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Attendance System using Face Recognition utilizing OpenCV Image Processing Library

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Abstract: ***Face recognition Technology is being appealing field in recent years. Taking attendance is a real-world task, which needs a creative solution to reduce time, efforts and resources. Face recognition Attendance is a technique to detect and recognize the students' or employees' face for marking their attendance by using unique face features extracted from the images captured. In proposed face recognition project, a raspberry PI based system will be able to detect and recognize human faces in a quick and accurate way via images or videos that are being captured through a Camera. It detects the faces within the image and compares it with the listed faces in the database. On recognition of a registered face on the captured image assortments, the attendance of that student is marked present otherwise absent. The system is developed on Open Source image processing library hence; it is not hardware nor software dependent. Many algorithms are used to ameliorate the performance of the system but the concept to be implemented here is Eigen matrix concept (Eigen Faces). It is used to convert the images into the matrix, based on the features of the images, to easily recognize the faces of the students, so that the attendance database can be easily updated.***
Keywords: OpenCV, Eigen faces, Face recognition, Face detection, Attendance System, Real time face recognition

I. INTRODUCTION

Presently, attendance management is important task in every educational organization. Managing students' attendance during lecture period is time consuming task. The most of the institutions uses pen-paper based approach and some have adopted automated methods such as fingerprint biometric techniques and RFID based attendance System. However, these techniques make students to wait in a queue that depletes time and it is intrusive. Some institutions still use manual attendance approach in which a subject teachers call out the students' name and mark the attendance manually. This approach may be considered as a time-consuming or sometimes it happens for the teacher to miss someone to mark present or students may answer multiple times to make proxy attendance of their friends. So, the problem of accuracy and reliability arise when we think about the traditional process of taking attendance in the classroom. Face recognition technology is one of the least intrusive and fastest growing technology. Face recognition based attendance is an approach to automatically mark the presence or the absence of the student in the classroom by recognizing their faces. It can also be implemented in the exam sessions to ensure the presence of the real student who has registered for exam. It works by identification of humans using the most unique characteristics of their faces via images captured through camera, so it becomes highly reliable for the machine to mark the presence of all the students available within the room.
The concept of this paper is aimed towards developing a less intrusive, economical and more efficient automated student attendance managing system using face recognition.

II. EXISTING METHODS

Some systems exist in automated attendance technique. However, only a few are enforced implementing a less intrusive approach. Some existing systems include Finger print based attendance, Iris based attendance and RFID based attendance. In this research, my focus is on face recognition and a cost effective architecture for its implementation. Face recognition based attendance system with raspberry pi 3A+ using Eigen faces algorithm has been proposed. In the work, a camera is placed at top position of the class that cover whole class which is interfaced with a raspberry pi 3A+ module for capturing students entering the class. The images are stored in the raspberry pi 3A+. The raspberry pi 3A+ module is used to achieve high speed of operation.

III.PROPOSED SYSTEM

To achieve the said aim, System is developed as a client-server based Cloud application. The system is designed to transfer heavy weighed task like face detection and recognition from client local system to cloud server, since image processing might be heavy weighed task, especially when amount of data is vast and large. The task of the said system is to capture the face of every student and to store it within the database for their attendance. The face of the student needs to be captured in such a manner that all the feature of the students' face needs to be detected. Thus, manual attendance taking is not required.

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The main task of the client local system is to listen for attendance request and continuous capturing of images from the Raspberry PI connected cameras mounted in front of the classrooms. The client system sends all captured images to the cloud web server for storage. Image processing unit on the cloud web server is built on an Open Source image processing library. Hence, the system is not hardware or software dependent.

IV. SYSTEM OVERVIEW

The system uses Raspberry PI connected Cameras affixed in front of a classroom disregarding of their location to continuously capture image of the entire class at fixed interval, over the duration of a lecture and sends images through the intranet to the cloud server for processing. The server processes the images by detecting and identifying the human faces contained, extract the faces and matches them with the registered faces of the students stored on the database. During the process of face identification, only the students that is registered with the course is marked as present, rest are kept unprocessed and admin (teacher) is notified about the unrecognized faces. On correct identification of a student face, the attendance register for the course is flagged as present for the student, otherwise it is marked as an absent.

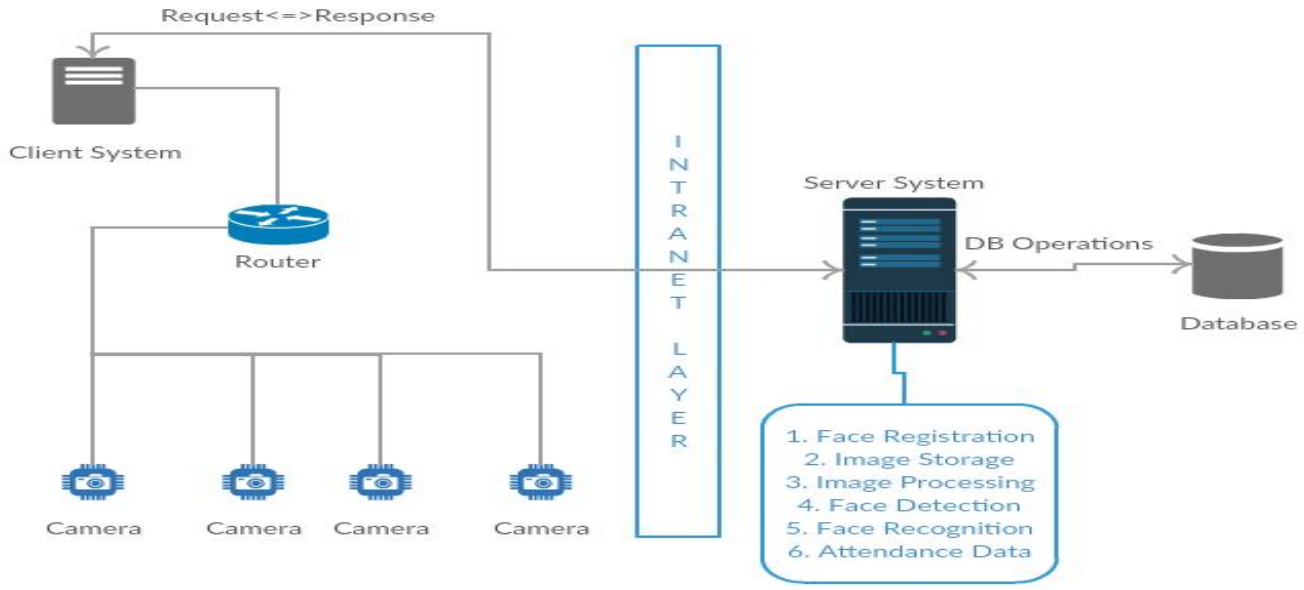


Figure 1. System Architecture

System is designed to run part of its components in local system as well as on a cloud server, the local system connects all the Raspberry PI connected cameras in different classroom locations using a router.

1) *Face Enrolment:* The enrolment process involves capturing students' photos with various angles, to create a database of students' photos template, the face templates are stored in the database for face recognition. This task is performed by the admin (teacher) on the day of course enrolment.
2) *Image Storage:* All images captured from the Raspberry PI connected cameras, and students' enrolled face templates are converted to binary and stored in the database.
3) *Image Enhancement:* Often, captured images have low brightness, as a result of poor lightning condition in the environment. Before these images are used for storing, detection or recognition purpose, it has to be normalized. Normalization ameliorates the accuracy of face detection and recognition. This process begins by converting the RGB image into a grayscale. Histogram normalization is then used for contrasts enhancement.
4) *Face Detection:* This is the ability to recognize human face in an image. System uses Haar Classifier for its face detection. Haar classifier is a face recognition algorithm trained with numerous human faces with various face positions, gestures and lighting condition. System uses this algorithm to detect multiple faces in an image and draw a rectangle on each detected face. The face images are extracted and resized to 128*128.
5) *Face Recognition:* System uses Eigen-face algorithm that uses Eigen matrix for face recognition. The algorithm is used to determine if enrolled face template stored in the database is found in the captured classroom image.

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Figure 2. Detected faces

V. FACE DETECTION METHODOLOGY

The simplest solution is to consider it as a template matching problem. Suppose Q is an N^2 x 1 vector, corresponding to an N x N face image I. The goal is to represent Q (X = Q - mean face) into a low-dimensional space.

X' − mean = $W_1U_1 + W_2U_2 + ... + W_KU_K$ (where K<<N2)

A. Computation of the Eigen-faces

Step 1: Obtain images of face, $I_1, I_2, ..., I_M$ (training data of faces)

All images of faces must be of same dimension and centered.

Step 2: Represent every image I_i as a vector Q_i

Step 3: Compute the average face vector F

$$F = \left(\frac{1}{M}\right)\sum_{i=1}^{M}\Gamma_i \quad (1)$$

Step 4: Subtract the mean face

$$X_i = \Gamma_i - F \quad (2)$$

Step 5: Compute the covariance matrix Z:

$$Z = \left(\frac{1}{M}\right)\sum_{n=1}^{M}X_n X_n^T = HH^T \quad (N^2 \text{ x } N^2 \text{ Matrix}) \quad (3)$$

Where $H = [X_1X_2X_3\ldots\ldots X_M]$ $(N^2 \text{ x } M \text{ Matrix})$

Step 6: Compute the eigenvectors U_i of HH^T

Step 6.1: Consider the matrix H^TH (M x M matrix)

Step 6.2: Compute the eigenvectors V_i of H^TH

$$H^THV_i = J_iV_i \quad (4)$$

Step 6.3: Compute the M best eigenvectors of HH^T: $U_i = AV_i$ (normalize U_i such that $| U_i | = 1$)

Step 7: Save only K eigenvectors (corresponding to the K largest eigen-values)

B. Face Detection

Each face Fi in the training set can be represented as a linear combination of the best K eigenvectors:

X'_i − mean = $\sum_{j=1}^{K} W_jU_j$, $Wj = U_j^T X_i$ (5)

(where U_j are eigen faces)

Each normalized training face X_i is represented in this basis by a vector:

$$Bi = \begin{bmatrix} W_1^i \\ W_2^i \\ W_3^i \\ \ldots \\ W_k^i \end{bmatrix}, \text{ where } i=1, 2, 3, \ldots, M$$

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VI. SYSTEM IMPLEMENTATION

The system is implemented using python and tested on Anaconda platform using Jupyter Notebook for backend server system. The face detection and recognition system was built on OpenCV image processing library.

VII. CONCLUSIONS

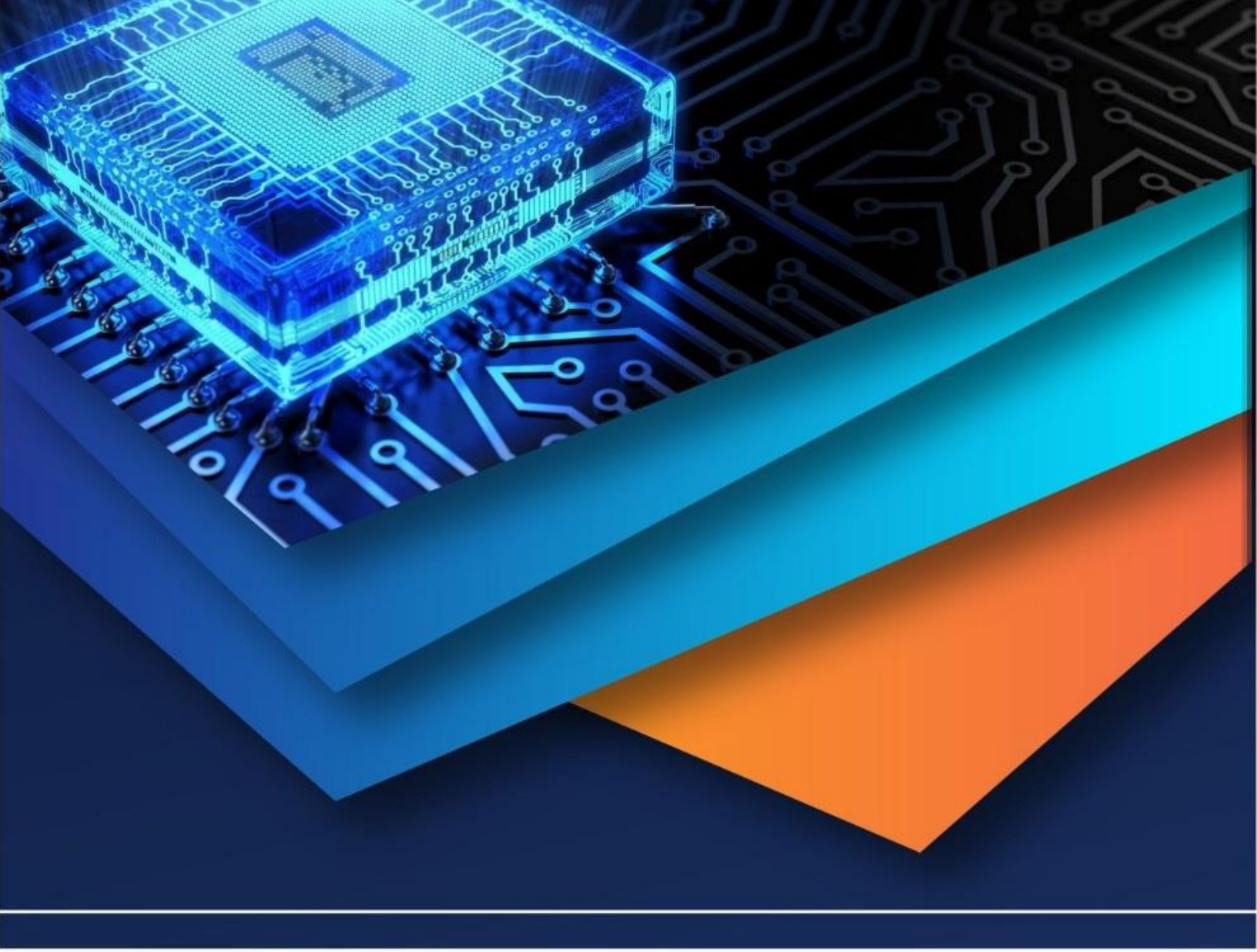
Thus, the aim of this paper is to capture the photos of the classroom, convert it into Eigen faces, compare it with the image database to ensure their presence or absence, mark attendance to the particular student to maintain the record. In this research, I tried to eliminate the attendance making challenges by demonstrating the use of face recognition in student attendance system. This Automated Attendance System helps in increasing the accuracy, speed and reliability ultimately achieving the high-precision real-time attendance to meet the need for automation.

The system is designed to be cost effective with no specific hardware and software required for deployment.

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