DESIGN AND CONSTRUCTION OF FINGERPRINT BIOMETRIC ATTENDANCE MACHINE

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Abstract

*Monitoring human attendance and punctuality are key factors in performance evaluation of any organization. This head count of people can be achieved using biometric driven modern technology to avoid tedious, misplacement/loss, dubious manipulation and error prone means present with orthodox techniques. This study aimed at design and construction of fingerprint biometric attendance machine for institutional application. Proteus 8.9 electronics application simulation software was used to design and simulate the system circuitry before hardware realization/construction through placement and soldering methods of components and subsystems. The brain of the system was centralized on Arduino UNO3 microcontroller board programmed through Arduino IDE to accept, process and store user's data during communication between the input component R305-fingerprint module and output components; the liquid crystal display LCD/serial monitor. Modified **C**-language was used as instructional language for programming the microcontroller which coordinates all input and output signals. The system was constructed and programmed to capture user's fingerprint image and assign it to student Matric Number, it registers, stores and verifies the ID for subsequent entry check with corresponding time of activities. The system was designed and constructed to work on direct current power supply, it can register and store 980 fingerprints. The system was calibrated and tested with a small sample of students and found efficient in terms of execution time and backup power. The system is durable, portable and has a rechargeable dc power supply. It is therefore recommended that it should be adopted in any organization where other means of attendance can be fraudulently manipulated to curb absenteeism, and other problems associated with orthodox means of attendance monitoring.*

Keywords: *Fingerprint module, Biometrics identification, IDE, **C**-language, Arduino UNO3, microcontroller.*

Introduction

Efficiency and performance of an organization can be measured to know the progress by monitoring some characteristics attitude to work such as punctuality of workers. The inflow and outflow of workers at recommended times for duties is an indication of discipline towards work, and most organizations have their active period from 8am to 4pm with extension in peculiar cases for production purpose (Raghuwanshi & Swami, 2017). One of the peculiar cases is the period of classes/lectures within higher institution of learning where student performance depends on punctuality. To instil discipline and have general better performance societies and management of various organizations have developed means of taking and monitoring attendance of people in any organization (Poornima et al., 2017). These measures trend back to stone age where orthodox means of performing this task includes the most commonly means of taking and recording attendance is the manual system, other attendance system includes: time sheet, register, mechanized system, time cards, biometric attendance, RFID based attendance system, GSM-GPRS, face recognition attendance system (Piss & Bhaskar, (2016); Noh et al., 2019). The manual method of taking attendance in many organizations results in time wasting, tedious/strenuous characteristics and human errors. Therefore, to proffer fast (less time consuming), negligible error and robust system, scientists and engineers look beyond the manual means but how to embed biometric characteristics as a means of monitoring attendance. In recognising the identity of an individual, personal identification is an important factor where this identification can be of two methods namely: Traditional method and Biometric method.

The traditional method is of two types which is the token-based and knowledge-based. The token-based method includes driving licence, passport, identity card and credit card. This document can be copied, stolen or lost. The knowledge-based methods are password or Personal Identification Number (PIN) that are used for confirmation of individual. The knowledge-based also has its own limitation, in terms of easily forgotten of PINs.

The term 'Biometrics' is the combination of two words, 'bio' means life and 'metrics' means measurements, therefore biometric is the measurement of the characteristics of an individual. The characteristics include, Fingerprint, Iris, Facial recognition, Voice (Mir et al., 2018). The technology is adopted to measure and statistically analyse people's biological information mainly for their identification, access control and surveillance. Biometric is a modern day technology but its concept was actually applied as far back as the fourteenth century. Chinese merchant uses fingerprinting during the fourteenth century to identify children (Ibidunmoye et al., 2013).

Biometric verification is gaining a lot of popularity among the public security system as well as in the commercial market. Biometric is applied in different areas such as digital attendance system at offices, security checkpoint at airports (Adeniji et al., 2016).

The traditional system is still mostly used in lecture room or laboratory session in most institution for taking attendance today. Lecturer or instructor will give out a sheet of paper containing list of students name to sign or in some cases, the student will be the ones to write their names, student ID and matriculation numbers to indicate their presence for a particular class which is time consuming (Noh et al., 2019). And also falsification in student attendance does occur rampantly in the traditional method. Therefore, there is need to ease and prevent the strenuous, inaccurate, impersonated and easily falsified means of traditional method of taking attendance by designing and constructing biometric fingerprint attendance machine.

Reliable biometric system such as fingerprint attendance machine can be adopted and deployed in institutional classrooms to monitor students' performances and efficiency of the institution (Basila & Danladi, 2021). The aim of this study is to design and construct fingerprint biometric attendance machine. This aim would be achieved through the following objectives: design of system circuitry and architecture framework, acquisition of system components/materials, construction and coupling of subsystems, and testing and calibration of the system.

Materials and Method

Materials

Biometric attendance machine is a system that has different sections/subsystems made up of many components such as electronic, electrical, computer/software and structural/mechanical. This section of the study highlights the materials used in realizing the system and the function of each within the system. Table (1) shows the materials description, quantity and functions in achieving the system.

Table 1: System Materials/Components Descriptions

Materials	Description	Functions	Quantity
Arduino Board/Microcontroller	Arduino UNO R3	This is the brain that accept inputs, processes it to give outputs.	1
Fingerprint sensor	R305/R307 finger print sensor module.	Captures finger print patterns as input.	1
RTC Module	DS3231 Real Time Clock Module.	For timing monitoring and documentation.	1
LCD Display	JHD162A 16x2 LED Display.	To display system outputs/status from microcontroller.	1
Potentiometer	10k	For adjusting LCD backlight	1
Push Buttons	Push-T0-ON Reset Tact Switch	To send input signal to the system.	5
Buzzer	5V Active Buzzer	As indication of activities within the system.	1
LED	5mm LED Red	As status indicator	1
Connecting Wire	Jumper Wires	For connection	20
Veroboard		Used as platform for soldering components.	1

5V Power supply Unit		Supplying suitable dc to the system and charging of system's battery.	1
Rechargeable cell	3.7 V lithium battery	Source of Emf	2

Methods

The methods adopted in this study starts with the design of system electronic circuitry using Proteus 8.9 electronics simulation application software. Figure 1, shows the system circuit design that comprises of inputs (power supply unit, finger print scanner,) section, processing unit (microcontroller), and output (LCD).

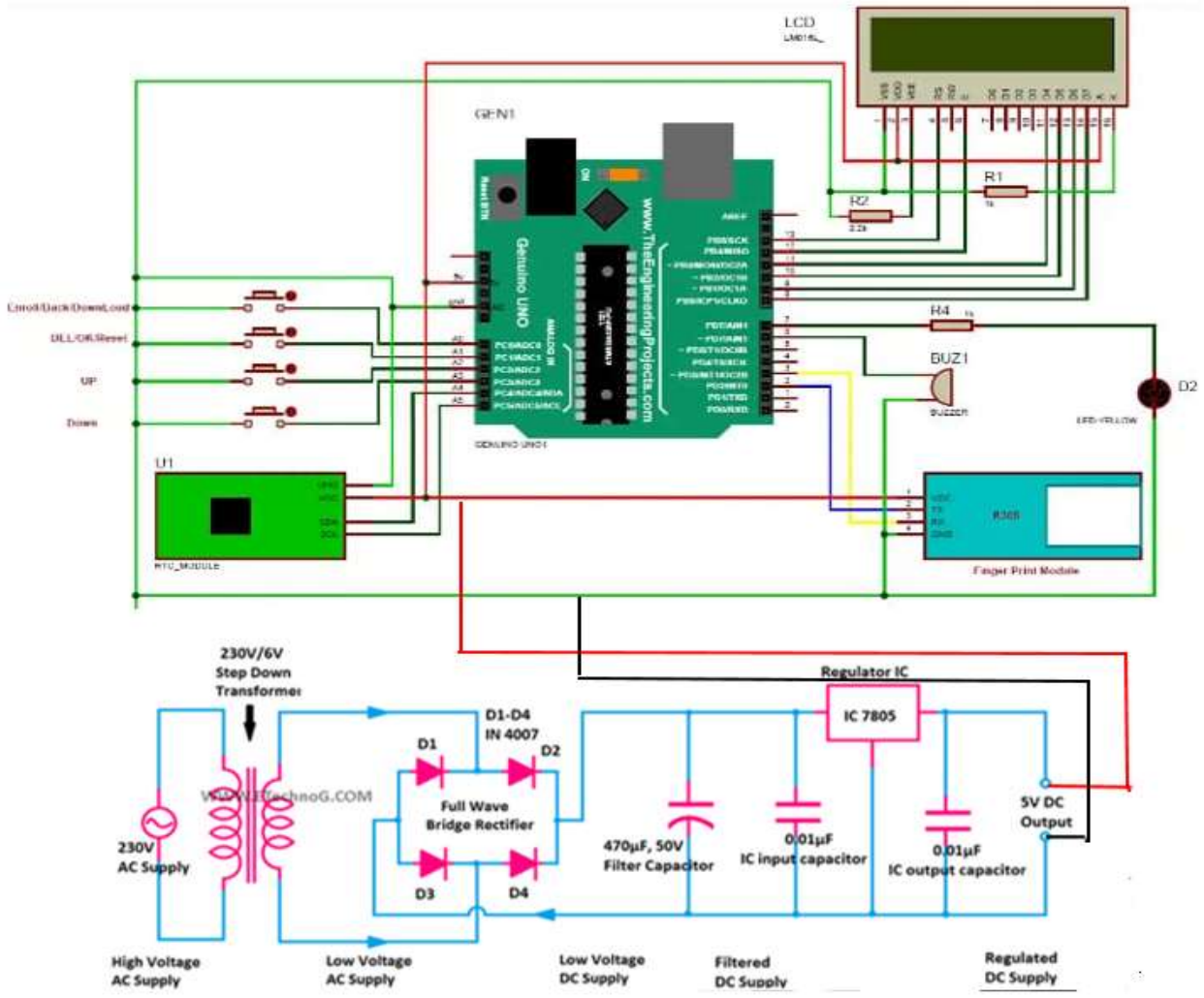

Fig. 1: System Circuitry Design Using Proteus 8.9

Complete fingerprint attendance machine comprises of various sub-systems that are constructed in this study through placing and soldering method of electronics components based on the circuit design shown earlier.

Construction of Attendance Machine Sub-systems: System Power supply

The power supply section was constructed to receive 220 V AC input signal through a step-down transformer which would be rectified using diodes in full-wave bridge format, the noisy d.c signal would be filtered and regulated to 5V d.c with the use of LM 7805 signal suitable to drive the system.

Construction of System Inputs Section

Connection of Fingerprint Module to the Arduino Board: Among the input components is an optical R305 fingerprint module driven by 5V, V_{CC} on the Arduino board, the fingerprint scanner receives input signal through RX (receiver) terminal that is connected to PIN 2 of the microcontroller on the Arduino board. The fingerprint module transmit signal through TX (transmitter), this terminal is connected to PIN 3 of the microcontroller, GND (ground) of the fingerprint module is connected GND (ground) on the Arduino board. This module captured user's fingerprint pattern as input while the microcontroller receives it for further processing and output delivery.

Connection of RTC Module to the Arduino Board: Real time clock module monitors the time of input of the fingerprint sensor. GND (ground) of the RTC module is connected to the GND (ground) on the Arduino board, V_{CC} of the RTC module is connected to 5V on the Arduino board, SDA of the RTC module is connected to PIN A4 on the Arduino board, SCL of the RTC module is connected to A5 on the Arduino board.

I/O Processor Unit

The microcontroller (ATMEGA 32P) on the Arduino UNO board requires a program (set of instructions) to be written on it to perform/process the desired operation that is required to execute. Source code was used to instruct the microcontroller to receive fingerprint pattern as input which is assigned to user's matriculation number, with RTC keeping record of the time of operation. The source code is then uploaded unto the chip before the Arduino can finally make use of it. The Arduino UNO3 microcontroller board is the brain behind the processing of the inputs received from fingerprint sensor to give outputs on the Liquid Crystal Display.

System Status Monitoring and Output Connection

The status and output characteristics of the fingerprint attendance machine is carried out by the microcontroller's processed information via liquid crystal display component. V_{DD}, and **A** terminals of the LCD are connected to 5V on the Arduino board, V_{SS}, V_o and K of the LCD are connected to GND (ground) on the Arduino board, RS of the LCD is connected to PIN 13 on the Arduino board, E of the LCD is connected PIN 12 on the Arduino board, D4, D5, D6, and D7 of the LCD is connected to PIN 11, PIN 10, PIN 9, and PIN 8 respectively on the Arduino board.

Connection of Push Button to the Arduino Board

Four push buttons are used in this study as input contact buttons to perform various operations of sending input to the microcontroller. The push buttons are soldered on a veroboard and connecting wires (positive and negative) is also connected to it.

The negative terminal of all the push buttons is connected to GND (ground) on the Arduino board. The positive terminal of the first push button is connected to PIN A0 on the Arduino board, the positive terminal of the second push button is connected to PIN A1 on the Arduino board, the positive terminal of the third push button is connected to PIN A2 on the Arduino board, the positive terminal of the last push button is connected to the PIN A3 on the Arduino board.

Results and Discussion

Power Supply

The power supply circuit was built with a step-down transformer, which steps the voltage from 220V to 9V AC. The AC voltage was rectified to DC using the bridge rectifier. The capacitors remove ripples by smoothening/filtering noise away and then regulated to +5V d.c by the IC LM7805. **Plate I** shows the constructed power supply unit for the automatic attendance system.

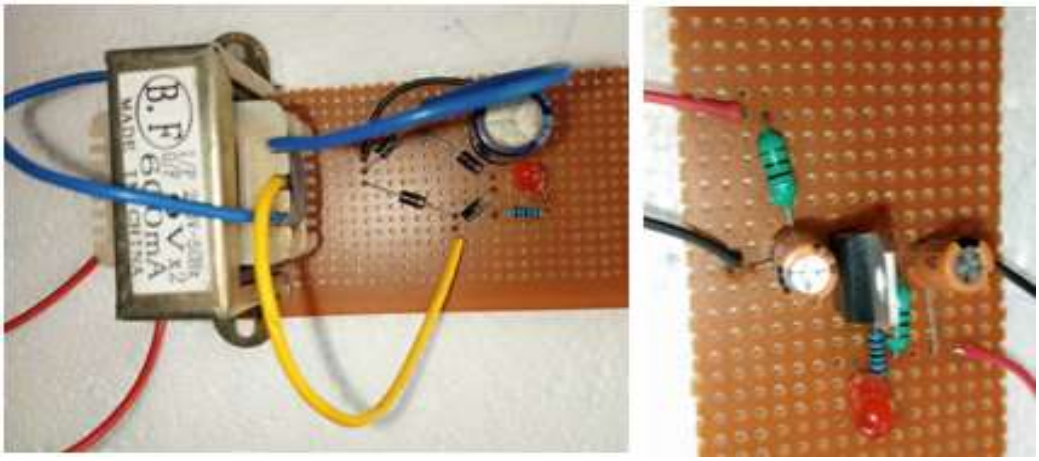

Plate I: Construction of power supply

The complete assemblage of the subsystems (power supply, input and output units) of fingerprint attendance machine is shown in **Plate II** before finally closing the casing.

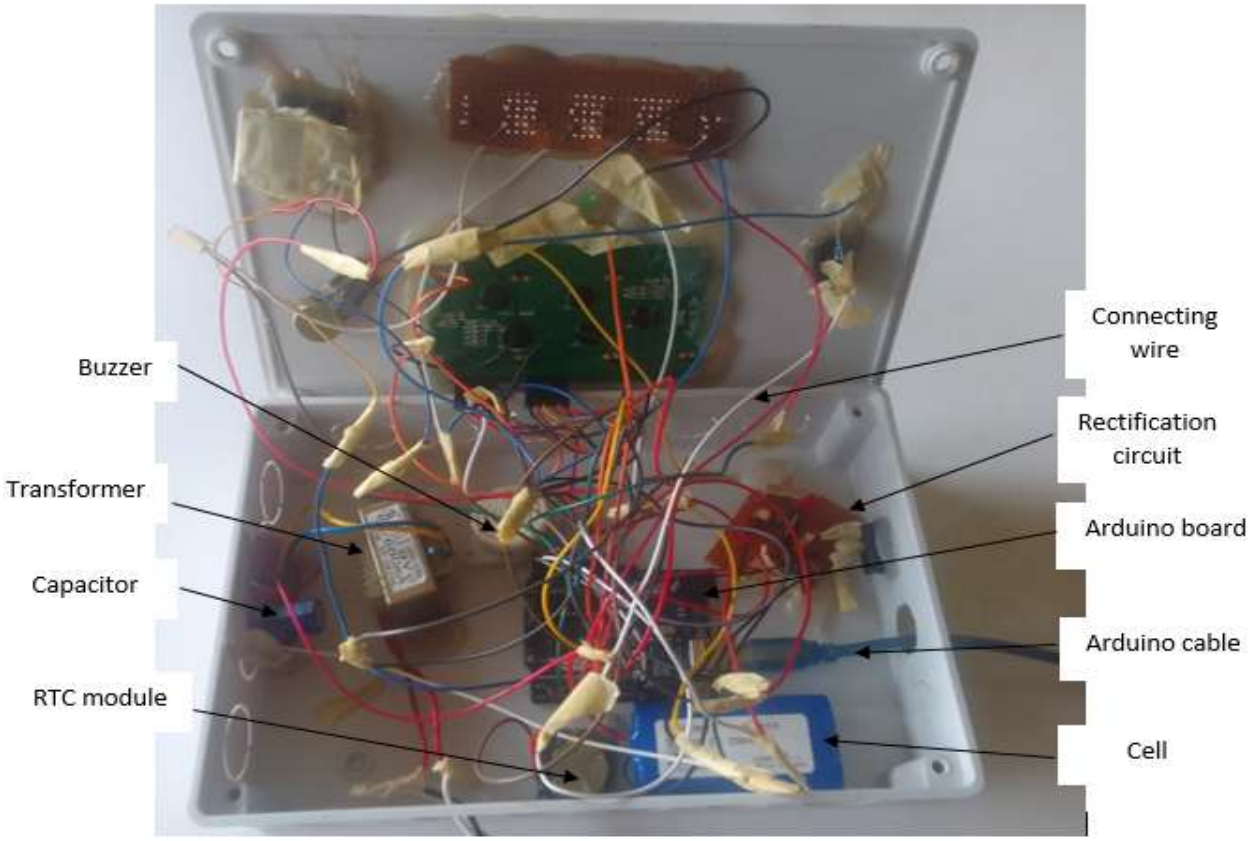

Plate II: Interior view of fingerprint attendance machine

The power supply unit output of 5V DC is fed into Arduino UNO board for system initiation and power.

Constructed Attendance System

The complete attendance system hardware connection of components and subsystems are shown in **Plate III** after construction following the design layout indicated earlier. There are 4 push buttons used to control the entire system. The functions of each button are:

1. Blue Button- Used for scrolling down and scrolling up of the information display on the LCD. It is also used for selection.

2. Yellow Button- used for scrolling up and scrolling down. It is also used for selection.

3. Green Button- Used to delete input data or to accept data with OKAY.

4. Green Button- This button is used to register/enroll user's captured fingerprint or to back to previous menu.

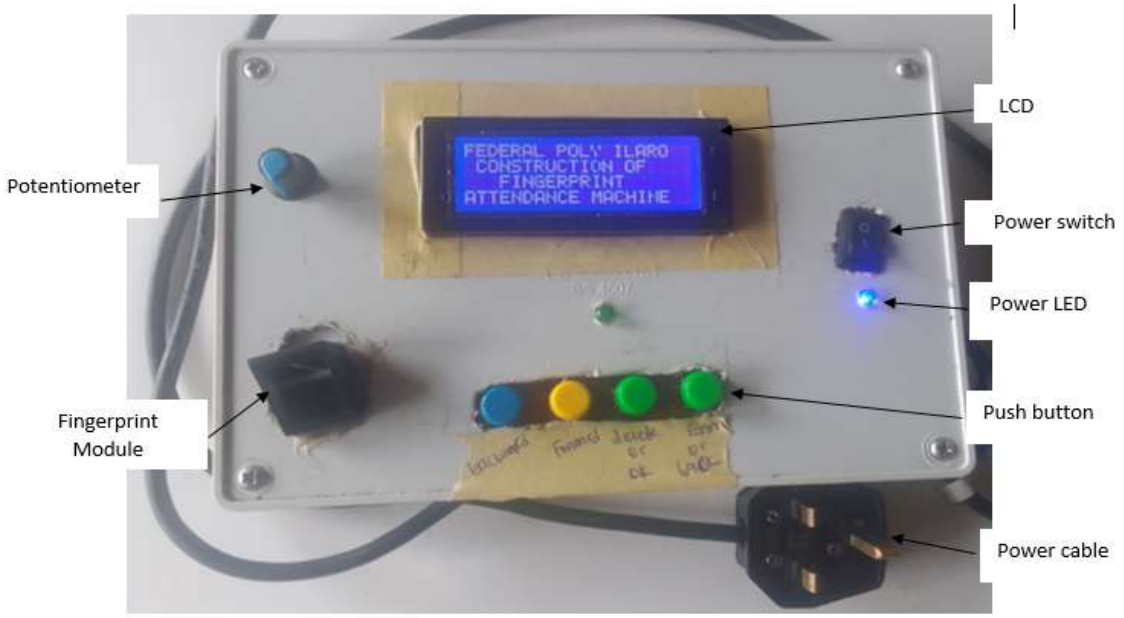

Plate III: Exterior View of the Completed System

The physical appearance of the fingerprint biometric attendance machine is composed of white plastic electrical box with length 23cm, breadth 15.5cm and height 5.5cm, that houses all the electrical component used. The component on the surface of the box are LCD, power switch, power LED, push buttons, power cable, potentiometer and fingerprint module.

The LCD output the operation that the system is performing, it displays the status of the finger placed on the fingerprint sensor.
Power switch is used to put the system in ON and OFF states.
Power LED indicates the ON and OFF status of the system.
Push button is used for selecting instructions shown on the LCD.
Power cable is for charging the system.
Potentiometer is used to increase and decrease the contrast of the LCD.
Fingerprint module is used to capture user's fingerprint.

Conclusion

Traditionally, student's attendance is taken using the manual method, which involves pen, and paper registers. The Biometric Attendance System using fingerprint was designed, simulated and implemented/constructed, and was able to address the attendance issues in Federal Polytechnic Ilaro, Ogun State. The developed attendance machine was found very helpful in saving valuable time of students and lecturers, paper and generating report at required time during the deployment. The system can record the clock in and clock out time of students and lecturers in a very convenient manner using their fingerprint to prevent impersonation and reduce level of absence. Also, it reduced most of the administrative jobs and minimizes human errors, avoids chance of "sign-for-me" attitude, eliminates time-related disputes and helps to update and maintain attendance records.

After design and construction, the fingerprint biometric attendance machine was deployed for use within limited sample class of project students. It is therefore recommended that this system should be utilized in situation where orthodox or manual methods fail. It should be adopted to curb the fraudulent manipulation of RFID method by students. The system can be deployed in a rural area where there is no access to electricity once when fully charged because of the rechargeable power backup.

References

Adeniji, V. O., Scott, M. S., & Phumzile, N. (2016). Development of an online biometric-enabled class attendance register system, in 2016 IST-Africa Week Conference, pp. 1–8, Durban, South Africa, May 2016.

Basila, A. & Danladi, H. A. (2021). Design, Simulate and Construct a Fingerprints Attendance System with Data Logging. *Nigerian Journal of Technology (NIJOTECH),* 40(4),703 -712 Print ISSN: 0331-8443.

German, R. L. & Barber, S. F. (2018). Current Biometric Adoption and Trends, 2018, https://identity.utexas.edu/assets/uploads/ publications/Current-Biometric-Adoptionand Trends.pdf.

Ibidunmoye, O. O., Akinduyite, E. O, Adetunmbi, C. O., & Olabode, A. O. (2013). Fingerprint-Based Attendance Management System, *Journal of Computer Sciences and Applications*, Vol. 1, No. 5, 100 105 Available online at http://pubs.sciepub.com/jcsa/1/5/4 © Science and Education Publishing DOI:10.12691/jcsa-1-5-4

Mir, G. M., Balkhi, A. A., Lala, N. A., Sofi**1**, N. A., Kirmani**, M. M.,** Itfaq, A. M., & Arif, H. A. (2018). The Benefits of Implementation of Biometric Attendance System, *Oriental Journal of Computer Science and Technology*, ISSN: 0974-6471, 11(1), 50-54.

Noh, N. H. M., Hassanuddin, N. A., Yusoff, S. Y., & Sukri, M. (2019). Continuous assessment as a mediating variable between class attendance and students' performance, *e-Academia Journal*, 7(18), 27–38.

Poornima, S., Sripriya, N., Vijayalakshmi, B. & Vishnupriya, P. (2017). Attendance monitoring system using facial recognition with audio output and gender classification, in 2017 International Conference on Computer, Communication and Signal Processing (ICCCSP), pp. 1–5, Chennai, India, January 2017.

Raghuwanshi, A. & Swami, P. D. (2017). An automated classroom attendance system using video based face recognition, in 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT), pp. 719–724, Bangalore, India, May 2017.

Piss, S. & Bhaskar, S. (2016). RFID and pose invariant face verification based automated classroom attendance system, in 2016 International Conference on Microelectronics, Computing and Communications (MicroCom), pp. 1–6, Durgapu