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Smart Attendance System Using Raspberry Pi

Amogh G, Gagan B, Guruprasad B, Suraj B, Rohit S
Department of Information Science and Engineering, SDM College of Engineering and Technology, Dharwad, Karnataka

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Abstract: The abstract outlines a system for monitoring attendance using biometric technology, specifically focusing on facial recognition. This system aims to replace manual attendance methods, providing a more efficient and reliable way to record attendance while eliminating the possibility of proxy attendance. The paper proposes the creation of an image database for the classroom and the training of the system using this database. During the recognition phase, a camera positioned in the classroom captures images of students' faces, which are then compared with the database to identify the individuals. Based on the identified faces, attendance is marked, and the information is promptly communicated to students/parents and the relevant faculty members. The implementation of this system utilizes a Haar cascade classifier for face detection and employs the local binary pattern histogram algorithm for comparing captured images with the database. The hardware used for this implementation is the Raspberry Pi 3B.

Index Terms—Automatic Attendance, Biometric, Face detection, Face Recognition, Haar Classifier.

I. INTRODUCTION

Traditional attendance marking in universities, colleges, and schools often involves face-to-face interactions, which can be inefficient, prone to errors, and time-consuming. To overcome these challenges, an automatic attendance monitoring system utilizing biometric processes is necessary. One such biometric method is fingerprint identification, where students' fingerprints are collected and stored in a database. However, this approach requires students to wait in queues, resulting in delays. Another method is iris recognition, but its implementation can be complex and time-consuming.

Among the biometric methods available, face recognition proves to be the most effective for attendance tracking. By capturing and storing images of each student's face in a database, the system can compare the captured images with the database during attendance marking. This method offers several advantages, including efficient time management, accurate results, improved security, and a reduced risk of fraud. Additionally, face recognition technology can find applications in various sectors, such as healthcare, banking, advertising, retail, universities, and corporate offices.

II. LITERATURE SURVEY

Several feature extraction and recognition algorithms are available for extracting features from images and recognizing them in an existing database. One such algorithm is the Eigen Faces algorithm, developed by Sirovich and Kirby in 1987. It captures the variation in collected faces and compares them with individual faces by generating eigenvectors through principal component analysis. The Fisher Faces algorithm, an enhancement to Eigen Faces, incorporates linear discriminant analysis to find linear combinations of features that separate different classes of faces. Another algorithm, the Local Binary Pattern Histogram, divides the grayscale image into 3x3 cells, compares pixel intensities with a threshold, and computes a histogram for feature extraction. The Scale-Invariant Feature Transform algorithm, introduced by David Lowe in 1999, detects and describes local features that remain invariant to transformations. The Speeded Up Robust Features algorithm, presented by Bay, and Van Gool in 2006, utilizes SURF descriptors and a multiresolution pyramid technique for object recognition and tracking. Although many advanced algorithms have emerged in recent years, their implementation may require higher hardware requirements than what is currently available.

III. IMPLEMENTED SYSTEM

The implemented system can be used for taking the attendance in universities, colleges, and offices. The architecture of the system is shown in Figure 1. A webcam

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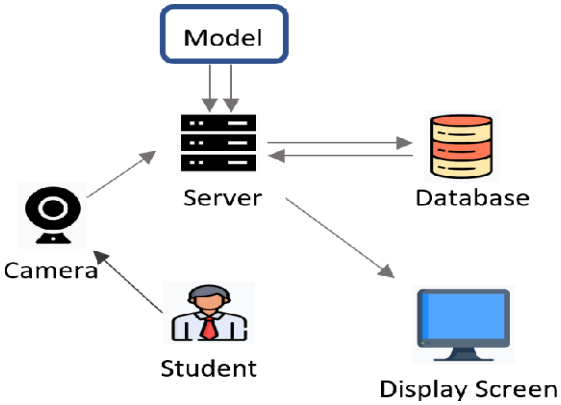

Fig. 1. Block diagram of the system

The implemented system has applications in universities, colleges, and offices for attendance management. The system architecture, as shown in Figure 1, involves connecting a webcam to a Raspberry Pi 3 B+. The webcam is positioned at the focal point in the classroom or office to capture images and extract human faces. The faces are then recognized using the existing database through OpenCV library files. The following steps are involved:

A. Capturing Images:
The camera module placed in the classroom or office captures samples for attendance recognition.

B. Creating a Database:
Data of individuals is necessary for biometric attendance. The face of each person is captured, converted to grayscale, and stored in the database along with their identity number. Multiple samples are taken with different facial expressions.

C. Detecting Faces:
The Haar cascade classifier, proposed by Viola and Jones, is used to detect faces in the captured images. OpenCV provides pre-trained classifiers for face, eye, smile, etc., based on edge and corner features.

D. Preprocessing:
To remove unnecessary background noise and elements, preprocessing techniques are applied. Feature extraction reduces the image to only the face, typically to a size of 150x150 pixels.

E. Face Recognition:
Face recognition involves training the algorithm with images and their corresponding identity numbers. Feature extraction is performed using various algorithms available in OpenCV, such as eigenfaces, Fisher faces, and local binary pattern histogram (LBPH). LBPH algorithm, widely used for face recognition, divides the grayscale image into 3x3 cells.

IV. EXPERIMENTAL SETUP AND RESULT

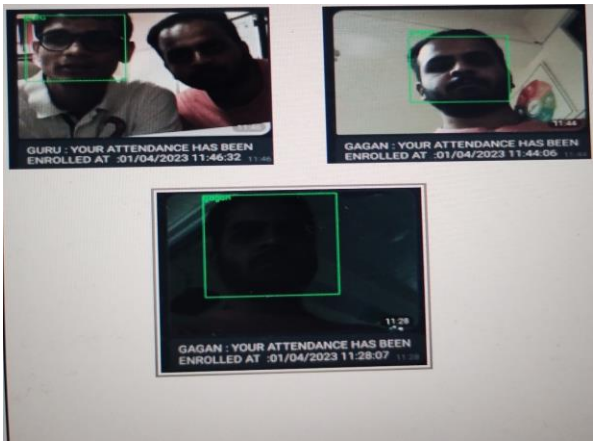

Fig 2: Face Detection and feature extraction phase

For this study, a collection of 5 students was chosen, and 50 images were taken for each individual. These images, along with their respective identity numbers, were stored in the database. The training process involved using these 50 images per person to recognize faces. In the classroom, the camera module placed at the focal point captured 100 images and identified the faces within them. If the probability of a face being recognized exceeded 50, the person was marked as present; otherwise, they were marked as absent. The system generated an Excel sheet with the attendance report, sent a list of absentees to the head of the department via email, and notified the parents of absentees through SMS.

V. CONCLUSION

The attendance monitoring system that has been implemented demonstrates a high accuracy rate of 96 percent. The system utilizes the Haar classifier and LBPH algorithms for face detection and recognition. In recent years, several advanced algorithms based on wavelet transforms, support vector machines, neural networks, and deep learning techniques have been developed. However, these advanced techniques often require sophisticated hardware such as high-end CPUs and GPUs. The cost of the system also increases significantly when using such advanced hardware.

In contrast, the implemented system is economical and highly practical, as it can be implemented with low-cost hardware while still achieving effective results.

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