Face Recognition Based Attendance System

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Abstract: The objective of the attendance system is to provide an alternative means to the traditional attendance system which consumes 10 to 15 minutes of time in 50 minutes of lecture hour. It also aims at eliminating human errors and proxy in recording the attendance of the student. This can be achieved by using face recognition for monitoring the attendance of the students in a class. The face recognition process is carried out by using the Cognitive Face API which follows the Principal Component Analysis (PCA) algorithm. Initially, the dataset of the students in a class are collected. The dataset is collected in a manner that for each student, a set of 25 images in various angles is collected. The features are extracted from the images that are collected by using the cognitive face API and the database is formed. The image of the class in columns is acquired immediately, when the input image is acquired by using a mechanical set up which captures image based on hour, the number of faces in the input image is detected. The detected faces are cropped and then stored in a folder. The features of the cropped faces are also extracted and it is compared and matched with the features in the database. When the feature matches, the attendance is marked for the particular student in the spreadsheet and then the attendance report of the class is being uploaded in the web-page. Thus, the attendance of the student can be recorded in an effective manner. This paper also helps in avoiding human error which is unavoidable.

Keywords: Cognitive Face API, Principal Component Analysis, IOT, Arduino UNO,HTML.

I. INTRODUCTION

Maintaining the attendance is very important in all the institutes. Every educational institute and office have their own method of taking attendance either manually similar to old paper or file-based approach and few office and institute have adopted new methods of automatic attendance with the biometric techniques. [1][2][4] RFID based attendance system where a RFID Tag will be provided for students they should make an entry by showing the tag in front of the RFID Reader. But in these methods students must wait for long time in making a queue at time they enter the office .[8]In addition to the features of RFID a GSM mobile communication device is used to send a message to their parents about the intimation their children's absenteeism. They have additional feature of updating the attendance in web server, where an administrator can view the attendance in an hour basis.[5] WLAN technologies can also be used to mark attendance by detecting the mobile phones with unique authentication of barcode based on their fingerprint. [6] A major role in attendance system to keep track of attendance where zigbee is used as a wireless communication link to transfer student's entry in class using zigbee transmitter and Receiver. Many biometric systems are available, but the key authentications are same in all the techniques.

Evolution of modern technology and everything moving towards smart which created by development of android app [9] whose student day today activities and homework's, video lectures and images of special occasion can be intimated. These existing works requires additional maintenance, lack in accuracy. Added to existing system little manipulation to be done to have more accuracy for that, the Database has to store which will have biometric details of an individual student and employee which plays a major part in the processes of identification and verification. [7]The biometric potentials like iris are unique for humans which gives better authentication and identical of individuals. These two processes compare the biometric feature of a person with previously stored template captured at the time of enrolment. The templates of biometric which can be obtained from human for identifications are gait, eye, hand geometry, iris, signature, voice and Fingerprints.[3]There are various machine learning algorithm of various support vector machines and classifier are likely to be used improve the efficiency of Face Recognition and also statistical tools are used to construct the face templates..

Face recognition is the process done in two ways, the first way is to detect faces and the second way is to match with the database. It involves capturing an image from a video or from a surveillance camera where the face has to be detected either by bounded box, crop and match with the existing identities to identify the person.

Face biometrics involves training known images, classify them with known classes and then they are stored in the database. When a test image is given to the system it is classified and compared with stored database. Face biometrics is challenging fields of research with various limitations imposed for machine face recognition like variations in head pose, change in illumination, facial expression, ageing, occlusion due to accessories etc. Face recognition algorithms are broadly classified into two classes as image template based and geometric feature based. The template-based methods compute correlation between face and one or more model templates to find the face identity. Principal component analysis, linear discriminate analysis, kernel methods etc. are used to construct face templates. The geometric feature-based methods are used to analyze explicit local features and their geometric relations (elastic bung graph method).Multi resolution tools such as contour lets, ridge lets were found to be useful for analyzing information content of images and found its

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application in image processing, pattern recognition, and computer vision. Curvelets transform is used for texture classification and image de-noising. Statistical tools such as Linear Discriminant Analysis (LDA), Principal Component Analysis (PCA), Kernel Methods, and Neural Networks, Eigen-faces can be used for construction of face templates.

To condense the Work focuses on an IOT platform to monitor students attendance system by one click option activated automatically by an Embedded Hardware ,featuring towards smart attendance system.These attendance will be marked, uploaded on hourly basis on an Web Portal.

II. OVERVIEW AND COMPONENTS OF SMART ATTENDANCE SYSTEM

All educational institutions', IT sector, office and administrators are concerned about irregular attendance. Students or people can truant at some time can affect student overall academic performance and work synergy. The usual method of taking attendance by calling names or signing on paper is very time consuming and insecure, hence inefficient.

A. System Overview

The proposed system uses face recognition for marking the attendance of the students. In the proposed system, the database of the students is first collected and the features are extracted and stored. The attendance of the students of a classroom is taken by acquiring images of the entire classroom using the mechanical set up designed for capturing the image of the class in two directions, the input image is enhanced and the number of faces in the input image is detected. The detected faces from the input image are cropped. The features of the cropped faces are extracted and compared with the database. If the student was recognized, attendance will be marked as present for the particular student. When the entire recognition process is completed, the attendance report is uploaded to the web-page that is designed to serve this purpose. The web-page can be accessed by the authenticated persons only.

Fig.1 shows the overview of the proposed Attendance system. The hardware components that are used to automate the image capturing mechanism are a motor, an actuator, two relays or drivers, an Arduino UNO board, RTC and two 6V batteries
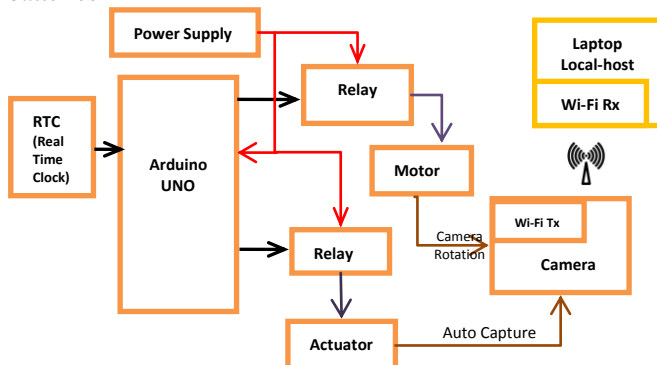

Fig.1: System Set-up

. The RTC is used as control for capturing the image of the class based on Hour. The stepper motor is used to rotate the camera and fix it in the direction such that it captures two rows

of the class, at once the actuator is used to press the clicker.When the image is captured, it is sent to the processing unit where the faces are detected and the attendance is marked. The attendance report is uploaded to a website and is displayed only to the authenticated persons

B. Laptop Local-host Block:

The training dataset is collected for each student and the features of each image are extracted. Fig.2shows the stage to stage process to maintain attendance is explained as follows.
- The camera is fixed in a rotating disk which is used to capture the images of the class.
- The image is captured in such a way that once when the disk rotates the actuator moves and then captures the image.
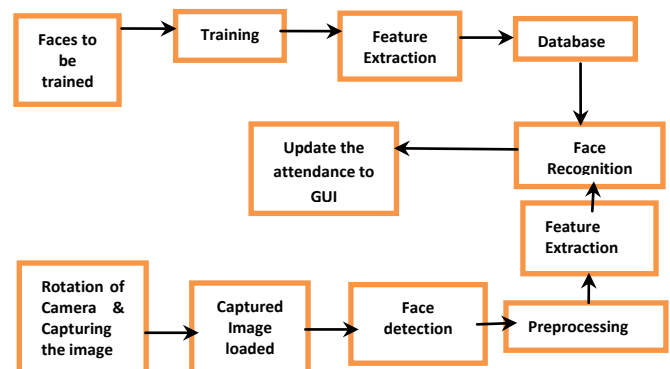

Fig.2: Flow Diagram of Attendance System
- Once when the image is captured it is loaded to the processing module. The following are the steps involved in recognition process.
  - I. The image of the class is acquired.
  - II. The face detection is done from the image acquired by using cascade object detector.
  - III. The detected face is cropped and then stored in a folder for feature extraction.
  - IV. The features of the cropped face are obtained by using the PCA algorithm.
  - V. Then the features are then compared with that of the test image dataset.
  - VI. If matched, the attendance is marked for that particular student and stored in the database.
- When the entire recognition process is completed, the spreadsheet is loaded to the website.

The captured image is given as input to the processing unit, the faces in the input image are detected and each face in the input image is cropped and the features of the cropped image are extracted. The recognition process is carried out by matching the features of the cropped faces which are detected from the input image with that of the features in database. The features are extracted by using the PCA algorithm and the Microsoft Azure Cognitive Face API is used as a tool for the detection and the recognition process. Cognitive Face API works based on the Principal Component

C. Principal Component Analysis (PCA)

Facial recognition is process of classifying input images in several classes. The captured image will additional noise due to lighting ,sitting positions of students, camera positions, and their angle and hence input

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image ware not completely random and may be difference in their patterns of the input images.

Based on the objects like eyes, nose and mouth position in any faces the relative distance between objects can be identified by the Eigenfaces in facial recognition. The Eigen faces can be extracted from original image data by means of the mathematical tool called Principal Component Analysis. By means of PCA one can transform each original image of the training dataset into a corresponding Eigenfaces. Identify all the Eigenfaces in order to reconstruct the original image exactly. Finding Principal Components of the distribution of faces, or the Eigenvectors of the covariance matrix of the set of face images.

Each image location contributes to each Eigenvector, so that the system can display the Eigenvector as a sort of face. Each face image can able to represent the terms in a linear combination of the Eigenfaces. The number of face image in the training set is equal to the number of possible Eigenfaces. The faces can also be approximated by using the best Eigenface, those that have the largest Eigenvalues, and which therefore account for most variance between the set of face images. The primary reason for using fewer Eigenfaces is computational efficiency.In linear algebra, the Eigenvectors of a linear operator are non-zero vectors which, when operated by the operator, result in a scalar multiple of them. Scalar is then called Eigenvalue (λ) associated with the Eigenvector (X).

Eigenvector is a vector that is scaled by a linear transformation.

$$AX = \lambda X \tag{1}$$

where A is a vector function.

$$(A - \lambda I)X = 0 \tag{2}$$

Where, I is the identity matrix. The non-trivial solution exists if and only if

$$Det(A - \lambda I) = 0 \tag{3}$$

Where, Det denotes determinant.

When evaluated becomes a polynomial of degree n. This is called characteristic polynomial of A. If A is N by N then there are n solutions or n roots of the characteristic polynomial. Thus, there are n Eigen values of A satisfying the equation.

$$AX_i = \lambda_i X_i \tag{4}$$

Where,i = 1,2,3,.....n

If the Eigen values are all distinct, there are n associated linearly independent eigenvectors, whose directions are unique, which span an n dimensional Euclidean space.

Face Image Representation is one of the main concept where Training set of m images of size NxN are represented by vectors of size N2. Each face is represented by $\Gamma_1, \Gamma_2, \Gamma_3,...\Gamma_m$. Feature vector of a face is stored in a N×N matrix. Now, this 2-dimensional vector is changed to one dimensional vector.

Average face image is calculated by

$$\psi = \frac{1}{m}\sum \Gamma_i \tag{5}$$

Where $\psi = \dfrac{(\Gamma_1, \Gamma_2, \Gamma_3,...\Gamma_m)}{m}$

Each face differs from the average by

$$\phi_i = \Gamma_i - \psi \tag{6}$$

Which is called mean centred image.
A covariance matrix is constructed as:

$$c = AA^T \tag{7}$$

Where $A = [\phi_1, \phi_2, \phi_3,...\phi_n]$ of size $N^2 \times N^2$

Eigen vectors corresponding to this covariance matrix is needed to be calculated, but that will be a tedious task therefore, for simplicity calculate $A^T A$.

Consider the Eigen vectors v_i of $A^T A$ such that

$$A^T A * X_i = \lambda_i X_i \tag{8}$$

The eigenvectors v_i of $A^T A$ are X_1 and X_2 which are N × 1. Now multiplying the above equation with A both sides

$$AA^T * AX_i = A * \lambda_i X_i$$

Eigen vectors corresponding to AA^T can now be easily calculated with reduced dimensionality where AX_i is Eigen vector and λ_i is Eigen value.

The Eigen vectors of the covariance matrix AA^T are AX_i which is denoted by U_i. U_i resembles facial images which look ghostly and are called Eigen faces.Eigen vectors correspond to each Eigen face in the face space and discard the faces for which Eigen values are zero thus reducing the Eigen face space to an extent. The Eigen faces are ranked according to their usefulness in characterizing the variation among the images.

A face image can be projected into this face space by $\Omega_K = U^T(\Gamma_K - \Psi); K = 1,2,3,...M$, where, $\Gamma_K \Psi$ is the mean centred image. Hence projection of each image can be obtained as Ω_1 for projection of image1 and Ω_2 for projection of image2 and henceforth

D. Arduino Uno

The Arduino UNO is a microcontroller board which is based on ATmega328 is the brain of the attendance system. It has General Purpose Input/Output pins interfaced with RTC and Relays which is used control the viewpoint of camera and activate automatic capture of photos of each class students for every period, this also enables Wifi device to transfer the attendance to the host system.

E. RTC-Real Time Clock

The attendance system which has RTC of DS1307 is I2C based clock generation microchip. This device is addressed by D0H, and has a small amount of memory which is capable of storing year, month, date, hours, minutes, and seconds. The microchip device is controlled by a master device ATmega328 through SDA and SCL lines. The microchip is connected with crystal oscillator 32.78KHz.to provide clock pulse for a timer circuit.

F. Battery and Relay

The system uses two 6V battery which is rechargeable. The lead-acid batteries use a gelled-electrolyte in a sealed, high impact plastic case. The construction of these high power-to-weight batteries eliminates the need to ever water or worry about spilling acid. The capacity is 20 Amps Hour and weighs of the battery is 4 lbs.

Relays are used as switch or control devices like motors or actuators with a microcontroller The proposed system uses two relays – one for linear actuator and other for the stepper motor with a power supply of 12V.

G. Linear Actuator

A linear actuator is an actuator that creates motion in a straight line, in contrast to the circular motion of a conventional electric motor. Many other mechanisms are used to generate linear motion from a rotating motor. Many other mechanisms are used to generate linear motion from a rotating motor.

H. DC Stepper Motor

The motors rotation has many direct relationships to those applied input pulses. The sequence of the applied pulses is directly associated with the direction of motor shafts rotation. The speed of the motor shafts rotation is directly associated with the frequency of the input pulses and therefore the length of rotation is directly associated with the quantity of input pulses applied. The 12V stepper motor is employed to rotate the camera and capture the image of two rows of the category.

I. Software Packages

OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision.This package is utilized acquisition of images of the students which forms the training dataset. The first step was in order to use the OpenCV is to create a virtual environment. Then, it can be utilized for the above-mentioned processes.

This system uses the dlib package for the purpose of detection of faces while collecting the dataset and when an input image is fed to the system, the faces in the images are detected using this package.

The SQLite package is used to create a database for the students with a person ID for each of the image being collected to form the training dataset. The SQLite package has three methods. They are connected, commit and execute. The connect method is used to open a connection to SQLite database. The execute method is used to insert a data in the database. The commit method is used to save the database. The close method is used to close the connection when no more data is to be added to the database.

Openpyxl is a Python library to read/write Excel xlsx/xlsm/xltx/xltm files. It was developed due to the lack of existing library to read/write natively from Python the Office Open XML format. It can be installed by using pip.This system uses HTML language for creating a Web page in which an authenticated user can access their login to find the attendance of each class with detail present and absent for a period.

III. SYSTEM MODELLING

A. Data Set collection

Effective marking of attendance from a classroom .this system needs an input data set of each students based on different brightness, illumination and expressions. Fig.3 shows the Data set samaple-1 of student whose twenty different expressions for 60 different people thus creating a 25x60 that is equal to 1500 different set of face images. Rotated images in left and right direction and different illumination conditions are also considered while making the

training set and further created data set sample 2 ,3 and 4 with 50,75,100 samples of student faces were collected .

A colour image is converted to greyscale image. These images will be useful for applying computational techniques in image processing. A greyscale face image is scaled for a particular pixel size as 200x200 because many input images can be of different size whenever it recognizes the input face.

Fig.3: Data set Sample -1

Similarly, the data set is collected for 60 students in the class. Features are extracted from the dataset.

B. Class Room Set-up of Image Acquisition

The image acquisition is done by using a 20MP camera and the image of the class is acquired by dividing the class into 2 columns. The input image is captured by the mechanical set up designed shown in Fig.4.
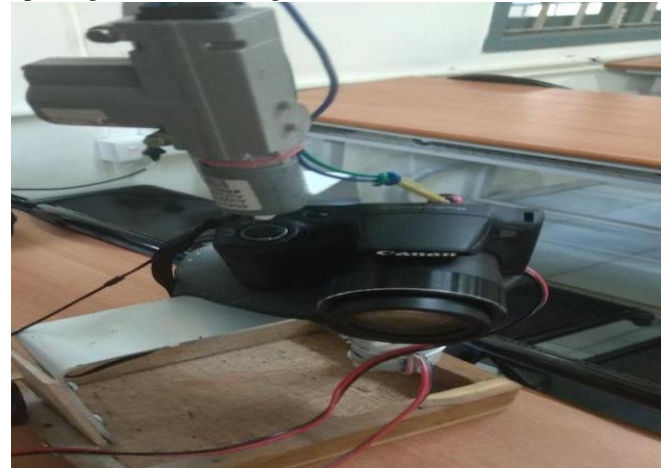

Fig.4:Mechanical wall mounting setup

The mechanical set up is designed in such a way that the camera rotates and captures the image of the class at a specific time (either at the start of the hour or at the end of the hour). Fig.5 shows the circuit connection of the Arduino with the relays and the RTC.
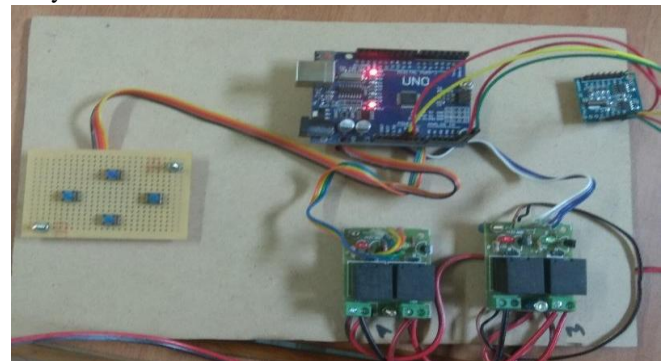

Fig.5: Designed Control Interface

The image of the class is acquired automatically and it is then uploaded to the localhost using the Wi-Fi transmitter in the camera.

When an image of the class is

transmitted through the Wi-Fi transmitter to the localhost, the face recognition process is initiated. The system is already been trained with the dataset of each student in the class. First, the system detects a number of faces in the input image and then, it crops the detected face and stores it in a folder and matches it against the training data set when the detected face has matched the attendance is marked for the particular student.

When an input image is provided, the system detects the number of students in the image and crops the detected faces from the input image and then extracts the features from the cropped faces using the cognitive face API tool which is a service provided by the Microsoft Azure. The extracted features are matched with the database i.e. the training set when the features match the attendance is marked for the student corresponding to the user ID (the last two digits of the roll number or registration number).
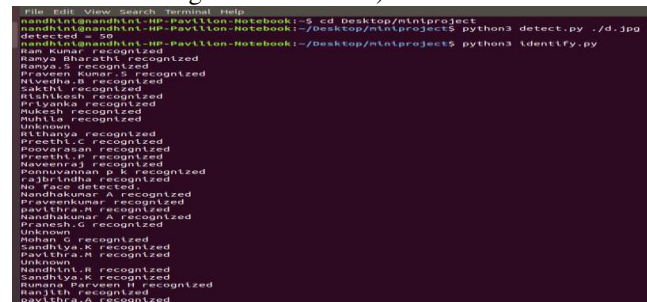
Fig.6: Recognition Result

Fig.6 represents the output of the Face recognition Based Attendance system. It shows the number of students whose faces are detected from the input image of the class. It also shows the students' name whose faces are being recognized by the system.

Fig.7: Cropped faces of Images of Students

Fig.7 represents the cropped images of those students whose faces are detected from the input image. The features of the cropped faces are extracted using the cognitive face API tool which uses the Principal Component Analysis algorithm. The extracted feature is compared with that stored in the database and if the features matches, the attendance is marked for the particular student in the spread sheet.
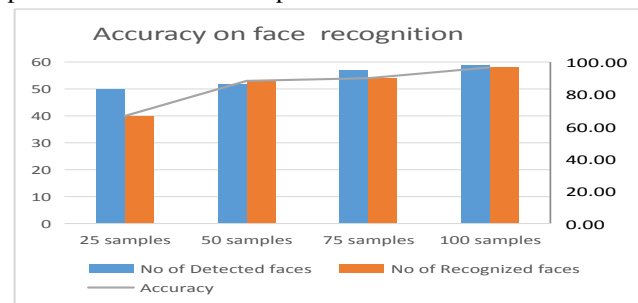

Fig.8: Accuracy chart various sample input images

Fig.8 shows the accuracy chart when number of samples for training dataset increases with deep neural network features the accuracy increases.

Fig.9 shows the authentication page, once when the username and password is correct, the access is provided and the user can select the class for which the attendance report will be displayed.
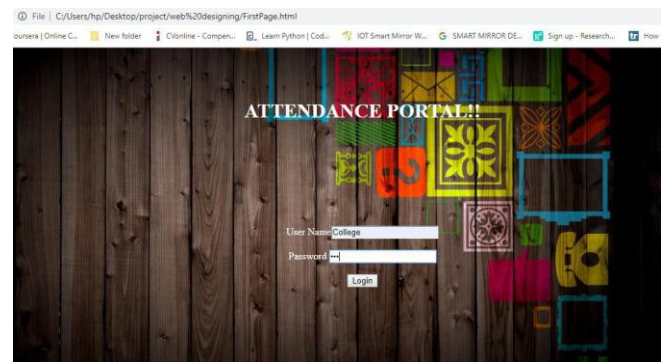

Fig.9: Website-Authentication Page

Fig.10: Attendance Report

Fig.10 shows the attendance report that is uploaded to the webpage. Thus, the attendance of the class is marked and it is uploaded in the webpage successfully.

IV. CONCLUSION

The designed system has proved to provide an alternative means for recording the attendance of the students in a more efficient and effective manner and also helps in avoiding human errors and proxy punching. It has put an end to the tedious process of maintaining a logbook for attendance and at the same time it has saved 10 to 15 minutes of time that is been previously spent on taking attendance during the lecture hour. The efficiency of the system in recognizing a student is 95.61%. The efficiency can be further improved by increasing the resolution of the images and also with wide angle cameras.

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