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# IOT based Face Recognition Smart Attendance System using ESP 32 cam

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**ABSTRACT:** The management of the attendance can be a great burden on the teachers if it is done manually. It is a demanding task in any organization. In traditional attendance system, the students are called out by the teachers and their presence or absence is marked accordingly. This is time consuming and tedious. To resolve this problem, smart and auto attendance management system is being utilized. But authentication is an important issue in this system. The smart attendance system is generally executed with the help of biometrics. Many organizations use finger print and card-based attendance systems. But considering the current COVID – 19 pandemic situations, using contact based biometric verification for attendance marking systems is unsafe and risk too. This is the right time to switch towards a face-based attendance system to avoid direct contact. As face recognition is one of the biometric methods, we won't come across authentication issues. So we developed a project on IoT based smart attendance system using Face recognition module. ESP32 cam is used to authenticate a person. First we need to enroll, all the information like student ID, name, class etc., after facing the ESP32 cam. When student come in front of ESP32 cam, it automatically detects, recognizes and stores the information in an IoT cloud. The staffs or any authorized person can assess these data's at any time. Here we are using HTTPS, to store the students' data's. If unauthorized persons in front of ESP32 cam, it will not take as a valid ID. Hence the problem of proxies can be easily resolved.

**KEYWORDS:** COVID-19 pandemic, fingerprint, IoT based smart attendance system, Face recognition, Esp32 cam

## I. INTRODUCTION

Face recognition is an important application of Image processing owing to its use in many fields. Identification of individuals in an organization for the purpose of attendance is one such application of face recognition. Maintenance and monitoring of attendance records plays a vital role in the analysis of performance of any organization. The purpose of developing attendance management system is to computerize the traditional way of taking attendance. Automated Attendance Management System performs the daily activities of attendance marking and analysis with reduced human intervention. The prevalent techniques and methodologies for detecting and recognizing face fail to overcome issues such as scaling, pose, illumination, variations, rotation, and occlusions.

The proposed system aims to overcome the pitfalls of the existing systems and provides features such as detection of faces, extraction of the features, detection of extracted features, and analysis of students' attendance. The system integrates techniques such as image contrasts, integral images, color features and cascading classifier for feature detection. The system provides an increased accuracy due to use of a large number of features of the face. The system is tested for various use cases. It considers a specific area such as classroom attendance for the purpose of testing the accuracy of the system. The metric considered is the percentage of the recognized faces per total number of tested faces of the same person. The system is tested under varying lighting conditions, various facial expressions, presence of partial faces (in densely populated classrooms) and presence or absence of beard and spectacles.

## II. LITERATURE SURVEY

Zhang and A.K. Jain (2004) [1] proposed the design and development of a portable classroom attendance system based on fingerprint biometric is presented. Among the salient aims of implementing a biometric feature into a portable attendance system is security and portability. The circuit of this device is strategically constructed to have an independent source of energy to be operated, as well as its miniature design which made it more efficient in term of its

portable capability. Rather than recording the attendance in writing or queuing in front of class equipped with fixed fingerprint or smart card reader. This paper introduces a portable fingerprint based biometric attendance system which addresses the weaknesses of the existing paper based attendance method or long time queuing. In addition, our biometric fingerprint based system is encrypted which preserves data integrity.

K.S. Huang and S.M. Tang (2008) [2] Proposed to conventional object tracking system can be designed using modules like GPS, GSM etc. Such system is vulnerable to various security problems. For this purpose it is necessary to implement security protocol across such system. This paper is describing design of basic object tracking system using collaborative security protocol using XOR-PRNG and Binary ECC. Thus implementation of such security term will enhance the overall operation of such system.

S.Lim, S.C. and M.M. Mansor (2009) [3] proposed the attendance system in most of the schools and colleges is documented manually. But, this process takes lots of time. The proposed system uses a wireless technology (RFID). Every student is provided with an RFID tag, which includes an inbuilt IC for storing and processing the information. The block diagram of this project includes a microcontroller, an oscillator circuit, preset circuit, LCD display and an RFID reader. In this RFID based Attendance System project, we will explain you how can we count attendance automatically by using RFID cards. RFID Technology (Radio Frequency Identification and Detection) is commonly used in schools, colleges, office and stations for various purposes to automatically keep a track of people. Here we will count the attendance of an authorized person by using RFID. By using RFID Tag and RFID Reader in system

X.L. Meng, Z.W. (2010) [4] Song suggested to rise in the number of applications based on Radio Frequency Identification (RFID) systems and have been successfully applied to different areas as diverse as transportation, health-care, agriculture, and hospitality industry to name a few. RFID technology facilitates automatic wireless identification using electronic passive and active tags with suitable readers. In this paper, an attempt is made to solve recurrent lecture attendance monitoring problem in developing countries using RFID technology. The application of RFID to student attendance monitoring as developed and deployed in this study is capable of eliminating time wasted during manual collection of attendance and an opportunity for the educational administrators to capture face-to-face classroom statistics for allocation of appropriate attendance scores and for further managerial decisions.

K. D. Mahajan et.al (2010) [5] proposed a system to maintain the attendance records, several government organizations and educational institutions in many countries still depend on the paper-based attendance approach. This approach has presented several disadvantages such as time-consuming and wastage of environmental resources. There is a necessity to change these traditional methods of attendance recording with more efficient ones. Thus, many works have been done in this direction. Moreover, this study aims to analyze the most recent studies on automated attendance systems regarding the timeline. The critical review has highlighted studies in the existing literature concerning technology, application domain, and main findings. Moreover, shed light on most numerous studies on any of three previous aspects.

Parvathy et.al (2011) [6] proposed a new system based on RFID. In the modern era, great developments have been done; which are based on Radio Frequency Identification Techniques. The applications are effectively applied to various diverse areas as transportation, agriculture, hospital / health care and other industries. RFID technique facilitates use automatic wireless identification through electronic passive and active tags with suitable readers. This paper illustrates a physical system which incorporates an application of RFID and wireless data base record entries. This system not only eliminates the time consumed in manual attendance but also maintains the record of entries which can be used for statistical purposes like allocation of appropriate attendance score and further administrative tasks.

E.Geoffrey et.al (2012) [7] proposed in the modern era, great developments have been done; which are based on Radio Frequency Identification Techniques. The applications are effectively applied to various diverse areas as transportation, agriculture, hospital / health care and other industries. RFID technique facilitates use automatic wireless identification through electronic passive and active tags with suitable readers. This paper illustrates a physical system which incorporates an application of RFID and wireless data base record entries. Our proposed system not only eliminates the time consumed in manual attendance but also maintains the record of entries which can be used for statistical purposes like allocation of appropriate attendance score and further administrative tasks.



P. Salunke et al (2013) [8] proposed the design and development of a portable classroom attendance system based on finger print biometric is presented. Among the salient aims of implementing a biometric feature into a portable attendance system is security and portability. The circuit of this device is strategically constructed to have an independent source of energy to be operated, as well as its miniature design which made it more efficient in term of its portable capability. Rather than recording the attendance in writing or queuing in front of class equipped with fixed fingerprint or smart card reader. This paper introduces a portable fingerprint based biometric attendance system which addresses the weaknesses of the existing paper based attendance method or long time queuing. In addition, our biometric fingerprint based system is encrypted which preserves data integrity.

Aniebiet et.al (2017) [9] proposed to maintain the attendance records, several government organizations and educational institutions in many countries still depend on the paper-based attendance approach. This approach has presented several disadvantages such as time-consuming and wastage of environmental resources. There is a necessity to change these traditional methods of attendance recording with more efficient ones. Thus, many works have been done in this direction. Moreover, this study aims to analyze the most recent studies on automated attendance systems regarding the timeline. Our critical review has highlighted studies in the existing literature concerning technology, application domain, and main findings. Moreover, shed light on most numerous studies on any of three previous aspects.

### III. PROPOSED METHOD

We aim to design a smart attendance system with the help of ESP 32 cam which will drive through Microcontroller and the corresponding information will be stored on the cloud. We eliminate the use of RFID and biometric methods to avoid physical contact with the device. In this project, we are using ESP 32 cam to authenticate a person. The data's of the each person will be stored in IoT cloud using GSM SIM800C Module. When student come in front of ESP32 cam, it automatically detects, recognizes and stores the information in an IoT cloud. Here we are using HTTPS, to store the students' data's. If unauthorized person come in front of ESP32 cam, it will not take as a valid ID and during that time a buzzer will alarm to indicate the invalid entry. Hence the problem of proxies can be easily resolved. The authorized person can access these datas anywhere from the world using network connection.

#### 3.1 Block diagram

The proposed system block diagram is shown in Fig. 1. The ESP 32 Camera is compatible with Arduino Microcontroller family which will detect the student face, and the digital information will be feed as the input to the controller. The already stored data in the SD card will be compared with the image captured. If the data matched, then the present status will be displayed in the LCD for the corresponding Student.

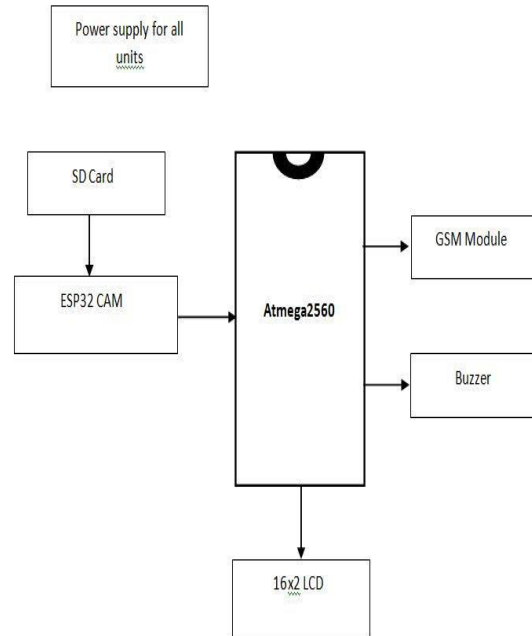


Fig. 1. Proposed Block Diagram

The unmatched student’s data base will be collected at the end of the day or after the given time and the absent information will be sent to their corresponding parents through GSM Module. If unknown person or un authorized person to the particular class come in front the ESP cam32, then the system compares the existing person’s details with the stored data. If there is no matching found, the system will ring a buzzer to alter the faculties or administrative executives about the presence of un authorized person.

### 3.2 Flow Chart

Fig. 2 represents the Flow chart of the proposed system. It gives the better understanding about out project. ESP 32 Camera will capture the student image and it will compare the data with already stored SD data. If the value is true, Present will be awarded to the student. Otherwise the absent value will be consolidated, and then the corresponding information will be sent as a SMS to the relevant student’s parent mobile number also the data will be stored on the cloud. If there is any change in other sensor status, buzzer sounds and the condition will be displayed in LCD. Student also gets to know about his present /absent status with the help of LCD Display. In addition with this process all the information will be stored in the web server automatically during this pandemic.

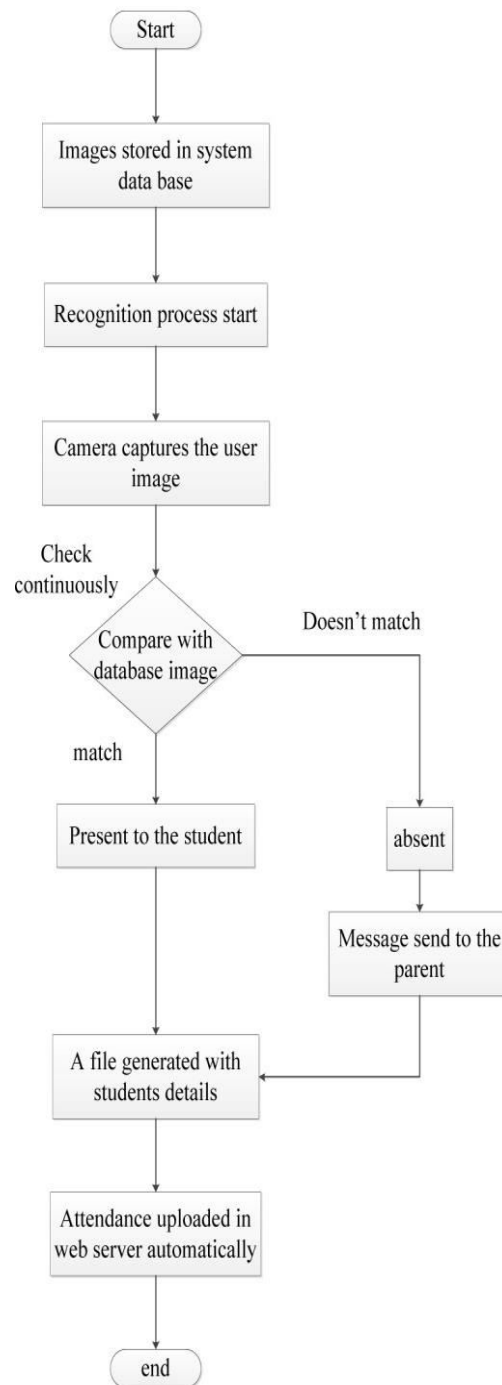


Fig. 2. Flow Chart

### 3.3 Components Used

The Atmel MCU ATMEGA16U2 MEGA 2560 R3 Improved Version CH340G Board is a micro-controller board based on the ATmega2560 which is shown in Fig. 3. It has a USB host interface to connect with Android based phones, based on the MAX3421e IC. It has 54 digital input/output pins (of which 15 can be used as PWM outputs); 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator; a USB connection, a power jack, an ICSP header, and a reset button. The MEGA ADK is based on the Mega 2560. Similar to the Mega 2560 and Uno, it features



an ATmega8U2 program as a USB-to-serial converter. Revision 3 of the Mega ADK board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU(Device Firmware Upgrade) mode.



Fig. 3 ARDUINO MEGA 2560



Fig. 4 ESP32 Camera Module

Fig. 4 shows the ESP32 CAM Wi-Fi Module Bluetooth with OV2640 Camera Module 2MP For Face Recognition has a very competitive small-size camera module that can operate independently as a minimum system with a footprint of only 40 x 27 mm; a deep sleep current of up to 6mA and is widely used in various IoT applications. ESP32S Wi-Fi Bluetooth combo module is an ultra-performance that is high ultralow-power consumption Wi-Fi and Bluetooth wireless platform based on ESPRESSIF ESP32 chipset. ESP-32S dual-core 448 Kbyte ROM | 520 Kbyte SRAM | 16 Kbyte SRAM in RTC | 802.11 b/g/n/e/I Wi-Fi | Bluetooth v4.2 BR | EDR & BLE | clocks & Times | peripheral Interfaces and security mechanism.

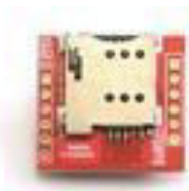


Fig. 5 GSM SIM800L

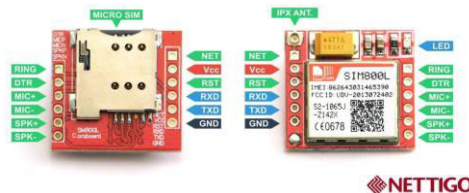


Fig. 6 Two Antennas

GSM SIM800L is a GSM module is shown in Fig. 5. This is Small SIM800L GPRS GSM Module Micro SIM Card Core Board Quad-band TTL Serial Port with the antenna; in this module two antennas have been included. SIM800L GSM/GPRS module is a miniature GSM modem, which can be integrated into a great number of IoT projects. You can use this module to accomplish almost anything a normal cell phone can; SMS text messages, make or receive phone calls, connecting to the internet through GPRS, TCP/IP, and more! To top it off, the module supports quad-band GSM/GPRS network, meaning it works pretty much anywhere in the world. First is made of wire (which solders directly to NET pin on PCB) – very useful in narrow places. Second – PCB antenna – with double-sided tape and attached pigtail cable with IPX connector. This one has better performance and allows putting your module inside a metal case – as long the antenna is outside.

SIM800L is a miniature cellular module which allows for GPRS transmission, sending and receiving SMS and making and receiving voice calls. Low cost and small footprint and quad band frequency support make this module perfect solution for any project that require long range connectivity. After connecting power module boots up, searches for cellular network and login automatically. On board LED displays connection state (no network coverage - fast blinking, logged in - slow blinking). This module has two antennas included which is shown in Fig. 6. First is made of wire (which solders directly to NET pin on PCB) - very useful in narrow places. Second - PCB antenna - with double side

tape and attached pigtail cable with IPX connector. This one has better performance and allows putting your module inside a metal case - as long the antenna is outside.

A liquid crystal display (LCD) is shown in Fig. 7, is an electronically-modulated optical device shaped into a thin, flat panel made up of any number of color or monochrome pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power. LCD has material, which continues the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.



Fig. 7 Liquid Crystal Display



Fig. 8 DS3231 Real Time Clock



Fig. 9 Buzzer

DS3231 RTC is a Precise Real-Time Clock Module with 32Kbit EEPROM and a built-in 10-bit temperature sensor having a resolution of 0.25C. The DS3231 RTC module Precise Real-Time Clock Module is a low-cost, extremely accurate PC real-time clock (RTC) with an integrated temperature compensated crystal oscillator (TCXO) and crystal. The device incorporates a battery input and maintains accurate timekeeping when the main power to the device is interrupted. The integration of the crystal resonator enhances the long-term accuracy of the device as well as reduces the piece-part count in a manufacturing line. The ds3231 Arduino is available in commercial and industrial temperature ranges and is offered in a 16-pin, 300-mil SO package. The buzzer is shown in Fig. 9. This is a Small PCB Mountable 12V Active Electromagnetic Buzzer. It is great to add Audio Alert to your electronic designs. It operates on 12V supply, uses a coil element to generate an audible tone.

### 3.4 Working Principle

The camera starts recording/capturing the images of the student crowd. After face detection and extraction of facial features, the system consults the database to check if the captured faces correspond to the ones in the database. If no, then the entities are not enlisted in the attendance and the system keeps checking for others. If the patterns match with the ones in the database with adequate confidence value, the subject is marked Present. The digital attendance record (Web application) is updated accordingly, with allowances made for exceptional additions by staff members. The ESP32 Camera Module (which is connected to the Arduino mega2560 micro controller) takes numerous images of each subject with varied facial expressions and stores this in the database. These images are then feature- extracted and an YML file is created which contains the numerical/vectored values of the features unique to each subject.

During normal attendance taking, the class shall preferably be illuminated with an artificial light source, so that external illumination conditions such as varying ambient lighting conditions have less effect on the accuracy of the recognition process. When the faces are detected, the background is completely neglected and a square box is enclosed over the face, and only the image portion within it is stored for comparison with the database. If the dimensions of the captured images are greater than those of the database images, proper dimension reduction is done for seamless comparison. The images in the database are then fed into a training algorithm, which generates the YML file containing the numerical vectored values of extracted features.

The recognition algorithm used in this project is Local Binary Patterns Histogram algorithm (LBPH). This algorithm is simpler to be implemented within the processing capabilities of the Raspberry Pi. This algorithm analyzes each image in the database independently and the images are qualified locally. Inbuilt functions in the Open-CV (Computer Vision)



.library can be used to implement the LBPH algorithm for face recognition. The image is divided into many square regions, and each square region is converted into LBPH matrix, which is a binary matrix created as a result of the LBPH operator. This matrix has in it binary values that forms the histogram representation of the image. This histogram is then compared to the histograms of face images in the database, and the confidence value determines the output of the recognizer. Based on the obtained result of the recognizer, a spreadsheet is created which contains tabulated attendance in real time. The faces were recognized at confidence percentages of 41%, 41%, 46% and 56% to the database images. However, distance from the camera module and face illumination pose a problem at the next stage when a whole classroom is considered. This can be countered by using a high-resolution, wide-angle camera. Another issue is the slowing down of the recognition when more subjects are added to the database, as the algorithms have to consider more feature evaluations and processing, thus overburdening the available RAM.

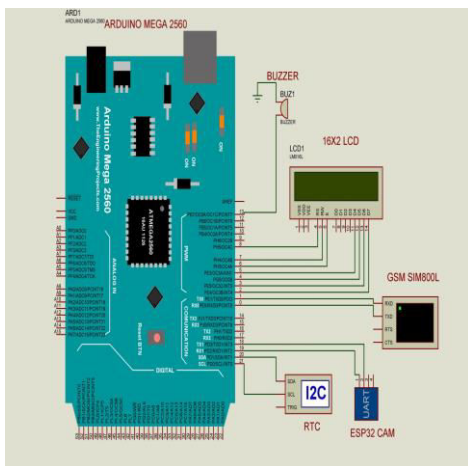


Fig. 10 Experimental Setup

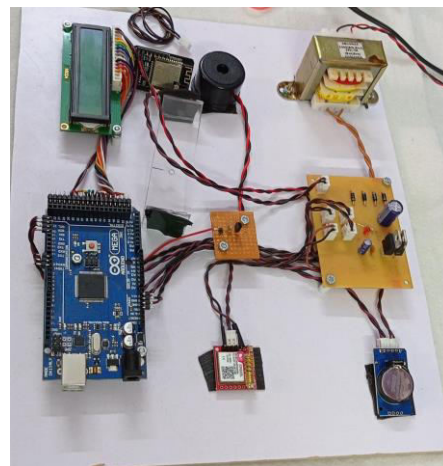


Fig. 11 Over view of the Proposed System

#### IV. RESULTS AND DISCUSSION

Fig. 11 shows the overview of smart attendance system using face recognition. It has Arduino Mega 2560, LCD, GSM Module, transistor, RTC timer, Arduino Power Supply and transformer. This is can be used in real time applications for attendance marking in any organizations.

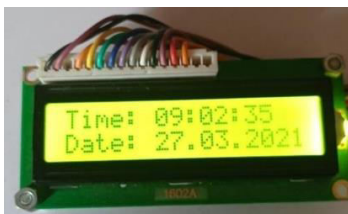


Fig. 12 Initial Status of the display

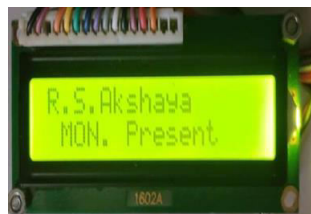
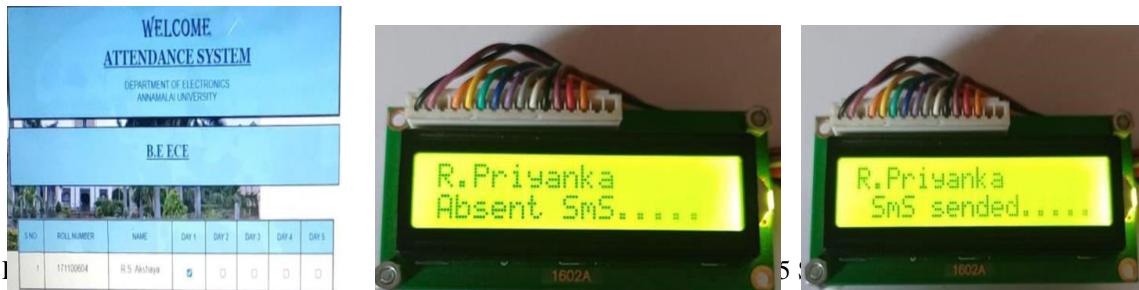


Fig. 13 Sample results for student present status



Before a person or a student comes in front of the ESP cam 32; it shows the current date and time in the LCD display as shown in the above figure 12. When a student comes near or in front of the camera module, it first detects the student's face and it immediately compares the detected face with the already stored data and finally it recognizes the person and it displays the name of the person in the LCD display. Along with the name that day and Present will be displayed in the LCD. This gives confirmation to the student or whoever stands in front of the camera module. The examples are shown in the above figure13. The data which is displayed in the LCD display is also stored in the Cloud for later use. Authorized persons can see the saved data at any time. This is shown in figure14.



When any of the student or someone is absent, after the given time or at the end of the day, the person or the student is marked absent in the Cloud and the same information is sent to the respective parents as SMS which is an emergency alert which is clearly explained in the figure 15 and 16.



Fig. 16 SMS Sent to the parent

## V. CONCLUSIONS

This project will help any institute or any organization to manage their attendance system very effectively. Since this system uses the biometrics as face recognition, it gives good authentication and also a best alternative for a contact based attendance system. This is highly needed and important in this COVID 19 pandemic situation. By utilizing this framework, the problem of proxies and students being marked present even though they are not physically present can easily be solved. There by reducing the risk of cheating on the part of the students and facilitate the administrative work on the part of the lecturers.

## VI. FUTURE SCOPES

The project that we have chosen is not limited only to this application but also extended to of greater use if it is remodeled using more complex equipment more sensors can be employed to make the complex system robust. A Handy and portable hardware device with door accessing method can be used anywhere with less effort. And given an keypad and can ask for the password whenever the card is scanned and can add the separate windows for every student and it can allow them to see that window. It can also extended as an security device in banking sectors or in a gated community.

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