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Face recognition-based student's attendance system using DLIB

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ABSTRACT

Daily attendance tracking is an integral part of any organization's day-to-day activity. It is also very important to have the records with the ease of maintaining them. Roll call method is considered as time taking and it also has any possibility of proxy marking. The proposed work speaks about the implementation of an attendance system by using face recognition. The Marked attendance is stored in a database and can be considered for or future purposes. At the time of marking attendance, this system will automatically take the pictures and apply implemented algorithm to Mark the correct attendance. The attendance is marked in the form of name, date, and time. Histogram of oriented gradient method is implemented for the detection and facial landmark estimation is implemented for computation and comparison of the students the implementation is done on a real-time basis.

Keywords: *Dlib, HOG, Face Recognition, Landmark, Detection.*

1. INTRODUCTION

Around the world, organizations need a system wherein attendance can be marked and tracked. It can be done via several methods out of which roll call is the basic method. Adoption of biometric attendance marking systems is increased over time which includes systems such as scanning fingerprints, RFID, retina recognition. The roll call method is considered a time taking activity and it can have disadvantages such as proxy marking. In RFID the person is given a card with a unique identity, but in case of loss of card this method turns out to be ineffective. Similarly, other methods such as retina recognition and voice identification also have disadvantages and turn out to be less efficient in today's world.

The face recognition method can be used effectively for the purpose of marking attendance in a more accurate and smart way of handling flaws in the system. Removing proxy attendance is achieved by constructing an application with face recognition methodology. As face recognition works on the identification from the backend the person need not do any active steps for their identity.

The face recognition technology has two major steps firstly face detection and then identification of the detected faces by comparing them with existing data set present in the database. Multiple face detection and recognition techniques have come into the picture with more applications of them in the real world. Face recognition works in two ways wherein it can be considered as the appearance-based method which considers one face as a single unit and secondly it can be also considered as feature-based technology which considers the features on the face such as nose, cheeks, eyes, eyebrows for the recognition of the faces. The proposed face recognition system uses the approach to reduce the limitations of the existing system by using machine learning. To achieve accuracy the system should have a camera of good quality. The face detection is performed by using a histogram of gradients that is HOG [1]. Face recognition is done by using facial Landmark detection. The front end of the implemented system, which is having a GUI based on HTML and backend is achieved by using python with a library called Dlib.

Whenever there is need to mark the attendance, the input image taken by camera in form of picture is send to the system for the analysis which includes comparison of input image with the data set of already trained and tested reference images of each student to Mark their attendance.

2. LITERATURE SURVEY

In recent times by using Technologies of computer vision the problems can be solved with Ease. One of the major implications of such Technologies is recognition. The developers can use a

large number of libraries that are already present in the languages. The research papers pics about the performance of the libraries when implemented in a particular system.

Bhattacharya, Shubhobrata, et al. [2] focuses more on theoretical information of building the Systems by using face recognition. The research work mentioned [3,4] talks about the implementation of the methodologies for which steps were used while developing the recognition system. The proposed solution has been developed on a large scale. While building any system major issue comes with the performance of the recognition system with the help of the speed with which the recognition method works.

As the implementation of face recognition systems has taken a large jump. Joseph et al. [5] speaks about the system implementation using image processing, eigenfaces, and PCA with MATLAB. The system implementation is done by using the front view of the face images, but the implementation needs to be e improved by using an application of different phase positions as well.

Patil, Ajinkya et al. [6] came up with the face recognition methodology for the attendance system using the VJ algorithm Also, so Haar cascade method is used for face detection and eigenfaces are used for recognition.

Kanti, Jyotshana et al. [7] came up with a way to mark the attendance with a more easy and Secure method which is by using an artificial neural network having the implication of PCA for face extraction and neural network for training and testing. Muthu Kalyani et al. [8] proposed the 3D model of attendance system with monthly tracking of each candidate.

The need for an alternative methodology to enhance or improve the function of recognition on position-based faces is achieved with the PCA algorithm [9] having higher accuracy but has limitations with the light condition.

Wagh, Priyanka et al. [10] speaks about different methodologies and their comparison with the face recognition algorithm which can be considered as a good way for maintaining attendance records.

3. SYSTEM DEVELOPMENT

The main motivation of the proposed system development is to create an attendance system in a more automatic way to reduce the limitations of the old manual attendance tracking system. The proposed system marks the attendance of each student if the student is registered, and dictator sets have been added as part of training and testing modules. Whenever the students come to Mark attendance, the system takes the pictures and finds if the human face is appearing in the given image or not. The histogram of oriented gradients is used for face detection and the deep learning technique calculates and compares 128-D face features which are used for the recognition purpose. After detecting and recognizing the faces with the existing data set present as part of the database, the system marks the attendance of the student in the form of a unique name, date, and time which is captured on a real-time basis. The Comma Separated Value (CSV) file is generated at the backend and is saved for the tracking purpose of the student's attendance.

While developing the face recognition system developer should consider the below problems to be resolved:

Finding faces: Face recognition can be done via various inputs such as pictures, videos but it is important to detect faces in all cases.

Position of the face: It is not always possible that the person is standing right in front of the camera, in many cases, the position can be treated that's why detecting positions play a vital role in the process.

Identification of unique facial features: Considering previous steps as prerequisites, this step can be considered as a major face recognition step because this step analyses the input image and find the unique values in the digital form from the face.

Person identification: The comparison between the available data set and the input image is done to come out with the output of the Identity of a person or marking it as an unknown face.

3.1 Components of Data Acquisition:

Image Acquisition: The image is captured using a good quality camera that is present in the system. This input image is considered as the starting point of the implementation of the proposed system.

Data Set Creation: Face recognition process must have the data set of the students which are created initially. The purpose of creating a data set is to train the system. In the system implementation, a data set of 10 students is created with their individual details. It has the images of the students in different positions for getting more accuracy. Each student has a subset of 10 images which is captured as part of data creation. The capturing of 10 images for students is done when the student registers himself or herself for the first time. While registering data and images in the system, the data set applies deep learning to compute 128-D facial features for each face. The data is then stored with the student's face to recall in the future recognition process. This process is applicable for every image which was captured during registration.

Storage: The JavaScript Object Notation (JSON) is used for storing the data. The representation of structured data depending on Javascript is done by using the text-based format. The main application of JSON is majorly used in web applications for the transmission purpose of the data. This solves the issue of temporary storage of any data with cheese consumed when with the help of any entity the data is created. The storage functionality of JSON can be done in the form of a string, array, number, etc. But it has some limits while storing data in the form of dates, functions, and unstructured data.

3.2 Face Recognition Workflow

3.2.1 Detecting and extracting the face: The input image is captured with the help of the camera which is provided as an input to the system which makes face detection an important step in the recognition process the algorithm is applied for the identification of human faces in the input image. Many image processing algorithms have been considered for face detection in the image and locating the detected faces. In our implementation histogram of gradients (HOG) [10] method is used for human face detection.

HOG Algorithm:

The first step in any system development is important because depending on it the search results where is the accuracy. If initially any face is skipped from the detection, then any other object can be considered as a face which results in inaccurate

output. To overcome this limitation algorithm called histogram of gradients (HOG) was invented by Navneet Dalal and bill triggs in 2005.

Steps of the HOG algorithm:
Step 1: Convert the input image into the grayscale image.

Figure 1: Image of Will Ferrel [11]

Step 2: For every pixel and their surrounding pixel, draw arrows towards the darker pixel.

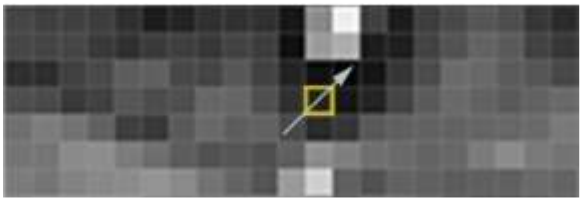


Figure 2: Pixelated version of fig 1 showing the gradient direction [11]

Step 3: Step 2 is continued until all the pixels in the image are replaced by the arrows which are also called the gradients indicating the main flow of the light in the frame of the image.

Step 4: The image can then be e broken into squares of 16X16 pixels and every block is replaced by the arrow direction which is the strongest in the given block.

Step 5: At last, the image is compared with the hug pattern which was derived from the training data set of the faces. The most common pattern is Marked.

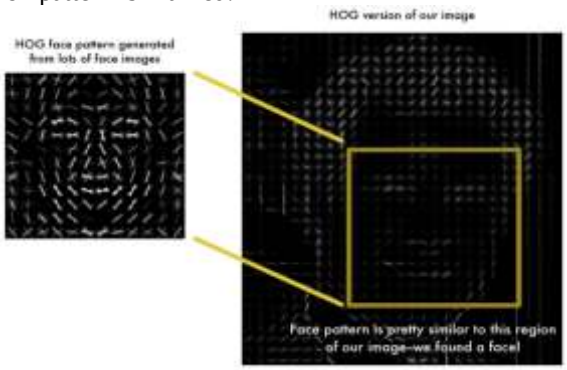


Figure 3: HOG based image being compared with the HOG which is generated from lots of face images [11]

The above steps will result in marking the faces in the obtained frame which was captured from the video which was received as part of the input.

3.2.2 Positioning of the faces: Every human face has 68 specific points which can be considered as 68 different landmarks on the face the main implication of face positioning is to detect the landmarks present on the faces and the position of the image. The inbuilt python script detects the face landmarks and correct positioning of the face as facial landmarks which helps with less distortion of the input image.

Facial Landmark Estimation:
The face recognition output can result in wrong recognition due to the positioning of the faces. If the input phase is positioned at the center, then it is very easy for the system to detect and recognize the appropriate face, but if the position of the face is turned either from the angle or different Positioning then the results of face recognition will worse.

To overcome this challenge face Landmark estimation algorithm can be used as part of face orientation estimation. The purpose of implementing face Landmark estimation is to find different 68 landmarks which are part of each face.

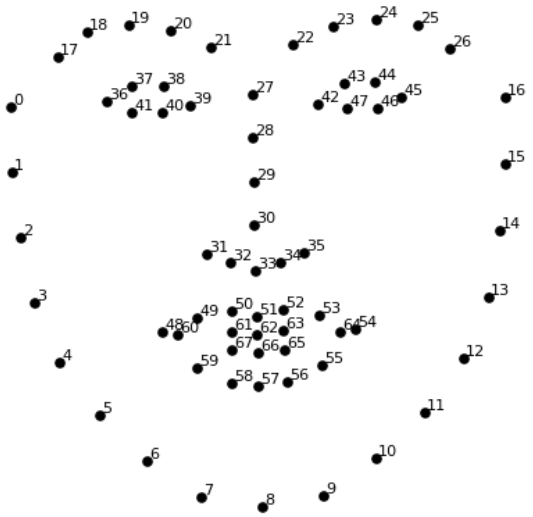


Figure 4: The 68 landmarks we will locate on every face [11]

For example, outer ages of the eye, the lower point of the nose, the upper portion of the chin, edges of the eyebrows, upper and lower positions of the lips.

Once these landmarks are identified, then the input face can be positioned in the center by using manipulations for centering.

3.2.3 Encoding of the faces: After performing the task of face detection of any given input image, the next task is identifying unique facial features when the face is located, 128 points which act as facial feature points are considered for each image that is taken as an input with higher accuracy and these 128-d points are then utilized for the face recognition.

3.2.4 Matching of the faces: After performing above steps, it is essential to use the best technique of learning having higher accuracy which can give output as a real feature vector. Within python, the function of compare_faces is used for identifying the euclidean distance between the input image and the available data set of images. If the input image is matched with the higher accuracy when compared with the data set the output is generated by marking the input image as an attendance.

3.3 Marking the attendance:
Once the face is detected within the image which is present in the JSON file, the attendance is marked with the details of every student in the form of name, date, and time. The output data is reflected into the Comma Separated Value (CSV) file which is generated automatically by Python.

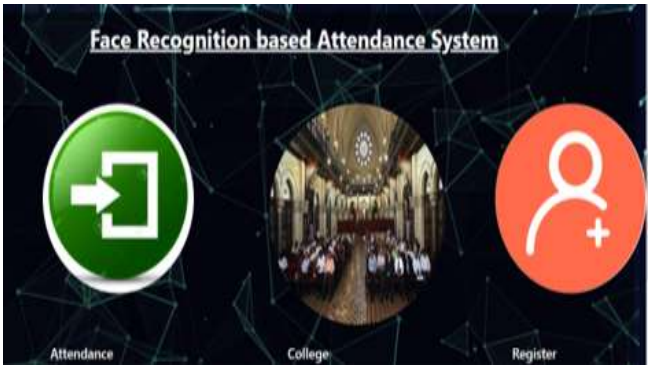
4. EXPERIMENTAL RESULTS

The Attendance Management System is simple yet affective. It consists of the following modules:

Student Registration
Face Recognition
Attendance Marking
Attendance sheet generation in .csv format

To initialize this system, the student should be registered with the unique ID. We have created a training dataset of 10 students (10 images for each) which results in 100 Images for testing purpose.

Home Screen for "Face Recognition based Attendance System:
The screen is comprised of two major functionalities:
1) Attendance: The button lets user to mark the attendance by clicking on the button.
2) Register: The button lets new user to register himself/herself for the first time.

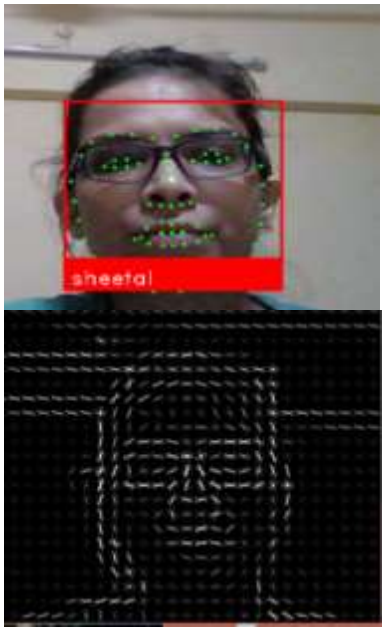


If an unregistred user tries to mark the attendance, the application does not accept it by providing "Unknown" name surrounding the user's face.

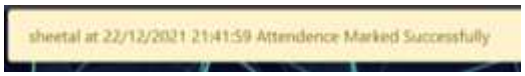
User can register himself/herself by providing Student ID.

Once Registration is completed, the user is presented with the "Registration Successful" message at the top of the page.

The registered user is displayed with the Registered Name surrounding the face, which successfully recognizes the face and marks attendance.

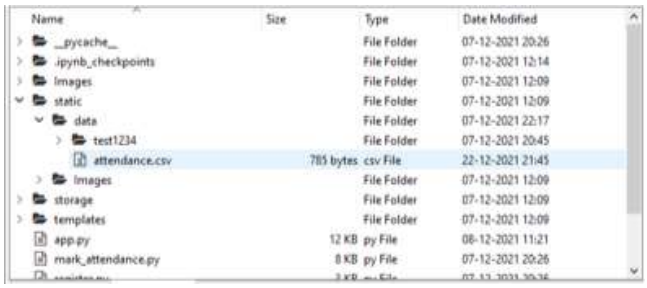


The user is provided with the Attendance Marked Successfully message at the top of the screen with Registered Name, Date and Time.



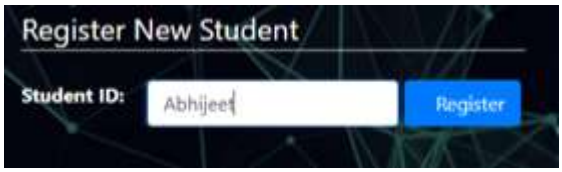
At the backend, PreTrained model Stores "N" number of pictures of the user while marking the attendance so that these pictures can be used for the further outcomes.

"Attendance.csv" file gets generated which contains marked attendance of the user.

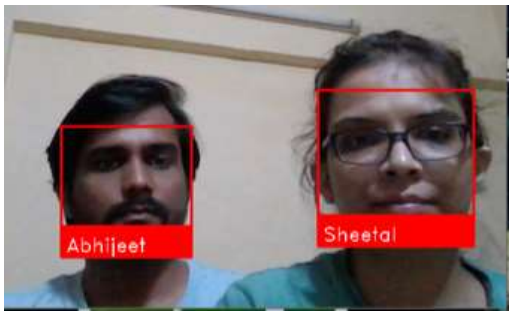


The .csv file can be viewed which gives details of the attendance in the format of "Student ID", "Date", "Time of Entry".

The registration can be done for another User with different User ID.



The implementation shows when two different registered users try for the Attendance at the same time. Respective registered names will be shown on the screen correctly.



Testing Results:
Action: System Launch
Inputs: Enter URL
Expected Result: The System should be launched with the home page.
Actual Result: The system is launched with the expected home page.
Test Result: Pass

Action: Camera Start Functionality
Inputs: Click on "Attendance" Button
Expected Result: The Camera should get started
Actual Result: The camera is started
Test Result: Pass

Action: Test Attendance for Non-Registered user
Inputs: Non-registered user Infront of Camera
Expected Result: The User face should be surrounded by box with "Unknown" as name.
Actual Result: "Unknown" name is provided to the user around the face.
Test Result: Pass

Action: Register user
Inputs: Enter "Student ID" and click on "Register" button
Expected Result: The message should be displayed as "Registration Successful"
Actual Result: "Registration Successful" message gets displayed.
Test Result: Pass

Action: Test Attendance for Registered user
Inputs: Registered user Infront of Camera
Expected Result: The User face should be surrounded by box with Registered Name.
Actual Result: Registered Name is provided to the user around the face.
Test Result: Pass

Action: Attendance Marked message verification
Inputs: Registered user Infront of Camera
Expected Result: The message related to Successful Attendance should be displayed with Name, Date, Time.
Actual Result: Attendance marked Successfully message gets displayed with Name, Date, Time.
Test Result: Pass

Action: Face Detection for more than one user at a time
Inputs: Two registered users Infront of camera.
Expected Result: The application should recognize both registered users
Actual Result: The application displays respective registered names around the faces.
Test Result: Pass

Action: Attendance marking for more than one user at a time
Inputs: Two registered users Infront of camera.
Expected Result: The application should mark attendance for both at the same time.
Actual Result: The application marks attendance for only one user.
Test Result: Fail

5. CONCLUSION AND FUTURE WORK

The proposed work concludes that the Attendance system was made with combination of different algorithms and it works with good accuracy and efficiency. By applying the methods described, accurate algorithms and quality face recognition results can be obtained. By applying HOG algorithm and facial landmark detection method with the help of dlib library of python, which beats other classifiers with its speed, accuracy and ease of implementation. Benefits using HOG classifier makes Dlib's HOG face detection easy for the usage and faster for training purpose. One can achieve high performance levels in recognizing human faces and analyzing facial features, even in the picture with different backgrounds.

Based on the experiment, the system can recognize the face in many cases and conditions such as pose, expression with which the obtained accuracy with HOG is more accurate than Haar Cascade for face recognition.

It should be noted that plenty of other algorithms such as Haar cascade were also explored which can be replaced by HOG but it was found that the HOG method is more efficient while having a little number of faces which is generally with the case of biometric and Attendance systems.

Future Work
Every research has improvements to be done in the future, therefore researchers work on new technologies which can overcome the problems occurred in the implemented Technology.

There can be multiple things which can have an impact on the performance of face recognition-based attendance system which includes the distance by which the face is recognized by the system camera or excessive images captured from various angles which might result in in hanging the system.

If the input images are of equal numbers, then the system performance can be improved although 100% accurate implementation is not possible, but the system can fail due to several reasons such as noise, internet speed, web camera issues. Similarly, if the students are twins or any siblings which are studying in the same class with same faces, it can result in wrong interpretations.

In the proposed system, if there are multiple faces at the same time in front of camera then system recognizes both but marks attendance of only one registered face which is the limitation and can be considered as the future work.

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