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RFID and Face Recognition Verified Temperature Monitoring Contactless Attendance System

Chaudhari Sanket Kishor [1], Chaudhari Pooja Suresh [2],
Baviskar Krushnna Hemraj[3], Patil Dipali Bhikan[4], Prof. Mayuri Kulkarni[5]
[1](Computer Engineering, Shri. Vile Parle Kelavani Mandal's Institute of Technology, Dhule, India)
[2](Computer Engineering, Shri. Vile Parle Kelavani Mandal's Institute of Technology, Dhule, India)
[3](Computer Engineering, Shri. Vile Parle Kelavani Mandal's Institute of Technology, Dhule, India)
[4](Computer Engineering, Shri. Vile Parle Kelavani Mandal's Institute of Technology, Dhule, India)
[5](Computer Engineering, Shri. Vile Parle Kelavani Mandal's Institute of Technology, Dhule, India)

Abstract:
Background*: The institutions and organization generally use fingerprint recognition and signature-based attendance system to mark the attendance. The fingerprint recognition system is secure and reliable but in both the process user has to get in contact with the surface of the attendance system, which can cause the spread of viruses and bacteria among the people, for example, diseases like COVID-19, influenza and the common cold can spread through getting in contact with a contaminated surface. So, in the pandemic of COVID-19 and other future infections, the uses of such systems are not feasible. For that, this paper presents the model which is secure, reliable and contactless. The model is consist of a serially connected face recognition and Radio Frequency Identification (RFID) module for marking the attendance, an Infrared thermal sensor for scanning body temperature and FAR Ultraviolet-C light container for self-sanitization of the complete module.*
Methods*: We have proposed the IOT based smart attendance system, which is secure, reliable and contactless. Our system is mainly integrated with four modules, first is to determine a person's risk for spreading the infection, for that system is consist of sensors that can detect the symptoms of infection, like in COVID-19 we used to scan the temperature of the user. The second module is of attendance process, we are using the RFID and Face recognition technology which makes the system contactless and the process of verification of the ID's (ID of RFID card and ID of an individual face) makes the system more secure. The third module is to maintain the whole system sanitized for that we are using a robotic arm consist of 100 nm to 240 nm ultraviolet-c light which can kill 99.99% bacteria on the surface of the system and last module is the website from which we can do the operations like user registration, updating, downloading the attendance etc. As a whole system, it will work like a smart attendance system, first, we have to register a face and RFID card of the user assigned the same ID for both, after that user can mark attendance while marking the attendance system will check the body temperature of the user after that it will recognize the face and RFID card, after verification of both the ID's system will mark the attendance. UV light arm will sanitize the system in a particular interval of time.*
Results*: The system is contactless and can be operated through the integrated website after face recognition ID is generating and the system is verifying that ID with RFID.*
Conclusion: *We have developed a contactless attendance system by integrating Face Recognition System with the RFID module which is fast, secure and by some minor changes we can use it as a solution to the other problems*
Key Word*: Facial Recognition, RFID, IR Thermal Sensor, FAR Ultraviolet-C.*

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I. Introduction

The behaviour of workers in a company is judged on the basis of their job performance, particular assessment role which is tracked by their daily attendance. Members will be kept responsible for observing their proper work schedule in order to ensure adequate service, good workplace ethics, and to achieve expected productivity and functional expectations within the organization. If the person is unable to satisfy these conditions and duties, he/she shall refer them to his / her supervisor.

In assessing the performance of the students within the class, the same scenario can be observed. The student must follow the percentage and schedule of attendance required to assist educators in evaluating each student's failure and strength in the class.

For such organizations, a secured, reliable and fast attendance system is required. The current tradition of tracking the attendance is fingerprint recognition but there are some challenges to this technology such as

FAR and FRR, the value of FRR of face recognition is 0.019 which can reduce the accuracy to some extent. Another main challenge to this system is that the number of people used to touch the surface of the attendance system can make the surface contaminated, different types of viruses and bacteria can sustain on that surface for a long time and transfer to the others easily.

To overcome these challenges, we have developed our model based on RFID technology which is a contactless process and has better accuracy than face recognition as it has only 0.005 FRR value, to make the model more secure we have integrated face recognition based verification so that there is no chance of false attendance. As our system is contactless there is no chance of spreading the virus through a contact although we have attached a FAR-UVC light container for automatic sanitization of the system. In most of the viral infections, fever is a common symptom so to reduce the community spread of the virus we have to integrate an IR thermal sensor which and detect the higher body temperature.

II. Related Work

In most of Institution, organization and hospitals the attendance tracking system is the manual signing on the attendance sheet or fingerprint recognition based attendance. Manual signing on the sheet can be prone to bogus attendance as it is not secure, reliable and it takes a lot of manual efforts to keep the data of the attendance Comparatively biometric attendance system such as fingerprint recognition is secure and reliable which makes it most popular in the market with the market share of around 50% [10], although it offers easy and reliable process the system has some challenges like false acceptance (FAR) i.e. a person that was not registered previously was falsely enrolled for attendance, false rejections (FRR) i.e. system failed to identify some registered users. These challenges can happen due to improper placement of finger, dirty finger or some injury to the finger, which can reduce the accuracy of the system up to 2.56% [11].

One hidden factor of these attendance systems is they are not contactless process so that user will get in contact with the surface of the systems, which can lead to spreading viruses among the community. Contagious diseases such as COVID-19, Influenza and Common Cold can transmit through physical contact with the surfaces touched by the infected person [13]. As per research, the basic reproductive rate (R0) of COVID-19 in India is approximately 2.09 [12]. So, in such cases, it is necessary to have a contactless, secure and reliable attendance system.

Most of the institutions are using RFID based attendance system as it is contactless, cost-effective, fast and has a long lifespan [14]. This system has some reliability issues like RFID scanner can only identify the ID of the particular tag but it cannot recognize the person who is marking the attendance, in such scenario people can mark bogus attendance of others by using RFID card of a particular friend and other people [2].

Table no 1: False Rejections (FRR) value

Types of attendance system	FRR value
Fingerprint Recognition	0.019
RFID	0.005

To overcome the reliability issues of the RFID we can integrate voice password with attendance system however it is easily sharable with others, so it is not the perfect solution to the problem [2]. Face recognition is the technology that we can integrate into the RFID attendance system as a validation process, it makes the process more secure as we provide the same ID to both systems.

We are considering our system for institution and organizations; hence the system must have better performance as well as less costing. For that we are using RFID-RC522, NODE MCU ESP-8266 [15] and Intel CPU module. Intel CPU is integrated with a quad-core 2GHz 64-bit CPU along with 4GB RAM and GUP which can easily handle all computations during the facial recognition process [16].

IR Thermal sensor-based thermometer can scan body temperature as accurate as a digital thermometer without any contact with our body. By which we can detect symptoms like fever and prevent that person to get in contact with other people [17].

Table no 2: Features of RFID Tags

Feature-s	Types of RFID Tag		
	Passive Tag	***Active Tag***	***Semi-passive Tag***
Operational range	Low Frequency- 10cm High Frequency- 1 m Ultra-High Frequency-12m	Low Frequency- 10cm High Frequency- 1 m Ultra-High Frequency- 12m	Low Frequency- 10cm High Frequency- 1 m Ultra-High Frequency- 12m
Battery	No	Yes	Yes
Cost of system	Cheap	Very Expensive	Expensive

Feature-s	Types of RFID Tag		
	Passive Tag	***Active Tag***	***Semi-passive Tag***
lifespan	20 years	5-10 years	10 years

Table no 3: The execution time of different attendance System

Types of attendance system	Average Execution Time (seconds)
Fingerprint Recognition	4.29
Manual Entry	18.48
RFID	0.2
Bar Code	2

Based on recent research we get to know that 207-222nm FAR-UVC light can efficiently kill the COVID-19 viruses without harm to exposed human tissues, the result says that 90% of virus inactivation can be happened in only 8 minutes of FAR-UVC light bombarding and 99.99% of virus inactivation in just 25 minutes [18].

To ensure more safety from FAR-UVC light we can build a container having multiple inner layers of 550 microns and above, as per research 550 microns of aluminium foil can reflect 75% of UVC light. Due to this maximum light get to concentrate on our system which can save power and use less electricity [19].

III. Proposed Model

Registration Process:

For registration of users, the system will have an integrated website from which registration of individual face and RFID card can be done. Our system has an HD camera module attached to the laptop which can capture high-quality pictures of the face. We are using NODE MCU ESP-8266 with an inbuilt wi-fi module as well as our system has an RFID-RC522 module for registering the users by using their unique RFID tags, after successful registration the ID and personal information of the user can be reflected to the database and website using wi-fi communication.

In the face recognition and registration process initially, our system must have the ability to detect the faces in the images and video frame, OpenCV is an open-source machine learning library that helps in the detection of objects in the frame moreover Haar cascade classifier is an adaptive machine learning-based approach in which cascade function is trained by some positive and negative images, in our case we are providing images of the faces and after training of the classifier it can extract the features from the new image of the face and detects the particular faces in the video frame.

There are several algorithms and function for face recognition, LBPH (Local Binary Patterns Histograms) is one of them with an accuracy of around 98.5% [16]. Local Binary Pattern (LBP) is a basic but very effective texture operator that marks an image's pixels by thresholding each pixel's neighbourhood and considers the outcome as a binary number and Local Binary Pattern (LBP) can be used together with histograms so that we can represent the face images in the form of the simple data vector. Mainly there are 4 parameters used by the LBPH algorithm they are as follow:

- Radius: the local circular binary prototype can be created by using radius as a parameter and it represents the radius around the central pixels, generally it is set to 1.
- Neighbors: the number of sampling points to create the local binary pattern of the circular. Bear in mind: the more you have sampling points, the greater the cost of computation. Typically it is set at 8.
- Grid X: In the horizontal direction, the number of cells. The further cells, the better the grid, the larger the vector of the resulting function dimensionality. Typically it is set at 8.
- Grid Y: the vertical direction of the number of cells. The further cells, the better the grid, the larger the vector of the resulting function dimensionality. Typically it is set at 8.

The first computational step of the LBPH algorithm is to create an intermediate image that better describes the original image, then the intermediate image is used for extracting the histogram for that image is divided into multiple grids using Grid X and Grid Y parameter and then histogram can be generated from each grid.

To perform a face recognition of a new input image, the LBPH algorithm uses the input image histogram to represent the image from the training database as the algorithm is trained with the face images and their particular labels which are the same as the IDs we obtained from the registration of individual RFID tag, we can compare two histograms to find the matching image as the input image and return the image which has the closest histogram. there are various ways to compare histograms such as Euclidean distance and absolute value. In this scenario, we can generate the ID of the user from the face recognition process.

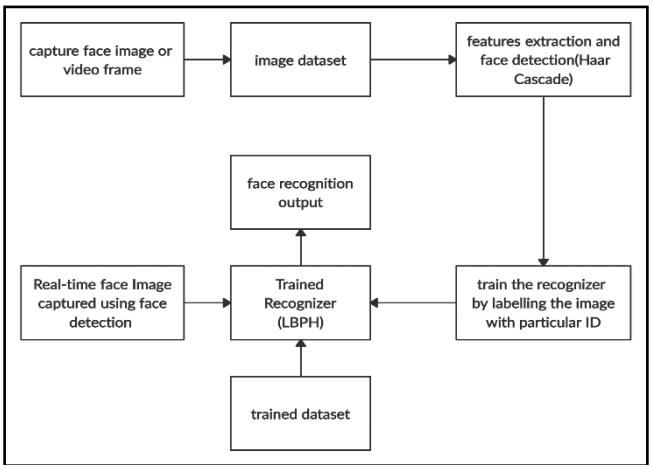

Figure 1: Block diagram of the face recognition process

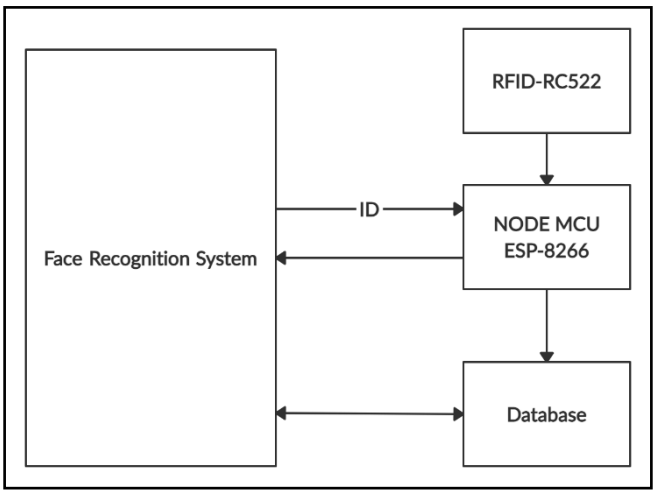

Figure 2: Serial Communication between Face recognition system and ESP-8266

Verification Process:

The system will work on the concept of Verification of two ID's, Face recognition and RFID respectively [1]. When the user will try to mark attendance, the individual face will be Recognize by the system, ID that is assigned to the face will be transferred to the ESP 8266(Node-MCU) by the serial communication where the ID will be verified with the ID of RFID card which is scanned by the user via RFID-RC522 during the face recognition process, if both the ID's are matched then verification will be done, otherwise, attendance will not mark by the system.

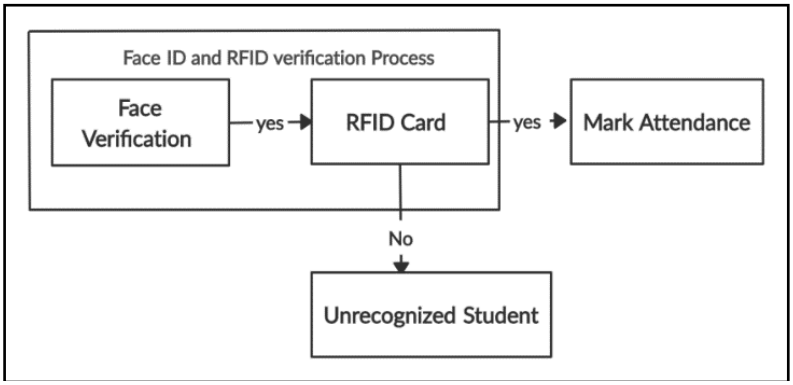

Figure 3: Block Diagram of the Verification Process

Temperature Screening:

Our system will be integrated with an Infrared Red thermal scanning sensor, which will automatically measure the body temperature of the user during the attendance process and if body temperature is above normal temperature then the buzzer will initialize.

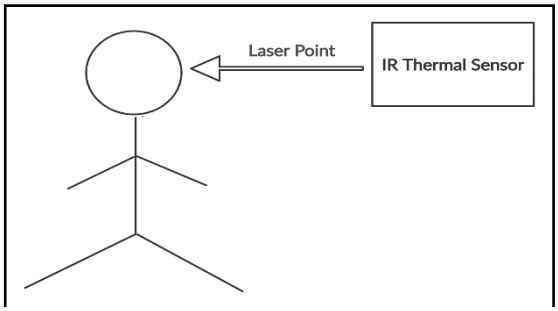

Figure 4: Temperature Screening

Sanitization Process:

After a Fix interval of time, the UV light arm will come over the system and bombard 222nm FAR-Ultraviolet-C rays, which can kill 99.99% of germs on the system. UV light will fix under a box-like structure coated with aluminium foil so that UV rays cannot leak. Movement of Robot like arm will be control through DC motors having gears, we are using DC motors with gears to ensure correct movement of the arm, Gears have the mechanism to lock motion of DC motors while they are in steady state.

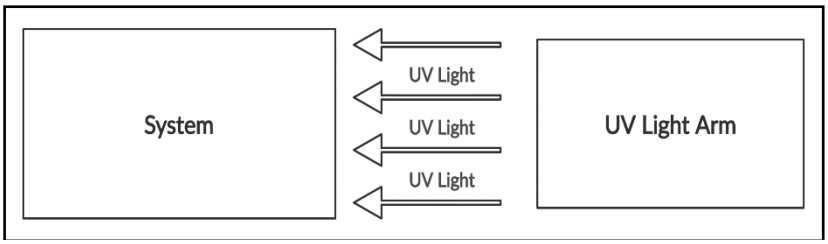

Figure 5: Sanitization by using UV light

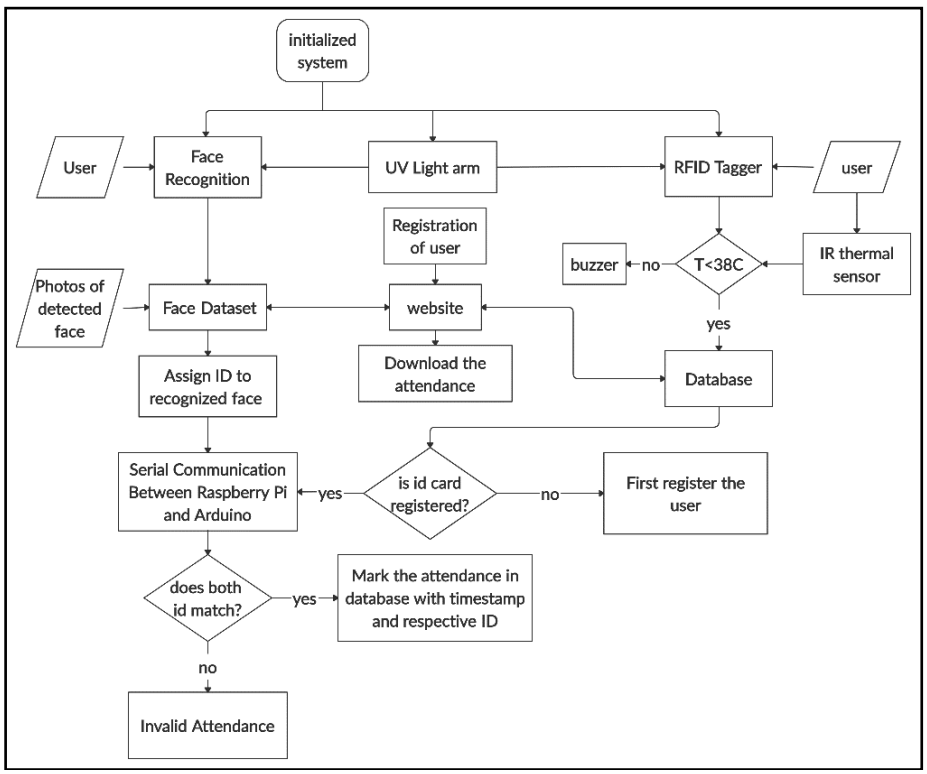

Figure 6: Block Diagram of the system.

IV. Description of the Proposed Model

The development of the proposed Attendance System included four modules Face Recognition, RFID, Temperature Monitoring and Sanitization. All the modules are connected to the same server IP address, a person with normal body temperature and having proper authority can mark the attendance. ID generated by the system is stored in the database as proof of attendance. There are the same ID's assigned to the Face Recognition and RFID module so that double verification can be done.

Circuit description:

The connections and circuits we have used in our hardware part is shown in Fig. 7. We have designed our circuits by using the fritzing software.

In the above figure, we can see that the MLX90614 infrared temperature sensor, LED display, Servo motor and the Buzzer is connected to the ESP 8266 (NodeMCU). When the user body gets in contact with the MLX90614 infrared temperature sensor it measures the temperature of the body, temperature sensor and LED display works on 3V so we have attached the sensor and display to the 3V PIN of NodeMCU while the servo motor works on 5V, for that we have provided the 5v power supply to NodeMCU and we have got same 5v output through the VU PIN, hence we have attached out servo motor to the VU PIN of the NodeMCU.

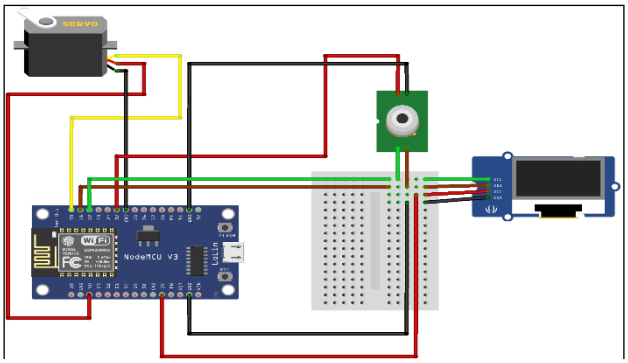

Figure 7: Temperature and Sanitization module circuit diagram

In Fig. 8. We have attached the RFID RC522 for scanning the RFID card it is also working on 3V. There is a serial communication between NodeMCU and the Face recognition system by which both the module communicate with each other.

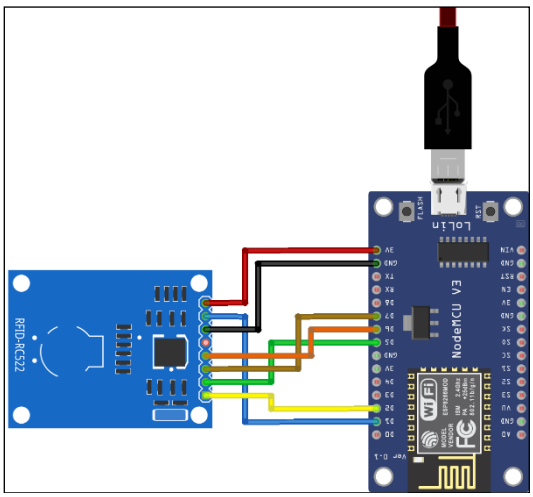

Figure 8: RFID module circuit diagram.

Hardware implementation of the project:

Our RFID and Face Recognition Verified Contactless Attendance System project has 4 modules, fig. 9 and 10 describe the implementations of the hardware.

Figure 9: RFID and Temperature module.

Fig. 9 is showing the RFID and Temperature module connected to the NodeMCU and NodeMCU is connected to the laptop, Object temperature and Ambient temperature is continuously measured by the MLX90614 sensor and displayed on the LED display. These readings are transferred to the Blynk cloud connected to the NodeMCU and can be displayed on the Blynk app. RFID-RC522 scanner is for scanning the RFID cards and transferred the ID to the database after verification.

In fig. 10, we can see that one arm is connected to the servo motor which rotates up to 180° according to the instruction given from the website by the admin. This arm fitted with the FAR-UVC light which can kill the germs on the surface of the attendance module.

Figure 10: Sanitization module.

V. Results

The first task is to detect the face and store the data of faces in the dataset for that we are using the frontal face haar cascade classifier as shown in fig. 11.

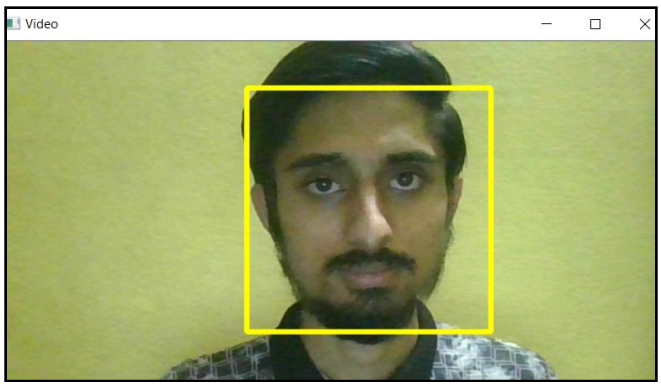

Figure 11: Face Detection.

After the face detection, we are capturing 100 images per user for training and testing the dataset, so that system can recognize the face of the particular user. We have labelled the dataset folder with an ID similar to the RFID card so that while face recognition system can generate a specific ID instead of any name or number, so that system can recognize the face of the particular user.

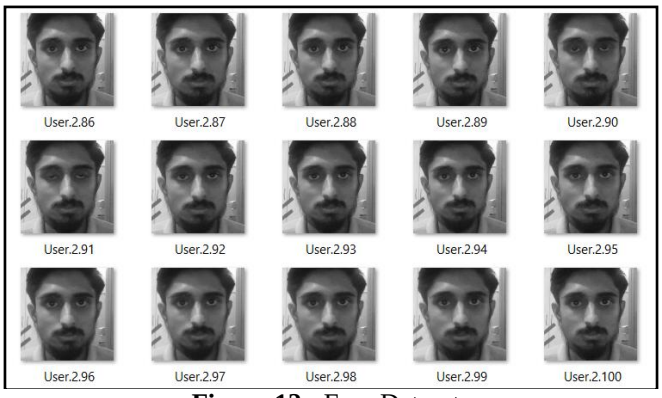

Figure 12: Face Dataset.

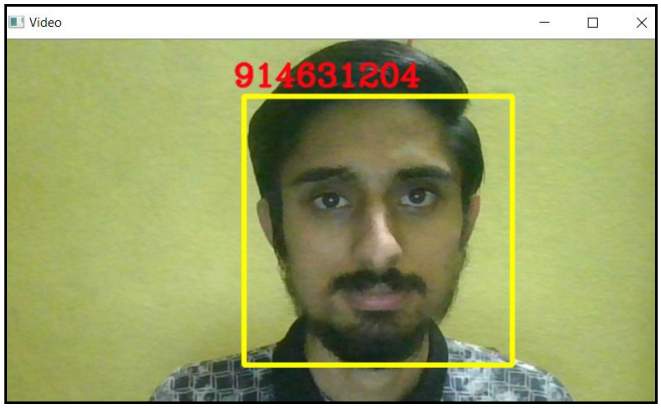

Figure 13: Face Recognition.

In fig. 13 face is recognizing by the system and a particular ID is generated, which will transfer to the NodeMCU via serial communication between the face recognition system and the RFID module connected to the NodeMCU. In parallel to face recognition, if the user scans the RFID card on the RFID module, generated ID will be verified with the ID of face recognition and if the ID's are matched then attendance will be marked otherwise system will generate a warning sound and attendance will be invalid.

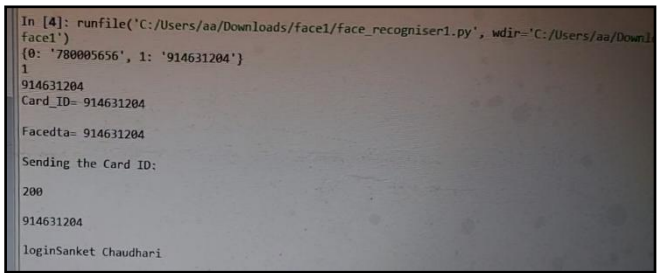

Figure 14: Valid attendance (ID matched).

In fig. 14 we can see that the face ID and the RFID card ID are matched and the attendance is stored in the database. On the other hand in fig. 15 ID did not match, hence the attendance is invalid and the system will generate the warning sound.

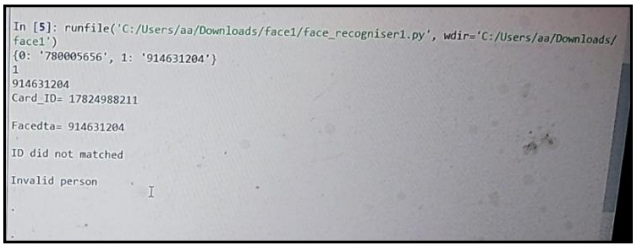

Figure 15: Invalid attendance (ID did not match).

We have also integrated the website into our system so that the admin can easily handle all the modules and also store the data and proof of attendance in one place as shown in fig. 15. Admin can download the attendance in the form of an Excel sheet, manage the user, add user, delete the user and can also change the state of the RFID device whether it is on attendance mode or registration mode.

Figure 16: Website.

The sanitization arm is operated through the website by using a slider range from 0º to 180º, so that arm can also rotate in the same range.

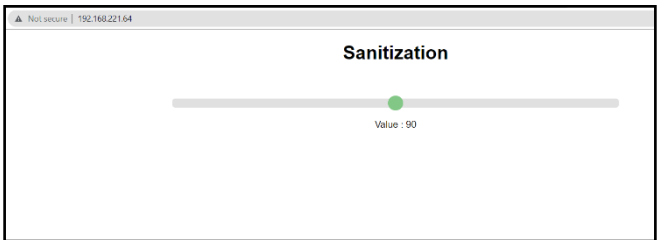

Figure 17: Sanitization arm control.

The fig. 18 we can see that the Blynk app is connected to the NodeMCU, all the temperature readings from the MLX90614 sensor are transferred to the app via wi-fi connection.

. **Figure 18:** Blynk cloud app.

VI. Conclusion

We have developed a contactless attendance system by integrating Face Recognition System with the RFID module which is fast, secure and by some minor changes we can use it as a solution to the other problems like in ATM for user authentication so that only authentic user can use the particular ATM card. PIN-less transaction of the credit card can also be secured by our system.

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