Attendance Management System using Facial Recognition and Cloud based IoT Technology

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***Abstract*—Automation is a necessity in the current times as it makes processes more economical and affordable in the long run. It also frees humans from performing banal tasks day in and day out. Once a process is automated the only check that is to be performed is whether it is turned on or not. Automated processes are not prone to errors and even if an error is identified rectification is easy and can be applied system wide without any delay.**

Taking attendance is a mundane but necessary task in many academic institutions. In this paper, an alternate and more efficient method of taking attendance is proposed that uses facial recognition and cloud based IoT technology to automate the entire system

Keywords— ***Attendance System, Facial Recognition, Microsoft Face API, IOT, Raspberry Pi***

I. Introduction

A ttendance is an important metric in judging a student's commitment to his/her coursework and sincerity in many educational institutions and professional environments. Currently in majority of educational institutions in India this process is carried out by the teacher, who manually calls all the students by name, verifies his/her presence and marks the attendance. This is a very labor-intensive process and is prone to errors (proxy attendance and incorrect marking). It also wastes a lot of time at the beginning of the class which could otherwise have been used productively. The solution to this problem must be a complete system, as it has to be implemented throughout the academic or professional institution for the solution to be even considered. IoT provides a perfect platform for a solution of this archetype. With the current rate of growth in the field and the ever-increasing demand for automation, the cost of sensors and other essential resources required to implement such systems has drastically reduced. With all this in mind, we decided to implement a feasible and efficient IoT based solution for the problem at hand.

II. Literature Survey

Detailed below are some of the methods currently in use to automate the process of attendance, and their drawbacks.

RFID based attendance system [1][2][4][7][8][11] has been proposed to reduce the manual effort. The RFID is programmed to contain a key that identifies a particular student. When the RFID card is flashed to the RFID reader in the classroom, it records the time and stores it in a cloud based storage service. In case of absence the student/parent will be informed with an SMS/email. This system however can be exploited by a single person carrying the IDs of multiple people.

M Newlin Raajumar et al [3] have proposed a GPS based attendance system accompanied with a smartphone application that verifies the location of the device thereby eliminating the need to stand in queues in front of the attendance system. The staff in-charge activates the attendance process in her/his end of the application and all students must register their presence at the GPS location of the class on the app. This process is very complicated and is limited by the availability of GPS in the area.

Bluetooth based attendance system has been proposed by RiyaLodha et al [5], Bluetooth tag is programmed with student ID, it works with Android application through Bluetooth communication. Mobile Application reads the tag based on location and time and sends the data to the database. The mobile application in the professor phone will ping the student's Bluetooth connectivity and fetch the presence Vishal Bhalla [10].

D Nithya [12] has proposed an attendance system based on facial recognition using the PCA algorithm for feature extraction. This algorithm uses the Eigen faces approach due to its simplicity, speed and learning capabilities. The difference between values of training and testing images is then calculated using Euclidian distance and features are classified.

Samuel Lukas et al [14], Mrunmayee Shirodkar [13] have proposed a facial recognition attendance system using distributed wavelet transform in combination with discrete

cosine transform. for feature extraction and a trained radial basis functional network for recognition. It is able to recognize multiple faces in a single image and has the capability to mark attendance for multiple students using a single picture of the classroom.

Automated Attendance system has been implemented using different technologies available. Many systems have been proposed using RFID technology. This system is easy to implement but prone to fraudulent usages. System which is based on biometric details like fingerprint and iris, takes more time to give their attendance. So, the time-consuming process of traditional attendance system has not been eliminated by this system. There is system implemented using Bluetooth technology, the disadvantage of this system is configuring Bluetooth network (piconet). Each piconet can have maximum of 7 slave devices and one master.

The automated attendance system implemented with face recognition using image processing with combination of IoT technology will overcome the disadvantages of other proposed technologies [15]

III. METHODOLOGY

We had a clear objective of making the attendance system effortless. IoT systems and technology have seen great improvement lately and they are perfectly suited for our purpose. In order to achieve this, we chose to deploy separate IoT devices in every classroom. The IoT device chosen here was a Raspberry pi board with camera. Each device is programmed such that it is connected to a trained data set present on Azure Cloud. Each data set stores about 5 pictures of each student in the classroom. For a class of strength 50, the cloud stores 300 pictures. Similarly, for an approximately 100 sections it would store 30000 pictures for a single college. The entire image processing is done with these 300 pictures separately run using the devices. The consolidated data of the student attendance will be used for various purpose.

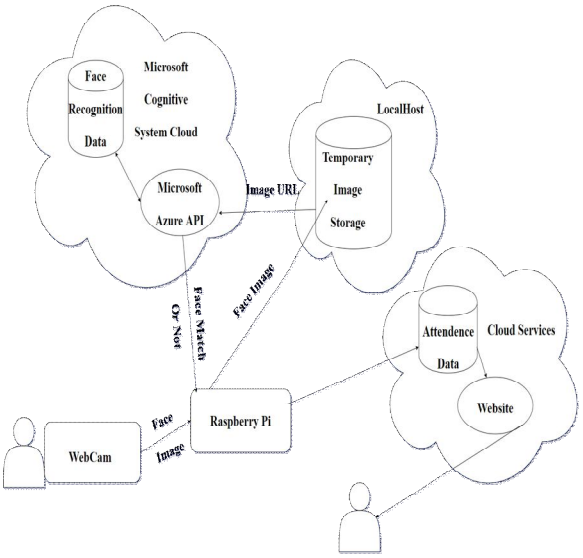

Figure 1: System Architecture of IoT device

In this system, we have done automatic attendance system using face recognition and cloud based IoT technology to train 50 students faces with Microsoft Cognitive services for face recognition and verification. Figure 1 explains pictorially how the face training process works. There are four major states in the training process. We used the Microsoft face API [16] for face detection and recognition. Once a face is trained a unique ID for the face and a group ID is generated. After training, the picture of the student is taken using a Raspberry PI Camera module. The Raspberry PI also hosts a NGROK Cloud that contains the mapping of the student name/ID to the unique ID generated during training. If a face is recognized then attendance records of the student are updated appropriately.

The proposed system will consist of multiple cameras each acting as a unique monitoring node each with its own unique ID. Data is processed on the cloud and is stored there, hence accessible from clout for the mobile and web application. The IoT device also has a temporary local storage which keeps the pictures of the attendees. Thus, the system belongs to IoT level 4[16] as depicted in Figure 2. Following are the different phases of the implementation.

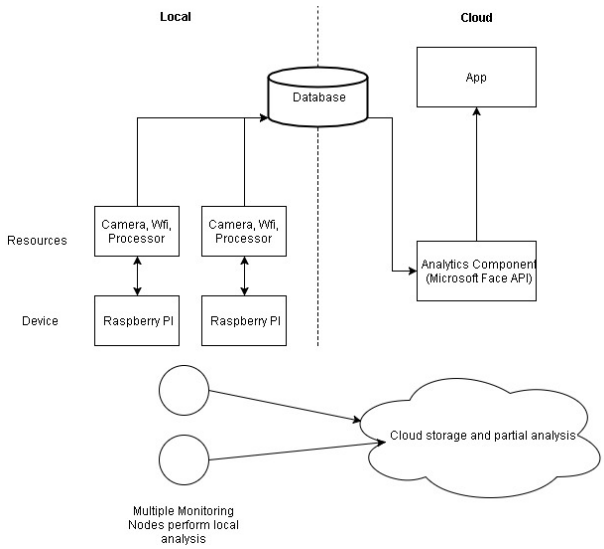

Figure 2: IoT Level Diagram (Level 4)

A. *Face Training*

Creating Group ID:

A group is a collection of persons. An entire class is a collection of people. The representation of different classes is through a group ID that is entered by the trainer. It is expected that the group ID is represented in alphanumeric, all alphabets in lowercase and permits two special symbols which is the hyphen '-' and the underscore '_'. So, a group ID could be like "cse_c_2018", as shown in Figure 3. Representing expected 2018 batch of Section C students of the Computer Science and Engineering Department.

Generating Person ID:

Every student of the particular classroom will be identified with a unique person ID automatically generated by Microsoft

Cognitive Services. The ID will be generated after a request is sent for each individual. Additionally, a name and certain user data is also sent as parameters (Figure 6). Here we took the name of the student as the parameter name and the student's USN as user data parameter. After this a person ID is allocated to that person. This ID is auto generated by the server. The new person id allocated can be observed in Figure 7.

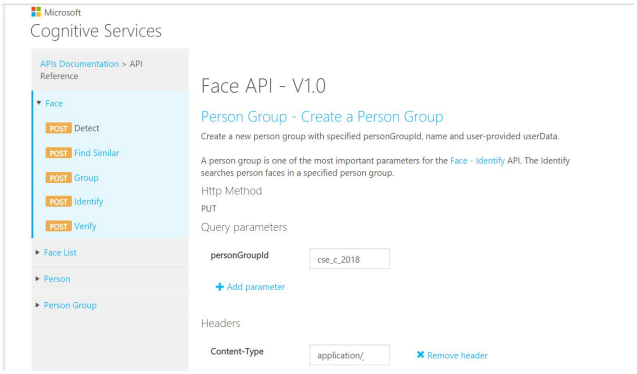

Figure 3: Passing person group id

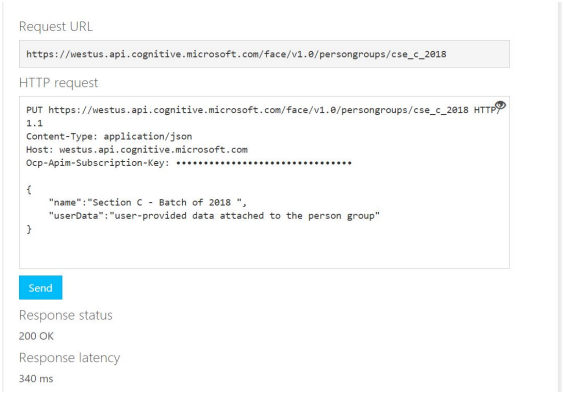

Figure 5: Group id is successful

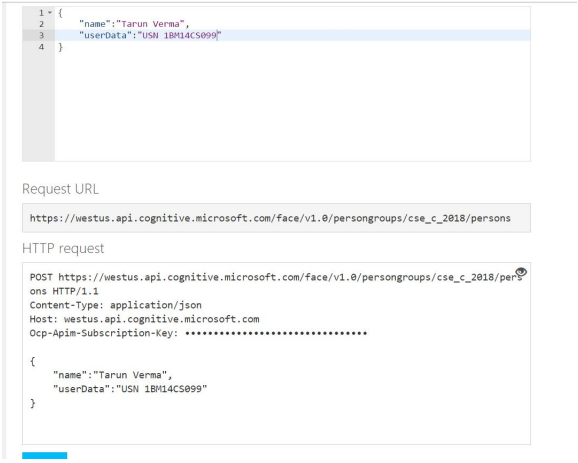

Figure 6: Create person

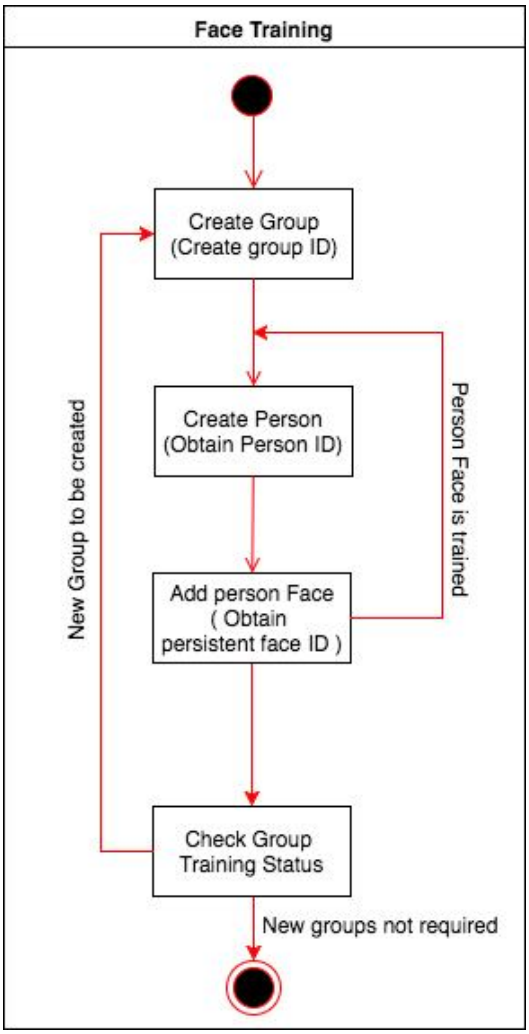

Figure 4: Face training process

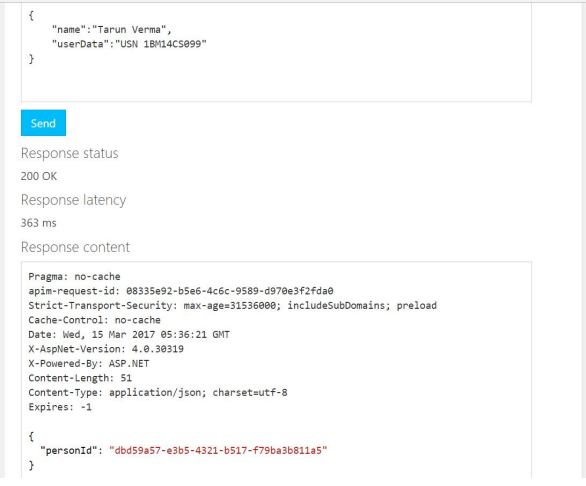

Figure 7: Person id obtained

Obtaining Persistent Face ID:

Each person will be identified by the APIs ability to recognize him/her with certain amount of confidence. Multiple pictures are trained for each person. The face in each of these pictures is identified by a persistent face ID (Figure 9). In order to generate persistent face ID, the API is fed with the URL of an image (Figure 8). Note that it is necessary to have the picture online in order to have it accessed through an URL. The more pictures are used with distinctive features; the better is the accuracy of the system.

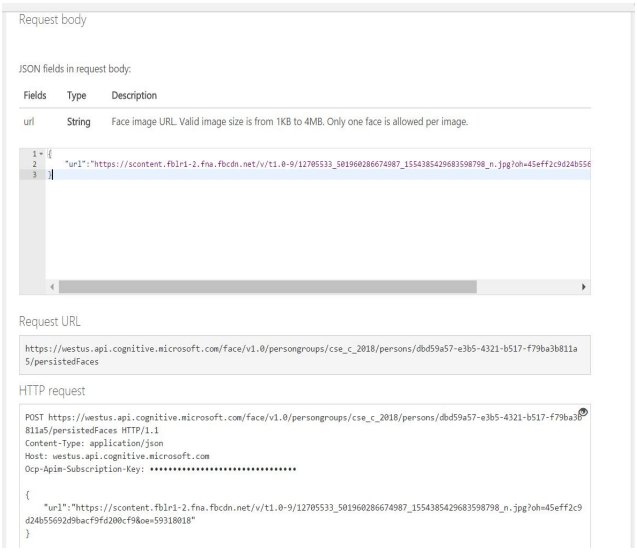

Figure 8: Saving first face

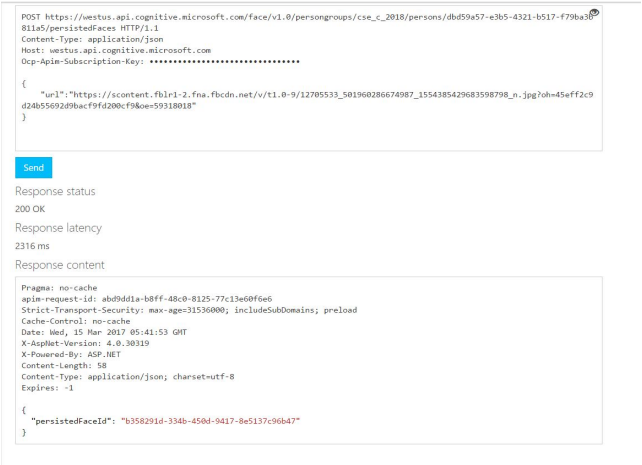

Figure 9: Obtain face ID

Validating Training Process:

Once a person's face is trained, it is necessary to check the training status before continuing. After ensuring that entire training process is complete, the system is ready to accept to queries for person identification.

Figure 10 is a collection of images of a single person at different ages, angles hairstyles and facial hairstyles.

Figure 10: Various types of images trained for a single person (with different angle and pixel clarity)

B. Face Detection

To initiate the entire process, system needs to have a new face to work on. Camera is live throughout the day and tries detecting faces. The detection of face is done using the Haar feature-based cascade classifiers [9]. Every time a student enters the classroom, the system detects a face in its video stream.

C. Image Capture

It starts taking images in a burst. It uploads each picture to the cloud for analysis. After which it continues to stream the video parallel to processing for attendance. The video stream is run on a Python code. Library primarily employed for the streaming and capturing is OpenCV [17] The captured images are stored in a particular directory with a name of format cX.jpg, where X is a positive integer. The captured image is immediately required to be processed.

D. Uploading

Processing on the cloud requires the face in the frame of the picture to be assigned with a face ID. In order to obtain a face ID, the program under execution requires to send a web link to an image resource.

E. Face Recognition

Face Identification is done using recognition techniques developed by Microsoft and embedded in its API. The API was built using state of the art algorithms like Principal Component Analysis, Linear Discriminant Analysis and Independent Component Analysis. Most of the tools and techniques Microsoft has implemented remains classified and only specific materials are offered for the developers to build under the IoT Core Build Program.

F. Database Development

A table is developed on the cloud. Once a person is identified, it is necessary to check if the person is already marked present for the day. If not, the person is marked present by incrementing his/her attendance count by one. Figure 12 displays the final attendance record of students.

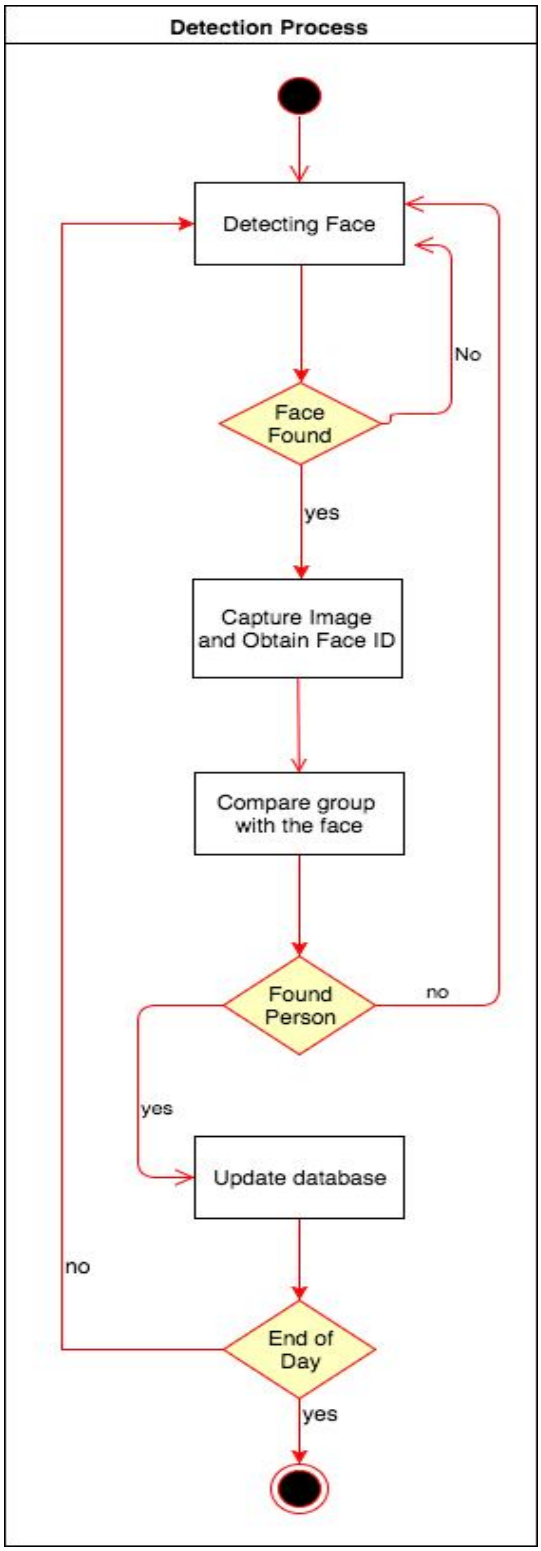

Figure 11: Face Detection Process

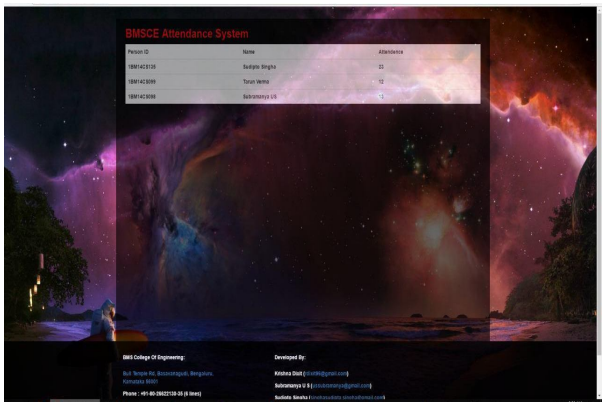

Figure 12: Database details

G. Mobile Application

The institution's faculty and management can access the database on their mobile phones via a mobile application. The mobile application can also be integrated with other applications of the institution. It can also act as a content provider which would provide data for other applications.

IV. System Analysis and Evaluation

We trained the cognitive system with the faces of about fifty students using five pictures of each. Five attempts were made to identify each of the people at a proximity to the camera. On all two hundred attempts the face identified was found to be correct with confidence values ranging between 70 to 80 percentages. Two attempts were also made against the face of an unknown person. On each case, it was observed that the system failed to identify the unknown person, as his face could not cross the threshold mark of 50% confidence. The closest identification to a known person was 32%.

We were also concerned about ensuring racial inclusiveness. Microsoft Face API seemed to be very promising on pictures involving faces from the American region. And hence the concern was for people from the south Asian region. Therefore, this project also acted as a test for the API for people from the region of South Asia. It was observed in the tests; the product is satisfactorily giving outputs. For a smaller sample set the efficiency is a 100%, it is expected that for a larger sample set, the deviation would be minimal.

A minor aspect of this project is the automated image capturing on face detection and requesting response from the API on the cloud it with the cloud. The OpenCV library was used here. The results it gave were satisfactory. The images weren't clear at times but since the camera was active again in less than five seconds, multiple shots of same person were taken. In case the frame of camera has multiple faces fit in, the API returns multiple values, the program is developed for a single face so it will take first value of the JSON response. A camera will have a certain solid angle of vision, say α steradians. All it sees fits in the angle. In order to have multiple faces fit in the solid angle the proximity from the camera is expected to be distant. In a few of our tests we

identified that the accuracy of the API decreases for distant pictures.

The response time of each face scan depends on the internet speed, it is observed that with a speed of 20Mbps the response time is about less than 2 seconds and in most cases about half a second. Once the face ID is reflected through the request response the database is updated. The attendance is incremented by a unit. The program is written such that on a single day the database is not updated more than once for a single person. The system can also have time as a parameter, where database is maintained at an hourly basis.

At the end of the day database is ready for the use of students, faculties and the management. A web and mobile interface is developed where the data is received real time from the database.

TABLE I: ASSESSMENT OF THE RESPONSES

No. of Faces	No of successfully detected faces	No of Successfully recognized faces.	% of correct recognition	No. of false acceptance	% of false acceptance
5	5	5	100	0	0
10	10	10	100	0	0
15	15	15	100	0	0
20	20	20	100	0	0
25	25	25	100	0	0
30	30	30	100	0	0
35	35	34	97.14	1	2.86
40	40	39	97.5	1	2.5
45	45	43	95.56	2	4.44
50	50	48	96	2	4

Above is the table which depicts the result of a prototype that was used in the analysis of efficiency of the prototype. It can be observed that after 50 face detections, the efficiency is 96%. This is the expected number of faces the system is supposed to be addressing in a day.

The graph below compares the face detected and face correctly recognized. It is noted that face detected increases linearly, which proves that the system is efficient enough to rightfully detect a face and capture image. In case of face recognized the efficiency gradually decreases but even after fifty faces it holds an efficiency is high.

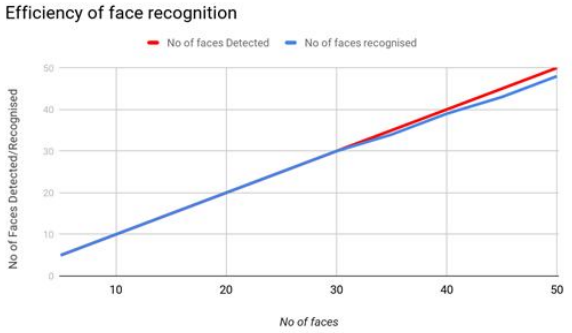

Figure 14: Efficiency of the System

V. FUTURE ENHANCEMENT

The attendance data collected could be used later to find various statistical relation with respect to the student performance. The project can be extended in other interesting ways, such as implementation of system for security access, dynamic face identification in public places.

VI. CONCLUSION

Asystem for automating the process of attendance has been successfully implemented using Image processing and IoT technology. The proposed system can prove to be utilitarian for not only academic institutions but also in other professional environments.

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