Fingerprint Enrollment

The following stages are internally maintained in the fingerprint module while enrolling a finger – 1) Image Acquisition. 2) Image Enhancement. 3) Edge Detection. 4) Extraction of Miniature points.

5.1.1 Image Acquisition

Fingerprint image acquisition is considered to be the most critical step in an automated fingerprint authentication system, as it determines the final fingerprint image quality which has a drastic effect

in the overall system. Automated fingerprint verification systems use live scan digital images of fingerprints from a fingerprint sensor. These images are used in image enhancement stage.

5.1.2 Image Enhancement

In general, due to skin conditions(e.g. dry,wet,bruise etc), sensor noise, incorrect finger pressure and inherent low quality fingers, many fingerprints acquired are of low quality that lead to problems in minutiae extraction. Image Enhancement improves the clarity of ridge and valley structures in the fingerprint images. Histogram equalization method is used for image enhancement.

5.1.3 Edge Detection

The purpose of edge detection is to significantly reduce the amount of data found in a fingerprint image and leave only the most important information. Edge detection works by finding points on an image where the gray scale of value changes greatly between pixels. They are many operators used for detecting the edges. The operators are Prewitt, Laplacian, Sobels, Robertson operators. The prewitt operator is one of the best edge detecting operators and it detects two types of edge – horizontal edges & vertical edges. The edges have to be detected in order to match the input image with already saved image. Edges are calculated by using differences between corresponding pixels intensities of an image. All the masks (vertical & horizontal) that are used for edge detection are also known as derivative masks. For vertical mask, it calculates the difference of right and left pixel values around that edge. For horizontal mask, it calculates the difference of above and below pixel intensities of the particular edge. Thus increasing the sudden change of intensities and making the edge more visible.

5.1.4 Extraction of Miniature points

After detecting the edges, some points are extracted. These extracted points are known as ‘miniature points’. Most of the minutiae extraction techniques trace the fingerprint skeleton to find different types of minutiae points. After the extraction of edges, the points are marked in it.

5.2 Taking Attendance

In this stage, authentication process is maintained. It is the most repeated process and it is done each time a student wants to make use of fingerprint module. When he/she places his/her finger on fingerprint scanner surface, the fingerprint will be processed by the scanner. The fingerprint pattern that has been extracted would be compared against the stored enrollment template that is already stored in fingerprint database. When the fingerprint pattern passes the comparison process, it shows a message and allows student's access. In order to find the matching process the correlation factor and the Euclidean distance has to be found out. Based on the tolerance value the matching results can be found out. The following messages are shown in LCD display after giving attendance –

(a) Late Consideration.

(b) Within Time.

Figure 5.2: Display Messages While Attendance.

We have maintained following rules for marking attendance of a student -

- Student should scan his/her finger correctly on the fingerprint sensor module. If fingerprint is not putted correctly on reader, it could lead errors. There are two reasons for error - Failure to enroll rate (FTE) and Failure to capture (FTC) rate of biometric device. FTC rate depends on functionality of the system and FTE occur due to poor quality inputs.

- Students should mark their attendance within 15 minutes of start time of class. For example, if a class starts on 11.30am, attendance will be marked (present) before 11.45 am. After that time, they will be considered for late attendance. If attendance has already been marked, student is not able to mark another attendance in that lecture.

5.3 Data Storage

All the attendance details will be saved in a file (.txt file) in SD Card. Here SD Card module is used to interface between arduino and SD card. Then we have extracted the file into excel sheet and from the excel sheet, we have calculated the attendance percentage of each students in different courses and other so.

Course_No	Date	Time	ID	Status		Class Dates	Course No	Toal Classes	ID	3200	Percentage	ID	3201	Percentage	ID	3203	Percentage
3200	18.09.2019	08:53:45AM	1	Present		18.09.2019	3200	6	1	2	33.33333333	1	2	28.57142857	1	3	60
3200	18.09.2019	08:54:01AM	2	Present		20.09.2019	3201	7	2	6	100	2	4	57.14285714	2	3	60
3200	18.09.2019	08:54:20AM	3	Present		23.09.2019	3203	5	3	4	66.66666667	3	5	71.42857143	3	4	80
3200	18.09.2019	08:54:45AM	5	Present		24.09.2019			4	3	50	4	6	85.71428571	4	3	60
3200	18.09.2019	08:54:55AM	7	Present		25.09.2019			5	4	66.66666667	5	7	100	5	5	100
3200	18.09.2019	08:55:45AM	8	Present		05.10.2019			6	5	83.33333333	6	2	28.57142857	6	2	40
3200	18.09.2019	08:55:55AM	11	Present		20.10.2019			7	2	33.33333333	7	3	42.85714286	7	3	60
3200	18.09.2019	08:53:45AM	13	Present		23.10.2019			8	3	50	8	4	57.14285714	8	4	100
3200	18.09.2019	08:53:45AM	14	Present		24.10.2019			9	5	83.33333333	9	3	42.85714286	9	3	60
3200	18.09.2019	08:53:45AM	16	Present					10	6	100	10	2	28.57142857	10	4	80
3200	18.09.2019	08:53:45AM	18	Present					11	4	66.66666667	11	3	42.85714286	11	3	60
3200	18.09.2019	08:53:45AM	19	Present					12	3	50	12	4	57.14285714	12	3	60
3200	18.09.2019	08:53:45AM	22	Present					13	3	50	13	3	42.85714286	13	3	60
3200	18.09.2019	08:53:45AM	25	Present					14	4	66.66666667	14	4	57.14285714	14	5	100
3200	18.09.2019	09:07:45AM	27	Present					15	5	83.33333333	15	5	71.42857143	15	2	40
3200	18.09.2019	08:53:45AM	28	Present					16	2	33.33333333	16	3	42.85714286	16	4	80
3200	18.09.2019	08:53:45AM	29	Present					17	3	50	17	4	57.14285714	17	1	20
3200	18.09.2019	08:53:45AM	31	Present					18	4	66.66666667	18	3	42.85714286	18	5	100
3200	18.09.2019	08:53:45AM	32	Present					19	3	50	19	4	57.14285714	19	3	60
3200	18.09.2019	08:53:45AM	36	Present					20	4	66.66666667	20	3	42.85714286	20	2	40
3200	18.09.2019	08:53:45AM	37	Present					21	5	83.33333333	21	4	57.14285714	21	3	60
3200	18.09.2019	09:05:45AM	39	Present					22	2	33.33333333	22	3	42.85714286	22	4	80
3200	18.09.2019	08:53:45AM	40	Present					23	3	50	23	2	28.57142857	23	2	40
3200	18.09.2019	08:53:45AM	43	Present					24	4	66.66666667	24	3	42.85714286	24	3	60
3200	18.09.2019	08:53:45AM	46	Present					25	3	50	25	4	57.14285714	25	4	80
3200	18.09.2019	08:53:45AM	47	Present					26	4	66.66666667	26	6	85.71428571	26	2	40
3200	18.09.2019	08:53:45AM	49	Present					27	5	83.33333333	27	7	100	27	3	60
3200	18.09.2019	08:53:45AM	50	Present					28	3	50	28	4	57.14285714	28	4	80
3200	18.09.2019	08:53:45AM	51	Present					29	2	33.33333333	29	3	42.85714286	29	2	40
3200	18.09.2019	08:53:45AM	53	Present					30	3	50	30	2	28.57142857	30	3	60
3200	18.09.2019	08:53:45AM	54	Present					31	4	66.66666667	31	3	42.85714286	31	4	80
3200	18.09.2019	09:06:45AM	55	Present					32	5	83.33333333	32	2	28.57142857	32	3	60
3200	18.09.2019	08:53:45AM	56	Present					33	3	50	33	3	42.85714286	33	4	80
3200	18.09.2019	08:53:45AM	58	Present					34	2	33.33333333	34	4	57.14285714	34	3	60
3200	18.09.2019	08:53:45AM	60	Present					35	3	50	35	3	42.85714286	35	4	80
3200	18.09.2019	08:53:45AM	63	Present					36	4	66.66666667	36	4	57.14285714	36	3	60
3200	18.09.2019	09:10:45AM	64	Present					37	5	83.33333333	37	3	42.85714286	37	4	80

Figure 5.3: Student Attendance Excel Sheet.

6 Prototype Design

This system has been designed as follows. Since the sensor wires are so thin and short, we stripped the wire a bit and melted some solder on so it made better contact. We have used LCD display to show messages. LCD display has 16 pins. Vo pin is connected to the potentiometer. Enable pin(connected to arduino digital pin 12) of the display sends data to data pins when a high to low pulse is given; Extra voltage push is required to execute the instruction and enable signal is used for this purpose. When we send data to LCD it goes to the data register and is processed there. When RS=1, data register is selected. The data register stores the data to be displayed on the LCD. RTC module is used for obtaining the current time & date for the fingerprint reader. It can record the exact time when a student attends the class. It has 6 pins. 32k & SKW pins are not connected. SDA & SCL pins are connected to the arduino's SDA & SCL pins respectively. Fingerprint R307 module is interfaced with the arduino. The students can store fingerprint samples in the module and can be configured in 1:1 or 1:N mode for identification for the right user. It has 4 pins. Tx and Rx pins of the module are connected to arduino digital pins 10 & 11 respectively as shown in figure 6.1. This connection is used for serial communication only one individual pin is used for transmitter and receiver thus the parallel communication is not possible.

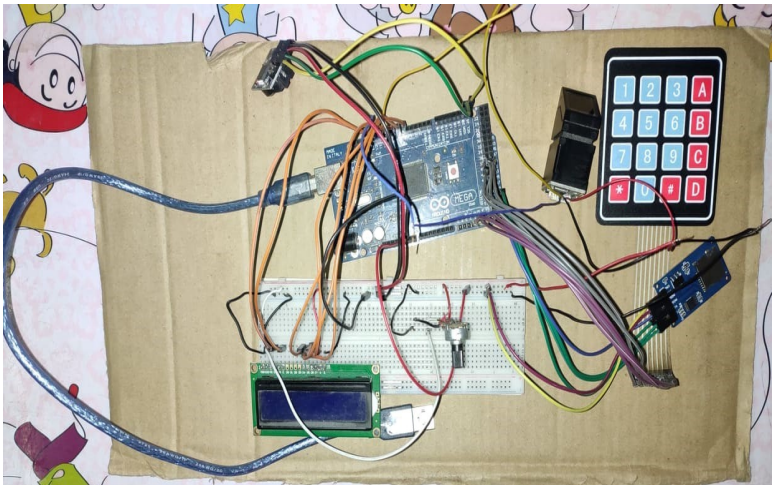


Figure 6.1: Circuit Design of the system.

4*4 keypad is also used to take class time & date and course no from the user. Enrollment and attendance process are also handled by the keypad. It has 4 row pins and 4 column pins. Row pins are connected to arduino digital pins 38, 39, 40, 41 respectively and column pins are connected to arduino analog pins A12,A13, A14, A15 respectively. SD card module is used to save the data. It has 6 pins. CS, SCK, MOSI, MISO pins are connected to arduino digital pins 53,52,51,50 respectively and another two are gnd and vcc pins. All the gnd and vcc pins of the equipments(like – fingerprint module, rtc module, SD card module, LCD display and potentiometer) are connected to arduino gnd and vcc pins respectively. When all the connections are done, the system has been tested.

7 Result Analysis

A class of 120 students has been tested for the proposed system. The system has been tested for 3 courses in 7 days. Some students were not properly identified due to the misplacement of their fingers. Other students have been properly identified, and their attendance has been updated. Some students were late, some were absent, and absent students did not affect the accuracy of the system. The accuracy of the system is shown in Fig. 7.1.

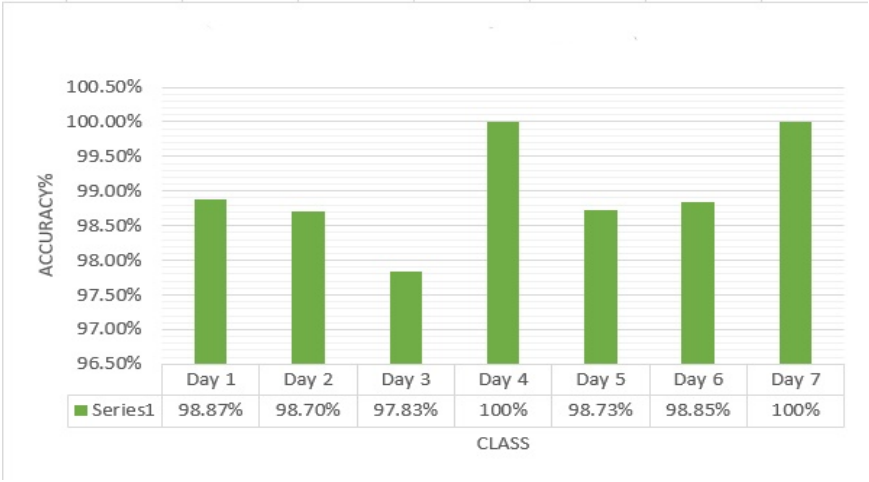
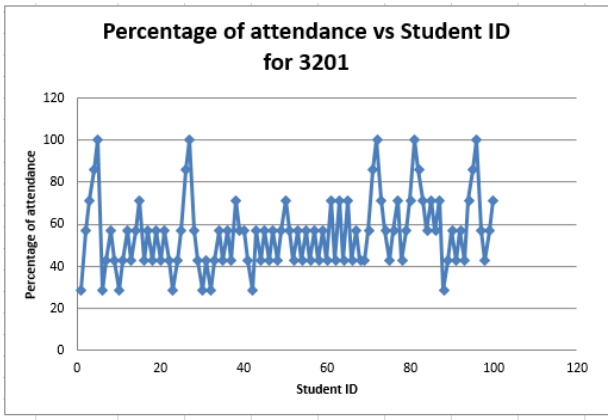


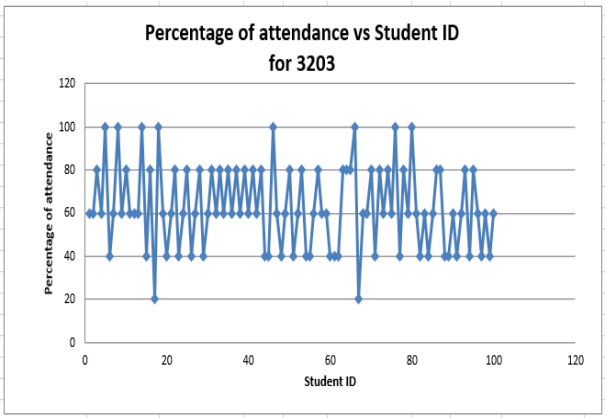
Figure 7.1: Accuracy of the system.

7 days of class and accuracy% are plotted on the x-axis and y-axis respectively. The graph shows how accurately the proposed system works in the test of 7 days. Accuracy is defined by the percentage of successful students who attempt to give their students. For example, on day 1, a total of 109 students tried to give their attendance, but 1 student failed to give the attendance due to misplacement of his fingerprint, and 108 were successfully identified and the remaining 11 students were absent. So the accuracy is 108/109 = 98.08%. Again on days 4 & 7, all the students who tried to give attendance were successfully identified. So the accuracy is 100% on these days.

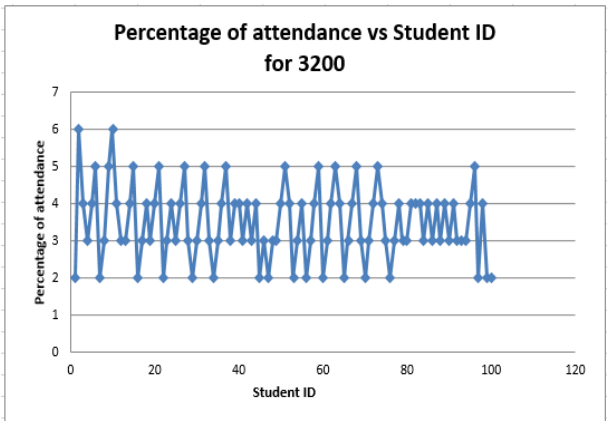
Some calculations were performed in an excel sheet such as we have calculated the percentage of attendance of each student in every course. Attendance percentage of every student in different courses are shown in figure 7.2.



(a) For 3201 course.



(b) For 3203 course.



(c) For 3200 course.

Figure 7.2: Attendance percentage of students in different courses.

A comparison between the proposed system and the manual system of attendance has been performed to see how the proposed system is closely accurate to the manual system. Here is a graph showing the comparison between these two systems in figure 7.3. Student ID and the corresponding percentage of attendance of that id for the proposed and manual system are plotted on the x-axis and y-axis respectively. Most of the days, the proposed system has worked as accurately as the manual system. Sometimes it has not worked 100% accurately because the system has failed to identify the fingers, the rejection rate is too small that we may ignore it. Overall the system saves a lot of time.

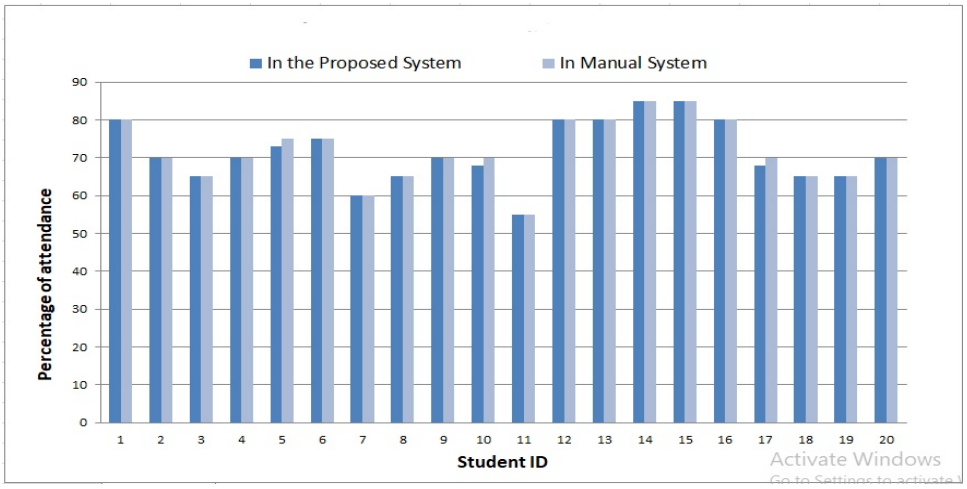


Figure 7.3: Comparison between proposed & manual system.

8 Discussion and Conclusion

An applicable attendance system has been designed for educational organizations in this project. If this project can be designed practically, it would help to reduce many issues such as denying the possibilities of cheating in recording the attendance, help to ease the lecturers to keep track of student's attendance, there will be no anonymous fingerprint which is able to tamper with the recorded data, and it saves time in taking attendance instead of up in front of the class. The contributions of this work include: 1) Taking around 0.5-1 sec to scan a finger during attendance. So taking around a total of 60-120 sec for 120 students is much less than a manual system. 2) Maintaining a rule for how to record attendance. 3) Scalability characteristic by holding the records for the increasing number of students.

The limitations of our proposed system are as follows – 1) This bio-metric device does not always read an individuals fingerprint accurately. If a student does not place his/her correct finger in the right spot, the fingerprint module may not read the student's identification properly. 2) In case of any physical changes in finger, our system fails to identify the student accurately. 3) Sometimes the system doesn't work properly because of loose connections.

In future, we will try to overcome all limitations and make some improvements in this project to make it more realistic such as the project can be extended to store the attendance details in database on the server and a website will be hosted on the server so that attendance details along with academic details will be visible to a student. The system may also be designed with IoT so that the authority can keep the parents informed about the student's performance via SMS alerts.

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