# Development of an Automatic Class Attendance System using CNN-based Face Recognition

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***Abstract*— We are living in the 21st century which is the era of modern technology. Many traditional problems are being solved using new innovative technologies. Taking attendance daily is an indispensable part of educational institutions as well as offices. It is both exhausting and time-consuming if done manually. Biometric attendance systems through voice, iris, and fingerprint recognition require complex and expensive hardware support. An auto attendance system using face recognition, which is another biometric trait, can resolve all these problems. This paper represents the development of a face recognition based automatic student attendance system using Convolutional Neural Networks which includes data entry, dataset training, face recognition and attendance entry. The system can detect and recognize multiple person's face from video stream and automatically record daily attendance. The proposed system achieved an average recognition accuracy of about 92%. Using this system, daily attendance can be recorded effortlessly avoiding the risk of human error.**

***Keywords—Face Detection and Recognition, Automatic Attendance, Convolutional Neural Network, Image Processing.***

## I. INTRODUCTION

Recording the daily attendance of students in all educational institutions is a major concern. In the traditional attendance system, a person has to check one by one if someone is absent or not which is very time-consuming. In other ways, everyone puts their signature on an attendance sheet which is not also appropriate as anyone can easily copy signatures for others [1]. An automatic attendance system can reduce all the complexities. In this work, we have developed a biometric artificial intelligence (AI) based system that will be advantageous in educational/official sectors where regular attendance is greatly needed.

A facial recognition system is a technology which can identify or authenticate a person from a digital image or a video stream from a video source. These systems operate in different methods. Usually, they compare extracted facial features from an input image of human faces within a database to recognize a person. It can also be defined as a biometric AI based application which can recognize a person uniquely by investigating the texture patterns and shape of the person's face. Through face recognition models, the application identifies a person and saves the record.

In recent years, face recognition from stationary and moving images has been an active and demanding research area in the field of image processing, pattern recognition and so on [2-6]. At first, images with different postures of an individual are collected as a training dataset. After that, face recognition is done for input facial images depending on their intensity value estimation. As a form of computer application, face recognition is being widely used in recent times on mobile platforms [7, 8]. It has also seen wider uses in other technological forms, such as robotics [9, 10]. It is generally applied as access control in security systems. This can be differentiated from other biometric systems using fingerprint, voice or iris recognition. Even if facial recognition systems as a biometric application have lesser accuracy than fingerprint and iris recognition, it is widely used because of its non-contact, lower time-consuming and non-interfering process [1, 11]. Nowadays, it has also become desired as a marketing and commercial authentication tool. Advanced human-computer interaction, video surveillance, automatic indexing of images, video database etc. are some other applications of facial recognition [12].

Here, in this work, the intention was to detect faces and recognize them in real-time for effortless recording of attendance. The main objectives of this work are:

- To detect faces from real-time video stream.
- To develop a machine learning model to recognize a person from a pre-trained dataset.
- To record attendance after recognition for future use.

The rest of the paper is summarized as follows. Related literature and studies are presented in Section II. The proposed system is described in Section III. In Section IV, implemented system's Graphical User Interface (GUI) is presented. Results are discussed in Section V. And the paper is concluded in Section VI.

## II. LITERATURE REVIEW

In recent times, different techniques, methods and algorithms have been used to perform facial recognition and increase the accuracy of facial recognition.

In [6], the authors developed a real-time multiple face recognition system using deep learning on embedded GPU. Convolutional Neural Network (CNN) based face recognition with face tracking and deep CNN face recognition algorithm have been used for the system. In [13], an automatic student attendance system was proposed that can be utilized in small and crowded classrooms. In this model, after the training stage, the user, e.g. the teacher, can get the attendance by taking one or multiple images of the classroom using his/her smartphone. The implemented system detects the faces in the images and recognizes which students are present in order to mark the attendance. But real-time video attendance was not possible with this system.

The Bilateral Filter, Haar-like features [14] techniques were applied to identify the model of the human face in [15]. The Simplified Fuzzy Adaptive Resonance Theory Map Neural Network (SFAM-NN) method has been compared to the Cascade Classifier Adaboost method to evaluate the efficiency of the proposed method. In [16], the authors implemented a system where the Viola and Jones algorithm [17] has been utilized for detecting face bounding box, constrained local model-based face tracking and face

2020 Emerging Technology in Computing, Communication and Electronics (ETCCE) | 978-1-6654-1962-8 /20/$31.00 ©2020 IEEE | DOI: 10.1109/ETCCE51779.2020.9350904

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landmark identification algorithms. It is also called the AdaBoost algorithm for face recognition. To perform facial recognition in this model, Principle Component Analysis (PCA) has been used. In [18], an automatic attendance management system was proposed using face recognition algorithms. A camera at the doorway captures students' image while entering into the class. But, that system faced limitations as it could not define two persons at the same time.

For the proposed system, we have used CNN architecture to detect faces and train the system.

## III. Proposed System

### A. System Overview

The goal of the proposed automatic class attendance system is to detect the faces of each student from a video stream and then recognize the faces by cross-referencing the detected faces with the ones stored in the system. This system also has the ability to detect and recognize multiple people on the screen automatically in real-time from the video stream.

The system starts by capturing the students' facial data and storing them with their appropriate labels to create a dataset. For recognizing faces, CNN model is used. Although Histogram of Oriented Gradient (HOG) method can also be used for detecting the faces, this method is less accurate than CNN and also requires the captured face to be completely straight in relation to the camera in order to be detected [19]. The dataset is then trained for the next step. The system is then connected to a video source, which is placed at a convenient position in the classroom. The system then analyzes the video stream and detects the faces of the students present in the classroom. The detected faces are then compared to those from the trained dataset. This is the recognition stage. The recognized students' data is then saved in an excel sheet, which marks their attendance.

### B. Methodology

The different parts of the system can be grouped into four main stages. These are:

- Data Entry
- Dataset Training
- Face Recognition
- Attendance Entry

These stages are discussed in the following section.

*1) Data Entry:* The first step is to include the faces of the students in the system for creating a dataset, which is shown in Fig. 1. For this, continuous photos of each of the enrolled students are taken by the system from a live video stream one person at a time, along with their names and IDs. The default setting is set to take 20 pictures at a 2 second interval from a live video stream. It is preferred that the students have different head positioning during this time to create a better dataset. The setting can be changed to increase the number of pictures taken to make a more accurate dataset. A folder for each student is created with the corresponding student's name and ID as the label. Each of the pictures of faces is then saved in that student's designated folder. Besides this process, previously taken pictures of the enrolled students can be added to the dataset for making it more diverse. In this case, the new photos will be saved in that student's previously created folder. After every data entry, the system is automatically trained using the currently available dataset. So, the system is already set to be used any time after the student's data have been entered.

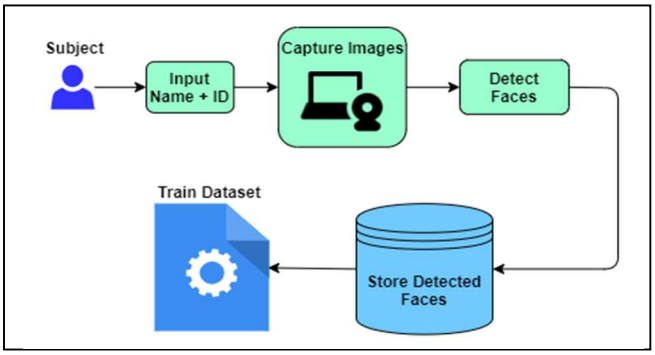


Fig. 1. Data Entry Process

*2) Dataset Training:* This step is automatically done after the Data Entry stage. But the system also has the option of manually activating this stage at any point. The training is done by a triplet training step. This method consists of three different face images, two of which belong to the same person. The CNN extracts 128 facial measurements, called embeddings from each face. These are stored as 128-d vectors. For the two images belonging to the same person, the CNN tweaks their weights to make the vectors closer while also making them slightly further away than the third picture. This whole process is done using the *face_encodings* function of the *face_recognition* library. The extracted data is then stored as a pickle file, which is used later for comparing and recognizing faces in the next stage. This step also automatically creates a spreadsheet that contains the names and IDs of all the students of the class, whose data has been entered in the previous stage.

*3) Face Recognition:* Fig. 2 depicts the steps of face recognition. In this step, the system can be set up by putting

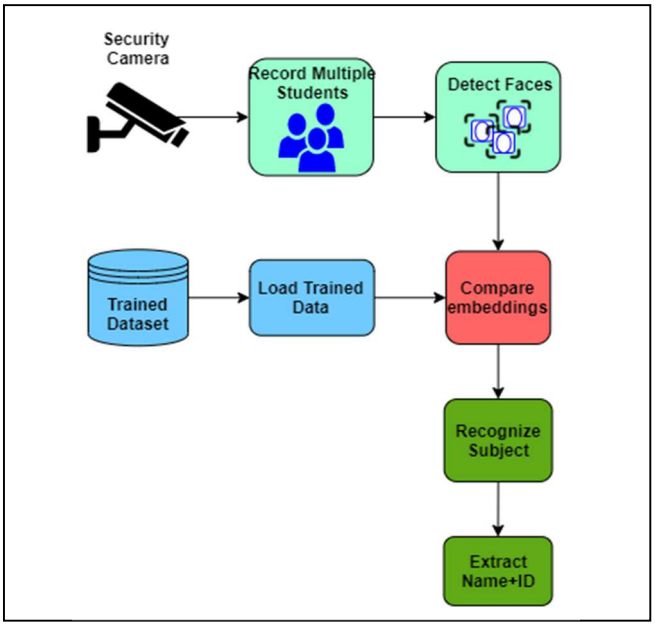


Fig. 2. Face Recognition Process

a video camera on a good position, preferably on the doorway of the classroom or inside the classroom itself where it has a clear view of the students. The system can then detect the faces of the students from the ongoing video stream of the camera. The detected faces are then compared to the trained dataset. A confidence value is assigned to each of the matches. The match with the highest confidence is selected and the label, which is the name and ID of the student, is extracted. If there is not a match of a high enough accuracy, then the student is labeled as 'Unknown'.

*4) Attendance Entry:* Steps of attendance entry are shown in Fig. 3. In each session of the video stream, which would be each period of classes, the names and IDs of the recognized students are automatically logged on a daily attendance spreadsheet along with the date, time and period name. There is also the option to calculate the total attendance during a specific time span, which can be a semester or month or year depending on the time range. The system can automatically calculate the total number of classes and also show the total attendance of the enrolled students for those classes.

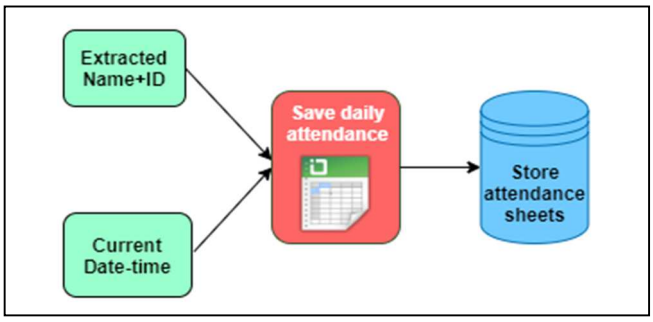


Fig. 3. Attendance Entry Process

## IV. Implementation

The proposed system is generated using python. We have used tkinter for creating the GUI and used the face_recognition module, which wraps around the dlib library, for detecting and recognizing the faces of students. Different pages of the developed application are presented next.

### A. Home

The homepage of the created system is shown in Fig. 4.

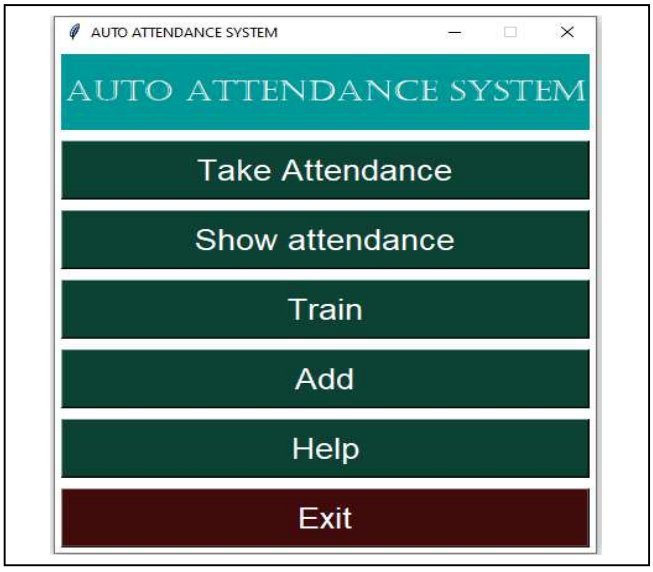


Fig. 4. Homepage of the System

### B. Add

The data entry stage of the system is done by clicking the 'Add' option. This opens a new page as shown in Fig. 5.

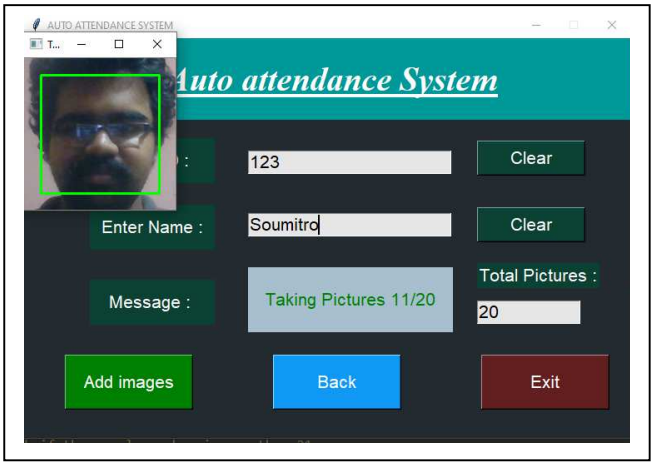


Fig. 5. Adding Data

The ID and name of the student have to be entered in the respective fields as shown in Fig. 5. If the ID is not numeric or the name is not alphabetical, then an error is shown in the message box. If the data is entered correctly, then the data entry phase will start. The camera takes a picture after every 2 seconds whenever it detects the student's face. The default number of pictures taken each time is set to 20. But this value can be changed to increase or decrease the dataset.

### C. Train

After the images of a student have been added to the dataset, the entire dataset is trained automatically. This allows the system to be ready to perform as soon as new data is added. There is also the option to manually train the dataset by selecting the 'Train' option from the homepage as shown in Fig. 4. After the selection, the page as shown in Fig. 6 appears.

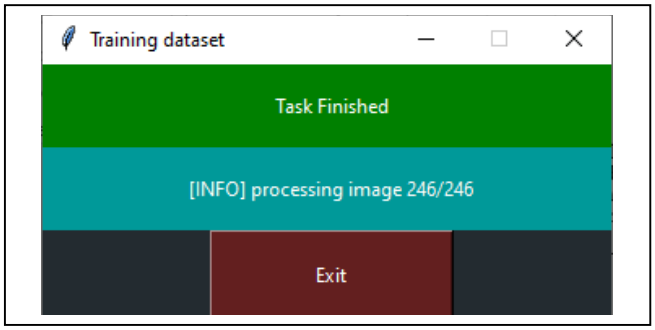


Fig. 6. Training the Dataset

### D. Take Attendance

The system can be signaled to automatically start taking attendance, by selecting the 'Take Attendance' option. This tells the camera situated in the classroom to start recording. The camera can also be set up to always stay turned on during class. From the video stream, the students' faces are detected and recognized. As shown in Fig. 7, a frame is taken from the video stream. Here, it can be seen that six students' faces are detected in rectangular boxes and identified showing their corresponding names and IDs. The system then starts marking and recording attendance. This process is repeated for every class period to automatically mark the attendance of the present students.

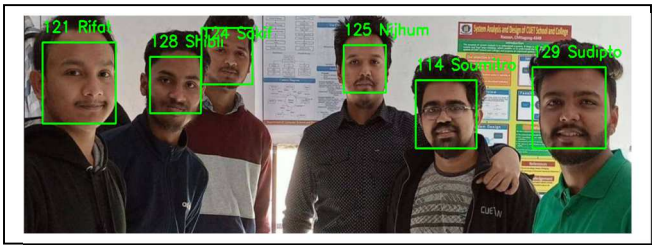


Fig. 7. Taking Attendance

### E. *Show Attendance*

The 'Show Attendance' option opens a new window as shown in Fig. 8, which gives the option to view specific attendance sheets or the total attendance of all the registered students during a specific time period as shown in Fig. 9.

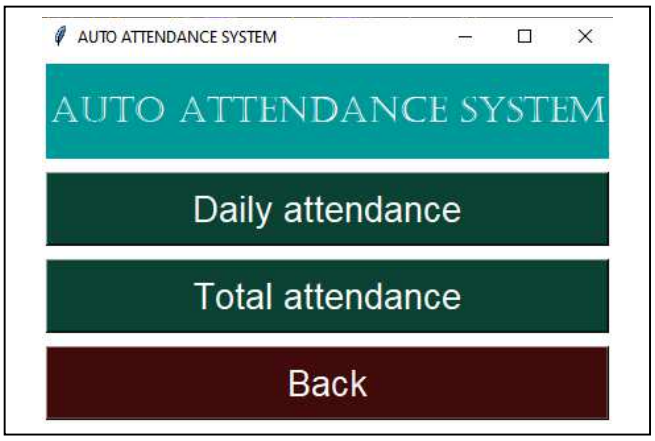


Fig. 8. Selecting Attendance Sheet

| | A | B | C | D |
|---|---|---|---|---|
| 1 | ID | Name | Total Pres | Total class |
| 2 | 100 | Mukto | 30 | 36 |
| 3 | 101 | Nahid | 32 | 36 |
| 4 | 102 | Mehedi_Rasel | 29 | 36 |
| 5 | 104 | Jami | 35 | 36 |
| 6 | 108 | Akram | 33 | 36 |
| 7 | 111 | shaiham | 35 | 36 |
| 8 | 112 | Shifat | 34 | 36 |
| 9 | 114 | Soumitro | 33 | 36 |
| 10 | 116 | Muktadir | 30 | 36 |
| 11 | 117 | Upol | 29 | 36 |
| 12 | 119 | Nur | 32 | 36 |
| 13 | 121 | Rifat | 33 | 36 |
| 14 | 124 | Sakif | 31 | 36 |
| 15 | 125 | Nijhum | 34 | 36 |
| 16 | 128 | Shibli | 34 | 36 |
| 17 | 129 | Sudipto | 31 | 36 |

Fig. 9. Viewing Total Attendance

## V. Result And Discussion

The primary goal of the system is to flawlessly mark and record attendance. For doing that, the main focus is to elevate the accuracy of the facial recognition system which is the cornerstone of this work.

The built-in webcam of a laptop is used as a default video recorder for testing the system. The accuracy of the system in relation to the number of input images per person in the dataset is calculated in TABLE I. The dataset consists of various number of images of 17 distinct people. The accuracy was measured by training a certain number of images per person and running the system to recognize them from five different frames from video source. This experiment was repeated four times while increasing the number of images per person during the training stage.

TABLE I. Accuracy Comparison

| Trial No. | Inputs per person | Result | | | | |
|---|---|---|---|---|---|---|
| | | *Total Faces* | *Correct Recog-nitions* | *False Recog-nitions* | *Accuracy (%)* | *Average Accu-racy (%)* |
| 01. | 5 | 6 | 4 | 2 | 66.67 | 49.21 |
| 02. | | 6 | 3 | 3 | 50 | |
| 03. | | 7 | 4 | 3 | 57.14 | |
| 04. | | 8 | 4 | 4 | 50 | |
| 05. | | 9 | 2 | 7 | 22.22 | |
| 01. | 10 | 6 | 6 | 0 | 100 | 74.09 |
| 02. | | 6 | 4 | 2 | 66.67 | |
| 03. | | 7 | 6 | 1 | 85.71 | |
| 04. | | 8 | 5 | 3 | 62.50 | |
| 05. | | 9 | 5 | 4 | 55.55 | |
| 01. | 15 | 6 | 6 | 0 | 100 | 81.03 |
| 02. | | 6 | 4 | 2 | 66.67 | |
| 03. | | 7 | 6 | 1 | 85.71 | |
| 04. | | 8 | 6 | 2 | 75 | |
| 05. | | 9 | 7 | 2 | 77.78 | |
| 01. | 20 | 6 | 6 | 0 | 100 | 91.94 |
| 02. | | 6 | 5 | 1 | 83.33 | |
| 03. | | 7 | 7 | 0 | 100 | |
| 04. | | 8 | 7 | 1 | 87.5 | |
| 05. | | 9 | 8 | 1 | 88.89 | |

By plotting the calculated values in the chart as shown in Fig. 10, we can see that the accuracy of the system is rising with the increase of input images. It is also observed that increasing input images for training the dataset also increases the accuracy of the system. This accuracy increases swiftly when the number of image per person in the dataset is between 5 – 20. But it gradually slows down and stabilizes at around 91~92 %, despite increasing the number of images per person in the dataset.

We have also found from our experiments, that if there is a discrepancy among the number of inputs for each student, the system sometimes becomes flawed and the student with a higher number of inputs is selected to be the one recognized by the system. To stop this error, the same number of inputs should be chosen during data entry stage. It is also perceived that the time taken to train the dataset increases drastically with the increase of the dataset. The time can be reduced if the

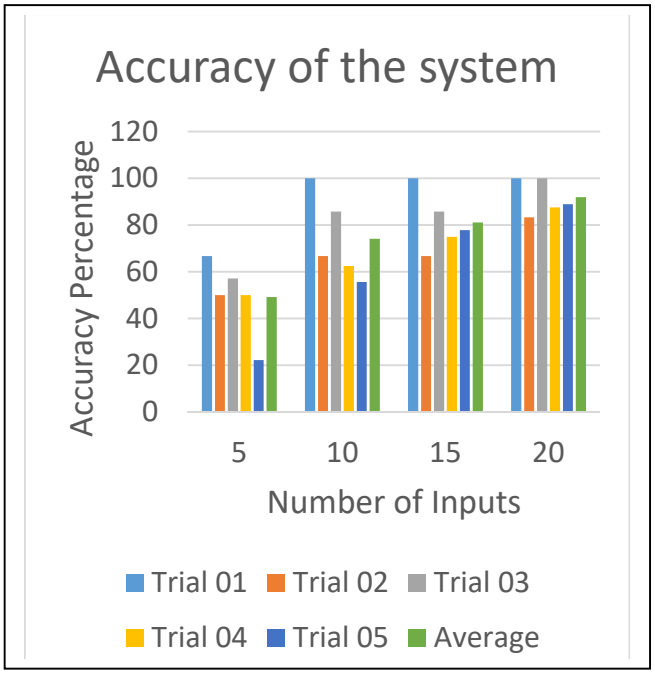


Fig. 10. Accuracy of the System

system is running on a relatively high-performance computer. We also found that the system can't detect the faces of people who are too far away from the camera. So, it is recommended to place the camera where it can have the best view.

## VI. Conclusion

In this work, a system for automatically marking and storing the attendance of a class has been implemented. Implementation process includes entering data of the students, training dataset, recognizing faces and marking attendance automatically. The CNN model used in this study can detect and recognize a person by their facial features even if they are not staring exactly straight into the camera. The proposed system can detect and recognize the students of the class with maximum accuracy of about 92% and saves the teachers' time and hassle by automatically marking and storing the attendance of the present students. For the system to be most effective, it has to contain a satisfactory and consistent amount of images of each person during the training stage. Also, the camera has to be positioned in a way that it has clear view of all the students. Furthermore, this system can be used in any organization for automatic attendance recording of staffs.

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