Automated Attendance System Based on Facial Recognition

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Abstract- *Nowadays Educational institutions are concerned about regularity of student attendance. This is mainly due to students' overall academic performance is affected by his or her attendance in the institute. Mainly there are two conventional methods of marking attendance which are calling out the roll call or by taking student sign on paper. They both were more time consuming and difficult. Hence, there is a requirement of computer-based student attendance management system which will assist the faculty for maintaining attendance record automatically.*

In this paper we have implemented the automated attendance system using PYTHON. We have projected our ideas to implement "Automated Attendance System Based on Facial Recognition", in which it imbibes large applications. The application includes face identification, which saves time and eliminates chances of proxy attendance because of the face authorization. Hence, this system can be implemented in a field where attendance plays an important role.

I. INTRODUCTION

Attendance is prime important for both the teacher and student of an educational organization. So it is very important to keep record of the attendance. The problem arises when we think about the traditional process of taking attendance in class room. Calling name or roll number of the student for attendance is not only a problem of time consumption but also it needs energy. So an automatic attendance system can solve all above problems.

There are some automatic attendances making system which are currently used by much institution. One of such system is biometric technique. Although it is automatic and a step ahead of traditional method it fails to meet the time constraint. The student has to wait in queue for giving attendance, which is time taking.

This paper introduces an involuntary attendance marking system, devoid of any kind of interference with the normal teaching procedure. The system can be also implemented during exam sessions or in other teaching activities where attendance is highly essential. This system eliminates classical student identification such as calling name of the student, or checking respective identification cards of the student, which can not only interfere with the ongoing teaching process, but also can be stressful for students during examination sessions.

II. LITERATURE REVIEW

Traditionally attendance was taken manually which is very time consuming and often leads to human error. Additionally, there are many uncertainties towards the sources of the attendance records which in fact, most of the attendance records are not retrieved from the actual situation. The old method that uses paper sheets for taking student's attendance can no longer be used. Based on the research, there are many solutions that are available to solve this issue.

According to research journal *Shireesha Chintalapati, M.V. Raghunadh, "Automated Attendance Management System Based On Face Recognition Algorithms", 2013.* This system, which is based on face detection and recognition algorithm, automatically detects the student when he enters the class room and mark the attendance by recognition him. This technique is to be use in order to handle the treats like spoofing. The problem with this approach is that it capture only one student image at a time when he enter the classroom thus it is time consuming and may distract the attention of the student.

The second research journals *"Face Recognition Based Attendence Marking System" (Senthamil Selvi, Chitrakala, Antony Jenitha, 2014)* is based on the identification of face recognition to solve the previous attendance system's issues. This system uses camera to capture the images of the employee to do face detection and recognition. The captured image is compared one by one with the face database to search for the worker's face where attendance will be marked when a result is found in the face database. The main advantage of this system is where attendance is marked on the server which is highly secure where no one can mark the attendance of other. Moreover, in

this proposed system, the face detection algorithm is improved by using the skin classification technique to increase the accuracy of the detection process. Although more efforts are invested in the accuracy of the face detection algorithm, the system is yet not portable. This system requires a standalone computer which will need a constant power supply that makes it not portable. This type of system is only suitable for marking staff's attendance as they only need to report their presence once a day, unlike students which require to report their attendance at every class on a particular day, it will be inconvenient if the attendance marking system is not portable. Thus, to solve this issue, the whole attendance management system can be developed on an embedded design so that it can be work similarly with just batteries that makes it portable.
In [3] the authors have proposed Wireless Fingerprint Attendance Management System. This system uses iris recognition system that does capturing the image of iris recognition, extraction, storing and matching. But the difficulty occurs to lay the transmission lines in the places where the quality of topography is poor.

The fourth research journal *"Fingerprint Based Attendance System Using Microcontroller and LabView" (Kumar Yadav, Singh, Pujari, Mishra, 2015)* proposed a solution of using fingerprint to mark the attendance. This system is using 2 microcontrollers to deal with the fingerprint recognition process. Firstly, the fingerprint pattern will be obtained through a fingerprint sensor, then the information will be transmitted to microcontroller 1. Next microcontroller 1 will pass the information to microcontroller 2 to do the checking with the database that resides in it. After finding a student's match, the details are sent to the PC through serial communication to be displayed. This design is good as it accelerates development while maintaining design flexibility and simplifies testing. But again, this system is attached to a PC which make it not portable. Other than that, the database information cannot be accessible easily. Meaning that, for the parents whom are interested in knowing their child's attendance cannot easily or conveniently access the information. Therefore, to provide accessibility of the student's information to the legitimate concerned party, the information can be uploaded to a web server for easy access. While the authentication for the appropriate access can be enforced through a login screen.

In conclusion, a better attendance monitoring system should be developed based on its portability, accessibility and the accuracy of the collected attendance information.

III. FACE RECOGNITION

One of the simplest and most effective LBPH approaches used in face recognition systems is the so-called eigenface approach. This approach transforms faces into a small set of essential characteristics, eigenfaces, which are the main components of the initial set of learning images (training set). Recognition is done by projecting a new image in the eigenface subspace, after which the person is classified by comparing its position in eigenface space with the position of known individuals. The advantage of this approach over other face recognition systems is in its simplicity, speed and insensitivity to small or gradual changes on the face. The problem is limited to files that can be used to recognize the face. Namely, the images must be vertical frontal views of human faces.

IV. LBPH ALGORITHM

Local Binary Pattern (LBP) is a simple yet very efficient texture operator which labels the pixels of an image by threshold the neighborhood of each pixel and considers the result as a binary number.

The LBPH uses 4 parameters:

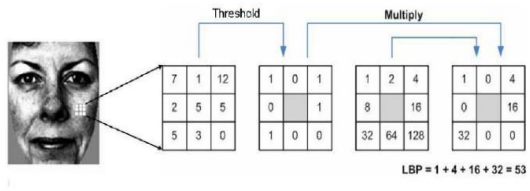
Radius: the radius is used to build the circular local binary pattern and represents the radius around the central pixel. It is usually set to 1.

- **Neighbours**: the number of sample points to build the circular local binary pattern. Keep in mind: the more sample points you include, the higher the computational cost. It is usually set to 8.
- **Grid X**: the number of cells in the horizontal direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.
- **Grid Y**: the number of cells in the vertical direction. The more cells, the finer the grid, the higher the dimensionality of the resulting feature vector. It is usually set to 8.

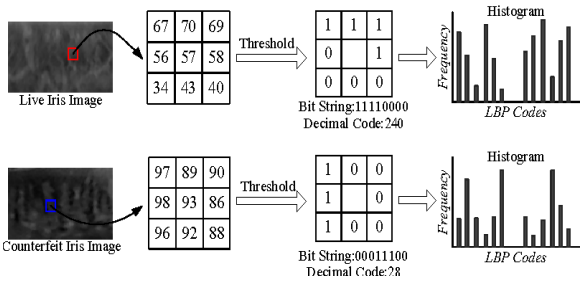
First, we need to train the algorithm. To do so, we need to use a dataset with the facial images of the people we want to recognize. We need to also set an ID (it may be a number or the name of the person) for each image, so the algorithm will use this information to recognize an input image and give you an output. Images of the same person must have the same ID.

The first computational step of the LBPH is to create an intermediate image that describes the original image in a better way, by highlighting the facial characteristics. To do so, the algorithm uses a concept of a sliding window, based on the parameters **radius** and **neighbours**.

The image below shows this procedure:



Using the image generated in the last step, we can use the **Grid X** and **Grid Y** parameters to divide the image into multiple grids, as can be seen in the following image:



The algorithm is already trained. Each histogram created is used to represent each image from the training dataset. So, given an input image, we perform the steps again for this new image and create a histogram which represents the image. To find the image that matches the input image we just need to compare two histograms and return the image with the closest histogram. To calculate the Distance between two histograms we use the Euclidean distance based on the following formula:

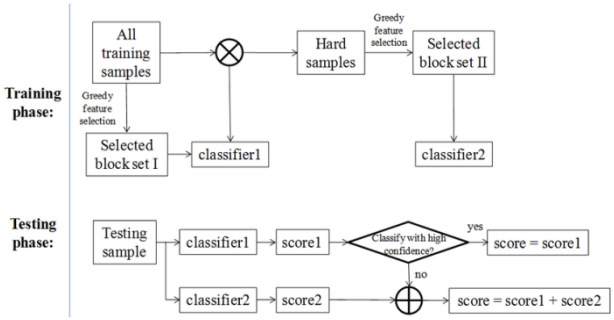
$$D = \sqrt{\sum_{i=1}^{n}(hist1_i - hist2_i)^2}$$

V. CASCADED CLASSIFIER

The basic principle of the Viola-Jones face detection algorithm is to scan the detector many times through the same image – each time with a new size. Even if an image should contain one or more faces it is obvious that an excessive large amount of the evaluated sub-windows would still be negatives (non-faces). This realization leads to a different formulation of the problem:

Instead of finding faces, the algorithm should discard non-faces. The thought behind this statement is that it is faster to discard a non-face than to find a face. With this in mind a detector consisting of only one (strong) classifier suddenly seems inefficient since the evaluation time is constant no matter the input. Hence the need for a cascaded classifier arises.

The cascaded classifier is composed of stages each containing a strong classifier. The job of each stage is to determine whether a given sub-window is definitely not a face or maybe a face. When a sub-window is classified to be a non-face by a given stage it is immediately discarded. Conversely a sub-window classified as a maybe-face is passed on to the next stage in the cascade. It follows that the more stages a given sub-window passes, the higher the chance the sub-window actually contains a face. The concept is illustrated with two stages in Figure shown below.



In a single stage classifier one would normally accept false negatives in order to reduce the false positive rate. However, for the first stages in the staged classifier false positives are not considered to be a problem since the succeeding stages are expected to sort them out.

Therefore, Viola-Jones prescribe the acceptance of many false positives in the initial stages. Consequently, the amount of false negatives in the final staged classifier is expected to be very small. Viola-Jones also refer to the cascaded classifier as an attention cascade. This name implies that more attention (computing power) is directed towards the regions of the image suspected to contain faces. It follows that when training a given stage, say n, the negative examples should of course be false negatives generated by stage n-1.

VI. IMPLEMENTATION

The present systems of attendance marking i.e. manually calling out the roll call by the faculty have quite satisfactorily served the purpose. With the change in the educational system with the introduction of new technologies in classroom such as virtual classroom, the traditional way of taking attendance may not be viable anymore. Even with rising number of course of study offered by universities,

processing of attendance manually could be time consuming. Hence, in our project we aim at creating a system to take attendance using facial recognition technology in classrooms and creating an efficient database to record them.

Block Diagram:

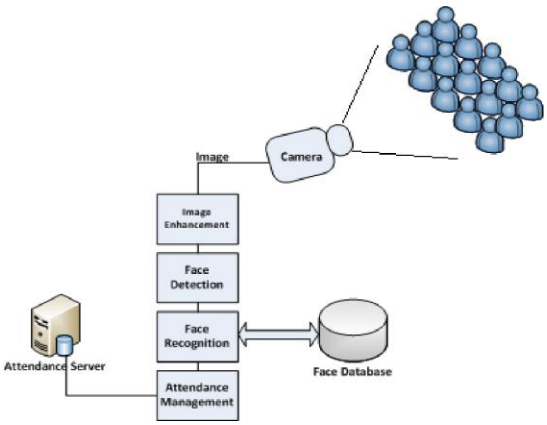


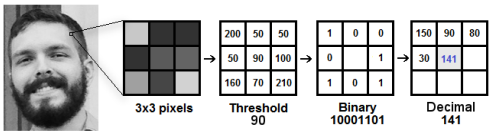
Fig: Proposed system

The block diagram in figure describes the proposed system for Face Recognition based Classroom attendance system. The system requires a camera installed in the classroom at a position where it could capture all the students in the classroom and thus capture their images effectively. This image is processed to get the desired results. The working is explained in brief below:

1. Creation of a GUI: The main interactive part of an software solution is its UI/UX interface here in this project the UI window with multiple buttons with each button having specified functionalities is created with python based indigenous Tkinter (also known as Tk/Tq) library functions.

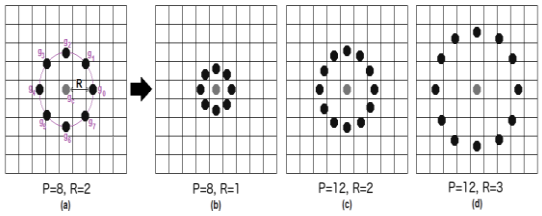
2. Training the Algorithm: First, we need to train the algorithm. To do so, we need to use a dataset with the facial images of the people we want to recognize. We need to also set an ID (it may be a number or the name of the person) for each image, so the algorithm will use this information to recognize an input image and give you an output. Images of the same person must have the same ID. With the training set already constructed, let's see the LBPH computational steps.

3. Applying the LBP operation: The first computational step of the LBPH is to create an intermediate image that describes the original image in a better way, by highlighting the facial characteristics. To do so, the algorithm uses a concept of a sliding window, based on the parameters radius and neighbours.



Based on the image above, let's break it into several small steps so we can understand it easily:

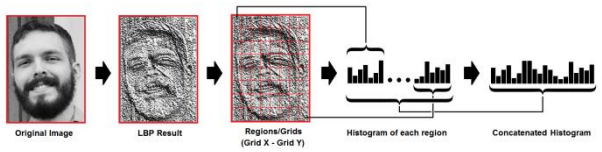
- ✓ Suppose we have a facial image in gray scale.
- ✓ We can get part of this image as a window of 3x3 pixels.
- ✓ It can also be represented as a 3x3 matrix containing the intensity of each pixel (0~255). • Then, we need to take the central value of the matrix to be used as the threshold.
- ✓ This value will be used to define the new values from the 8 neighbors.
- ✓ For each neighbor of the central value (threshold), we set a new binary value. We set 1 for values equal or higher than the threshold and 0 for values lower than the threshold.
- ✓ Now, the matrix will contain only binary values (ignoring the central value). We need to concatenate each binary value from each position from the matrix line by line into a new binary value (e.g. 10001101). Note: some authors use other approaches to concatenate the binary values (e.g. clockwise direction), but the final result will be the same.
- ✓ Then, we convert this binary value to a decimal value and set it to the central value of the matrix, which is actually a pixel from the original image.
- ✓ At the end of this procedure (LBP procedure), we have a new image which represents better the characteristics of the original image.
- ✓ Note: The LBP procedure was expanded to use a different number of radius and neighbors, it is called Circular LBP.



It can be done by using bilinear interpolation. If some data point is between the pixels, it uses the values from the 4 nearest pixels (2x2) to estimate the value of the new data point.

4. Extracting the Histograms: Now, using the image generated in the last step, we can use the **Grid X** and **Grid Y**

parameters to divide the image into multiple grids, as can be seen in the following image:



Based on the image above, we can extract the histogram of each region as follows:

• As we have an image in greyscale, each histogram (from each grid) will contain only 256 positions (0~255) representing the occurrences of each pixel intensity.
• Then, we need to concatenate each histogram to create a new and bigger histogram. Supposing we have 8x8 grids, we will have 8x8x256=16.384 positions in the final histogram. The final histogram represents the characteristics of the image original image.

5. Performing the face recognition: For recognition, the feature locations are refined and the face is normalized with eyes and month in fixed locations. Images from the face tracker are used to train a frontal Eigen space, and the leading three eigenvectors are retained. Since the face images have been warped into frontal views a single eigen space is enough. Face recognition is then performed using the Eigen face approach with additional temporal information added. The projection coefficients of all images of each person are modelled as a Gaussian distribution and the face is classified based on the probability of match.

6. Attendance Recording: We use Excel spreadsheet to store the recorded attendance for easy-to-use output format, which is also the software which is familiar to majority of the institution staffs. This is done using Spreadsheet Link EX toolbox. If a student is recognized, the corresponding cell is updated with '1', else a '0'. Using the formatting in the Excel, we can effectively retrieve the information effectively.

FLOW CHART

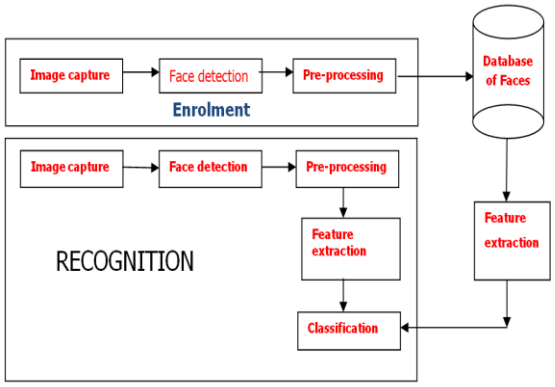


Fig: System Architecture

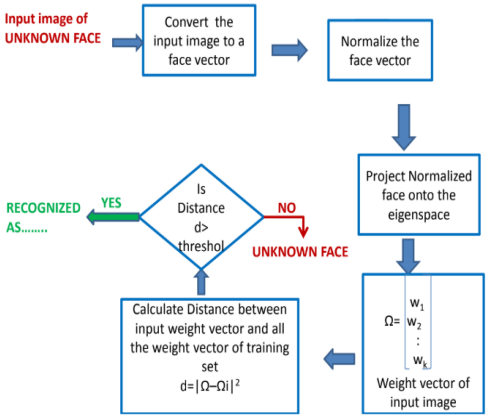


Fig: Recognition of Unknown Faces

VII. RESULTS AND ANALYSIS

Using the all the functions we have created, we have tested for output in using existing test images as well as in real-time. Following section, the screenshots of the output of different functions are given. We have tested the system with the help of three volunteers.

Designed GUI window

GUI window is successfully developed as shown in below figure .The required interactive window along with functional buttons and notification bar is made using tkinter library functions tool. Fig shows image capturing window for taking and tracking images.

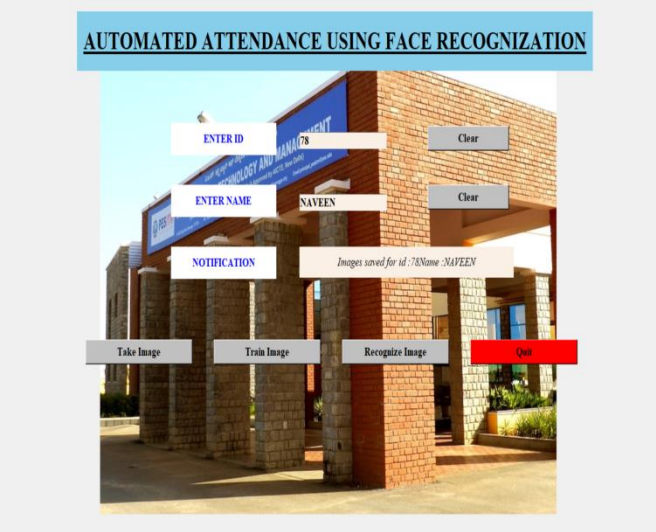


Fig: GUI designed using TKINTER-python

Image capturing, Face Detection and Cropping:

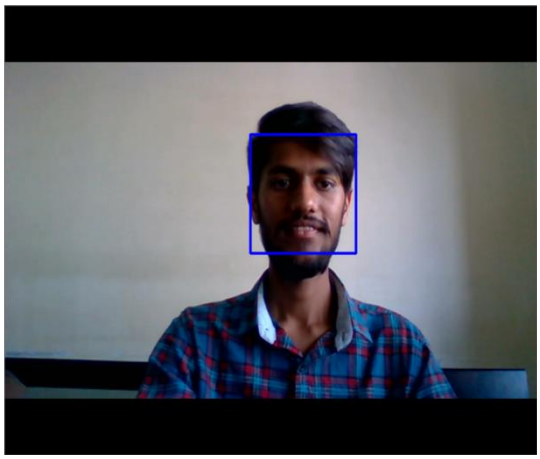


Fig: Image showing detected Face region bounded by the Rectangular box

"cv2" command is used to get the boundary around the detected face. In the below figure it is shown with blue colour rectangular boundary.

Collect Training Dataset

Using the function Train Database we create a database of the enrolled students which is stored in the folder.

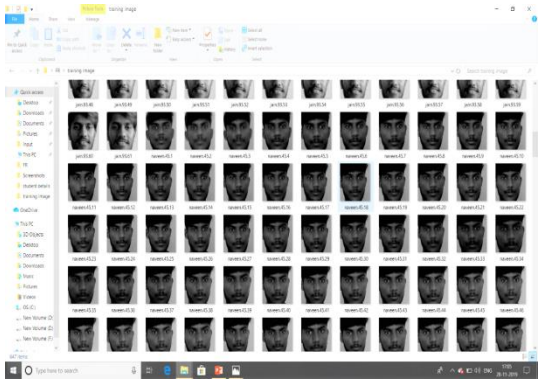


Fig: Showing the Images of the Training Set

Face Recognition

Cropped facial images are fed into the face recognition algorithm and we get the results. The Eigen faces algorithm is applied to the image and compared with the database. We get the output as in below figure after this process.

Fig: A students is recognized and appropriate message is displayed

If a person whose database is not present in the database, his image is simply ignored. However proper lighting has to be maintained in order to prevent in any false detection.

Output in MS Excel

The recognized face acts as an proof of attendance and an excel sheet with .csv extension is created and attendance is marked with timestamp using CSV library as shown in below Figures.

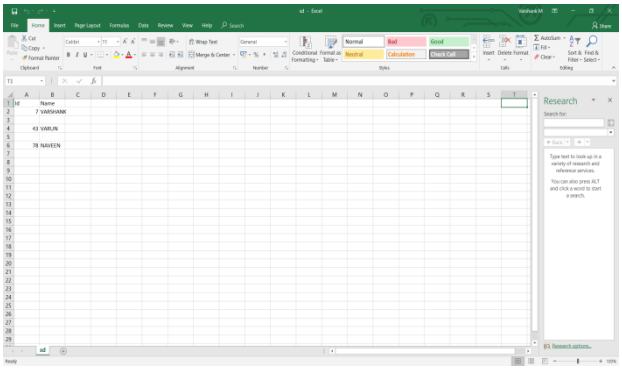


Fig: CSV file data columns with date and timestamps

VIII. CONCLUSION

In this system we have implemented an attendance system for a lecture, section or laboratory by which lecturer or teaching assistant can record students' attendance. It saves time and effort, especially if it is a lecture with huge number of students. Automated Attendance System has been envisioned for the purpose of reducing the drawbacks in the traditional (manual) system. This attendance system demonstrates the use of image processing techniques in classroom. This system can not only merely help in the attendance system, but also improve the goodwill of an institution.

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