

Automatic Attendance Management System using Image Processing

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Abstract—It is common in education institutes to record attendance which is mostly manual. Significant time and effort are being spent into recording attendance in classrooms which is a hindrance for a flow of teaching. To limit the effort and time taken, we need a smart, effective and authenticated attendance system. Generally biometrics like fingerprint, Iris, hand geometry, face recognition and technologies like RFID are being used for smart attendance system even though each of them have their own demerits. Using RFID in schools is not reliable as it may lead to proxy/false attendance. Whereas, finger print recognition is a reliable one but it does not really ensure the presence of the candidate after the fingerprint is taken. Hence there is a need in the market to build a smart attendance system which is reliable, effective, time & effort saving. Currently, techniques of Image processing mixed with face recognition are often used in several industries for various applications and these processes are done without any human intervention. Hence it would be a great fit for building a smart attendance system. We have several algorithms that help in object and face detection. The work aims to select the most reliable algorithm and build a system that takes attendance for students using face recognition and image processing techniques. The proposed system architecture will include primarily an interface with camera and microcontroller that has enough CPU process power to perform image processing. The work involved evaluation of different algorithms like PCA (Principal Component Analysis), LDA (Linear Discriminant Analysis), ICA (Independent Component Analysis), Fisherfaces to underpin the most suitable one for the application. PCA is an effective, robust algorithm and works better with images without disturbances while can even work on Images with disturbances but fails when matrices are singular. Eigen faces are fast, effective but are sensitive to lightning and position of head. However, the Viola-Jones algorithm uses Haar classifier, integral images, AdaBoost filtering, cascading which makes it the best object detection algorithm for frontal face. The application was developed with the Viola-Jones algorithm running on Raspberry PI with a pair of USB cameras. The system when evaluated in a real time classroom, showed an accuracy of up to 75% in different lighting conditions, head positions and other external factors.

Index Terms— RFID, OpenCV, Image Processing, Raspberry pi, Face recognition.

I. INTRODUCTION

In many educational boards and universities, certain level of attendance is mandatory without which the student is considered to be not fit for taking the final examination. With such rigor in guidelines, the faculty members will have to spend time and efforts to record the attendance for every session. Many faculty members feel that taking attendance manually is a waste of time to be taken up in the midst of important discussions of the course.

It is absolutely important to develop a system that can be fool proof and more efficient to automatically record the attendance

A. Motivation

Finger print and RFID technology are not that reliable to implement in schools when compared to Face recognition. Hence, it would be great if each classroom is equipped with a system that recognizes only the students of that particular class according to the schedule and marks their attendance. Also, sometimes the students might miss the classes without their parents/guardian's notice. Therefore, it would be helpful for the parents if an email alert system is included which sends email alert to parents regarding their ward's absence.

B. Objectives

The main objective in developing this system was to replace the existing traditional attendance system. In order to achieve that, the sub-objectives were,

1. Selection of the best image processing algorithm for the respective application
2. Run the application on reference setup to evaluate face recognition for attendance
3. Develop the application towards deployment that includes configuration, database creation, face recognition and logging attendance records to cloud for further analytics.

The current systems using the following to record attendance,

1. Finger Print Recognition
2. RFID
3. Iris Recognition
4. Manual

The Finger Print recognition uses Image acquisition techniques to take the image of the finger and stores the unique attributes in the system through which the finger print is recognized and the attendance is marked. On the other hand, the main disadvantage of the RFID technology is anyone can mark anyone's attendance with their RFID tag. Hence, it's not reliable to implement this technology in schools. Beside these, we have Iris technology which takes longer to match the attributes and record the attendance which is not reliable to include in schools.

Hence, the objective of this project was to replace all the above technology with face recognition technology to mark attendance of students using image processing techniques. It takes lesser time than Iris according to the studies.

II. LITERATURE Review

The main concept is the 'Object Detection Algorithm' submitted by Viola Jones (2001). It is an algorithm that uses Haar features, Integral images, cascading to detect different types of objects including Human faces. Based on this, 'Facial parts detection using Viola Jones algorithm' was submitted by K. Vikram and S. Padmavathi (2017) explains about how feature extraction is done for face detection. Details on analysis of haar features, Integral Image calculation are key takeaway parts of this paper.

Ishita Gupta et al. (2016) [5], in this research worked on face recognition and the target was to improve the potentiality of face-recognizing system utilizing traditional algorithms of face detection as well as recognizing mechanisms like PCA. This paper aimed replace other attendance marking technologies by face recognition and clearly showed the differences, merits and demerits of each algorithm which helped in choosing the suitable algorithm for this project. The importance of profile creation and database was also clearly mentioned which helped in the initial stages of this project.

RokNovosel et al. (2017) [9], in his research, presented an informational system that is POC accessed over the internet, had security via a procedure of recognizing faces, and that gave certified users the ability to reach critical data which provoked the idea of using a raspberry pi for this project which not only helps in Image processing, facial recognition but also helps in database communication and other information processing.

III. PROPOSED METHODOLOGY

The functionality of the system was mainly divided into following steps,

1. To select an appropriate algorithm for face recognition
1. To capture faces using camera module connected to controller
2. To match the faces detected with the profiles created in database
3. To mark attendance automatically for the profile of detected faces.
4. To send email alerts to the guardians of their respective ward's presence/absence

The initial step of the project is to understand the working of the face detection algorithm and learn about OpenCV libraries. Knowledge on python for code writing is also essential. Viola-Jones algorithm is considered to be the best one for face detection with high accuracy and speed. Understanding the algorithm is a major and important task to improve the performance of the system.

Before proceeding with the hardware, the face detection was achieved using a PC with a camera. The accuracy was 97%. It was observed that by varying the Image parameters, the accuracy could be modified.

The main issue with using facial recognition in schools is students can sit in different angles, directions sometimes and the recognition will be altered or the face will not get recognized.

Hence, attendance will not be marked and false email alerts will be sent unnecessarily. So work has also been done to improve systems accuracy irrespective of few parameters.

After facial recognition, the code leans towards storing the recognized profile as present and this process continues according to the time mentioned in the code. Since we will be having the list of students who are present, the absentees list can be easily created via code. Both these lists of data will be recorded in a excel sheet automatically by the code and will be stored in the given location. The time of recognition can also be recorded if necessary.

IV. SYSTEM ARCHITECTURE & DESIGN

The block diagram in Figure 2 shows the hardware components that were used to implement this project. The main components include a controller that can interface with camera. Raspberry pi which has a good community support is been selected and USB Camera is been selected as interface to keep standard interfaces instead of very specific interface.

The main goal of this system was to mark attendance of the students in the class at particular time interval accordingly. It was worked in different parts,

1. Algorithm Selection
2. Database Creation
3. Image Capture
4. Face Detection
5. Face Recognition & Classification
6. E-mail alerts
7. Data record

A. Algorithm Selection

The work involved evaluation of different algorithms like PCA (Principal Component Analysis), LDA (Linear Discriminant Analysis), ICA (Independent Component Analysis), Fisherfaces to underpin the most suitable one for the application. PCA is an effective, robust algorithm and works better with images without disturbances while can even work on Images with disturbances but fails when matrices are singular. Eigen faces are fast, effective but are sensitive to lightning and position of head. Face net is another face detection system which uses vectors of same identity to recognize. It is also used for future prediction and detection. On the other hand, the Viola-Jones algorithm uses Haar classifier, integral images, AdaBoost filtering, cascading which makes it the best object detection algorithm for frontal face. The application was developed with the Viola-Jones algorithm running on Raspberry PI with a pair of USB cameras. From the understanding, it was concluded that the algorithm using dlib is the fastest and the one which uses face net is of highest accuracy. But since, the system needs a cross between both accuracy and speed, the Haar classifier is considered as the suitable and appropriate one for this particular system.

B. Database Creation

Creation of database was a major role in developing this system. A total of 34 real time student profiles were created with mailing information. A folder for each student was created with 30 pictures of themselves via profile creation code. It was observed that, the system's performance totally depended on the number of sample pictures of the individual taken and the lighting conditions. It was observed that system is more accurate if the pictures are taken are in different angles and lighting conditions.

C. Image Capture

A pair of Logitech C270 HD Cameras has been used to capture the whole classroom. From the frames, the detection and recognition was done and attendance was recorded.

D. Face Detection

From the many available algorithms that use techniques like Eigenfaces, kernel methods, 3D recognition, local binary patterns, thermal sensors, Fisherfaces etc like mentioned above, the algorithm proposed by Viola Jones for object detection was chosen and implemented. This algorithm uses Haar features to detect the specific object, which is face in this particular case. Haar cascading gives higher accuracy and takes lesser time to process and hence, choose for this system. The algorithm takes mean and variance of all the normalized images to compensate with the lighting conditions and the backgrounds which was apt for this application and hence saved the processing time.

E. Face Recognition & Classification

The feature extraction in this algorithm is done by PCA which is Principal Component Analysis. The algorithm compares the datasets of the input image with the dataset of the already trained image.

F. E-mail alerts

SMTP library was used to send email alerts of the students' presence to their respective parents/guardians.

G. Data Record

The marked attendance was recorded and stored in an excel workbook for teachers reference using 'openpyxl' library.

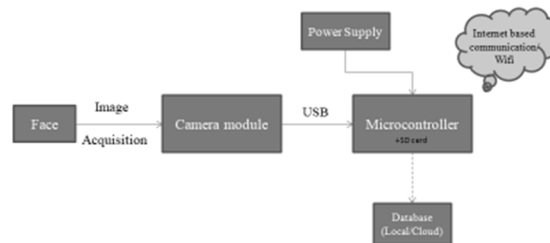


Figure 1 Block Diagram

V. SOFTWARE PROGRAMMING

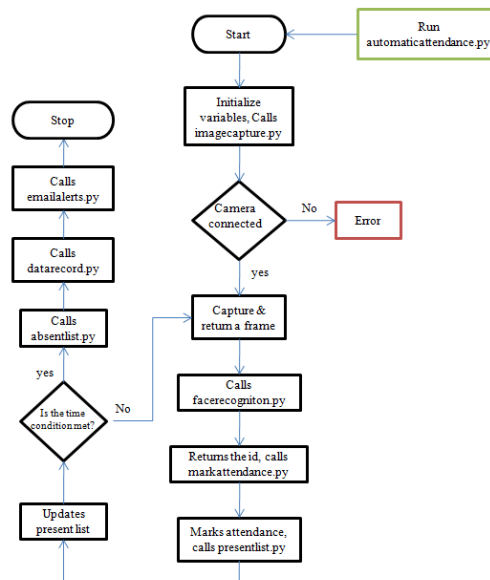


Figure 2 Software Flowchart

Code has been developed for recognition using 2 USB Cameras (Logitech C270 HD Cam) that are connected to the Raspberry pi. The whole system was made in 3 programs for profile creation, training, and recognition. The recognition part has 5 small codes which work on different aspects like Image capture, email alerts etc.

Fig. 2 is the software flowchart of the developed system

VI. RESULTS

A. Analysis

Table I shows the various parameters considered during the project development and the results that have been observed against. The whole project has been worked with 32 real time subjects and approximately 14 trials have been done in a real time classroom full of students. The subjected classroom has a mixture of subjects to test recognized faces and unrecognized ones for comparison.

The accuracy of the system came up to approximate 71% which varied with different parameters like face masks, lighting conditions, face position, facial expressions.

Face detection worked with 100% accuracy when all the features were visible clearly. But it was observed that, the accuracy dropped to 71% when the features aren't clearly visible due to seating position/lighting/face masks. In Figure 3, it can be observed that, the face of a student who turned away from the camera was not detected and recognized as one of the eyes is not visible to the system. Hence, the Haar feature that justifies the eyes failed and the face was not detected. It can also be observed that, the system recognized a single person multiple times. Figure 4 shows the real time setup done in a classroom. This is because, the profiles of few were missing and the system recognizes them with the closest profile that is available in the database. Hence profile creation is an important step in facial recognition.

TABLE I. RESULTS

Parameters	Values	Comments
IDE	Thonny, Pycharm	Thonny is lighter IDE
H/W	PC, Raspberry pi	
Algorithm	Haar	Effective, fast
No. of Subjects	32	From the same class
No. of Trials	~14 (Real Time)	Different arrangements
Subjects detected/Recognized	23 (varies)	Depended on visibility of features like eyes, nose, mouth, mask.
Run Time	~90 seconds	Excluding the timing condition given
Accuracy %	~71%	Varied with different inputs



Figure 3 Real time classroom monitoring-1



Figure 4 Real time classroom monitoring-2

But the systems accuracy improves definitely with a high quality camera, good lighting conditions and face position.

VII. CONCLUSION

The main objective of this work was to replace the usual manual/RFID/biometric attendance in educational institutions. It was achieved by developing an automatic attendance that uses facial recognition, image processing techniques to recognize the presence of the students and record their attendance.

Attempt has been made to improve the accuracy by working on the factors that affect the accuracy. The work started with study of various face detection, object detection algorithms and pick the best one for this application. Clearly, Viola Jones object detection algorithm served the purpose for this work. The frontal face

classifier by this algorithm was the most suitable, fast, better and accurate. Efforts were put into creation of real time database with almost 32 students as subjects. Each student's profile was automatically created using a code which collects their details and stores 30 pictures of each student. All the setup was done using raspberry pi which was very much suitable for higher processing speed. Work has also been done on a email alert system and data analytics system using different libraries. Even though face recognition concepts are being used everywhere now, it is not being used in classrooms due to the issues that come along with. Hence, attempt has been done in overcoming these issues and developing a reliable system.

It can be concluded that the system's reliability and accuracy can be improved by research and modification of existing algorithms according to the factors that affect the system. There is a huge scope for face recognition models and systems ahead in the educational field with intensive research.

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