Smart Attendance Capturing Mobile APP

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Abstract- **Student participation and eventual course success are influenced by the classroom attendance check. Even now, the majority of university lecturers still take attendance by calling out students' names or having them sign an attendance sheet that is passed around the classroom. In addition to being time-consuming, this method carries the risk of students falsifying their attendance by signing the attendance of other students, particularly in large classes. Alternatively, techniques based on RFID, wireless, fingerprint, iris, and face recognition have been developed and tested for this purpose. The biggest drawback for a university is the high system installation costs, despite the fact that these approaches have certain advantages. Therefore, the goal of this paper is to suggest a mobile application for attendance based on face recognition that doesn't require any additional equipment or money. Students at Keystone School of Engineering tested the suggested system, and the outcomes were quite positive.**

Keywords- **Face detection, face recognition, attendance capturing application, mobile application.**

I. INTRODUCTION

Since student participation in the classroom promotes successful learning and raises success rates, the majority of educational institutions are concerned about student participation in courses. Additionally, a high classroom participation rate inspires teachers and creates an atmosphere that is conducive to more willing and informative instruction. Regularly taking attendance is the most popular method for increasing course attendance. Data on attendance is typically created in two ways. Some educators would rather use names and mark students as present or absent. Some educators would rather distribute a paper signing sheet. Teachers manually enter the attendance data into the current system after collecting it using one of these two methods. However, because they take a lot of time and are prone to errors and fraud, those non-technological methods are inefficient.

The present paper aims to propose an attendance-taking process via the existing technological infrastructure with some improvements. A face capturing attendance mobile application has been proposed with a face recognition infrastructure allowing the use of smart mobile devices. The paper is organised as follows. Section II provides a brief literature survey. Section III introduces the proposed system, and section IV follows results. The last section gives the main conclusions.

II. LITERATURE SURVEY

In this section, we review a few related systems and their different methods in recording students' attendance.

1. *Smart Attendance System using RFID tags:*

Using student ID cards and RFID readers, the RFID- based attendance system logs students' attendance as they enter the classroom. Its drawbacks include the possibility of fraud (students using friends' cards, for example), phony absences in the event that a student forgets their card, and expensive setup fees. Other shortcomings of Bluetooth- based systems include the inability to identify students who are close but not present in class. Overall, even though the cost of RFID devices has decreased, RFID systems still require a large investment in additional hardware, such as computers, cables, and servers, which could result in a high setup cost.

2. *Smart Attendance System using Fingerprints:*

A fingerprint-based attendance system combined with GSM technology is an RFID substitute. This system ensures accurate and secure attendance recording by using fingerprint verification to verify student attendance. In order to keep guardians updated, the system also uses GSM to send them weekly attendance reports. Only one student can scan their fingerprint at a time, which slows down the process. Other issues with the system include high installation costs and limited usability. A fixed fingerprint scanner at the classroom entrance necessitates teacher supervision to keep students from leaving after scanning, which adds to the time and effort required of both teachers and students.

3. *Smart Attendance System using Iris Recognition:*
Daugman's Algorithm is used in the remote iris recognition portion of the attendance system. This system offers a very safe and precise way to track attendance by identifying a student by scanning and analyzing the distinctive patterns in their iris. Because it can be forged and requires little physical contact, iris recognition is thought to be more accurate than other biometrics like fingerprints. The ability to record attendance remotely eliminates the need for in-person interaction and boosts productivity. Nevertheless, these systems frequently call for high-resolution cameras and sophisticated image processing equipment, which can be costly and difficult to set up and maintain. This approach is a viable choice for organizations that value precision and automation in attendance management because, in spite of the expense, it provides improved security and reduces fraudulent attendance.

4. *Face Recognition-Based Classroom Attendance System:*
Two cameras are used in this system to record attendance: one at the classroom entrance to identify students as they arrive, and another inside the classroom to keep an eye on faces throughout the lesson. Even though face recognition at the door aids in automating attendance, students may depart later, resulting in inaccurate records. During the lecture, the in-class camera takes pictures, but maintaining good image quality necessitates regular camera upgrades, which raises expenses. Furthermore, both approaches require additional equipment, which raises the setup's complexity and cost. Although contactless attendance tracking is available, the system's viability and affordability for extensive or prolonged use are constrained by the requirement for multiple devices and the possibility of recognition errors.

III. METHODOLOGY

The Smart Attendance Capturing Mobile App was developed using a methodology that consists of several structured phases, including requirement analysis, system design, implementation, and performance evaluation. This hybrid system employs a web-based desktop application for face detection, recognition, and attendance management in addition to a mobile IP webcam for real- time image capture. These are described in the following sub-section.

1. *Research and Requirement Analysis:*
The primary objective of the proposed system is to reduce dependency on manual or hardware-based attendance methods. Existing technologies like fingerprint scanning and RFID have drawbacks like high maintenance costs, fraud risks, and high costs. Therefore, a system that makes use of easily accessible resources, such as webcams and smartphones, is proposed. Real-time facial recognition, student identity mapping, database storage, and report generation are examples of functional requirements. Non- functional requirements emphasize precision, effectiveness, and ease of use.

2. *System Design:*
The desktop web application and the mobile IP webcam application are the two primary parts of the system's design. Real-time video frames are continuously streamed from the IP webcam to the PC, where OpenCV is used to process the images. With distinct modules for image acquisition, face detection, face recognition, and attendance marking, the architecture facilitates modularity. A user interface for managing student records, viewing attendance logs, and creating reports is also included in the system. The frontend is created with web technologies like HTML & CSS and the backend database is SQLite.

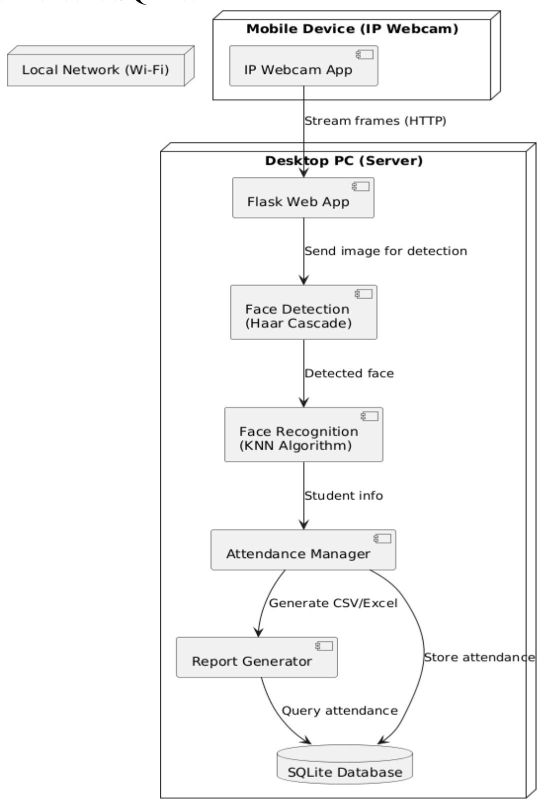

Fig 1: System Architecture

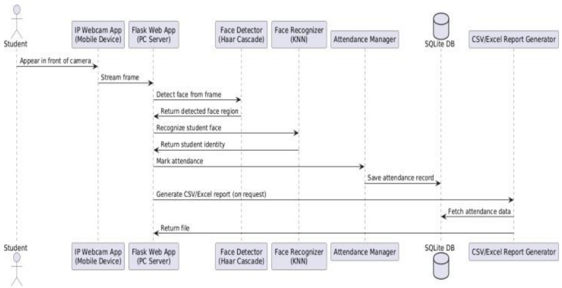

Fig 2: Work Flow

3. *Face Detection using Haar Cascade Classifier:*

We used the machine learning-based Haar Cascade Classifier for face detection, which trains a cascade function using a large number of positive and negative images. Using characteristics like edges and lines, it effectively identifies objects in an image—in this case, human faces. The image is scanned by the classifier at various locations and scales. We calculate performance using the Precision, Recall, and F1-score formulas:

- Precision = TP / (TP + FP)
- Recall = TP / (TP + FN)
- F1 Score = 2 × (Precision × Recall) / (Precision + Recall)

Where TP is True Positives (correct face detections), FP is False Positives (incorrect detections), and FN is False Negatives (missed faces). The goal is to achieve high precision and recall for accurate face detection.

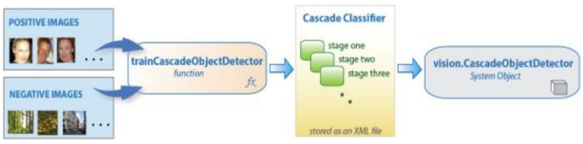

Fig. 2: Haar Cascade Classifier workflow

4. *Face Recognition using K-Nearest Neighbors (KNN) Algorithm:*

The K-Nearest Neighbors (KNN) algorithm is used for face recognition after face detection. A face encoding library (such as face_recognition built on dlib) is used to encode the detected face into a 128-dimensional face embedding vector. A pre-trained dataset of student images with labels is then used to compare these vectors. The KNN algorithm uses Euclidean distance to determine which match is the closest:

$$d(x, y) = \sqrt{\sum_{i=1}^{n}(y_i - x_i)^2}$$

Where xi and yi are the components of the embedding vectors for the input face and known faces respectively. The student is marked present if a match is found within a predefined threshold distance. Accuracy, precision, and recall metrics are computed to evaluate recognition performance.

5. *Implementations:*

OpenCV's Haar Cascade Classifier, which was trained on frontal face data, was used to implement the face detection module. An IP Webcam app is used to take pictures, and it sends frames to the web application created with Flask or other Python-based web frameworks via an IP address. Every frame is examined for faces, and those that are found are then recognized using the KNN model. The roll numbers of identified students are automatically recorded and timestamped.

Students are registered with their roll numbers and several face samples(50 images) during the initial training phase, and the system keeps track of these facial encodings in a database.

6. *Testing & Evaluation:*

To make sure the system was reliable, it was tested in a controlled classroom setting with different lighting setups and camera perspectives. To test the model's face detection and recognition capabilities, a test dataset with known student faces was used. To visualize performance and compute metrics such as accuracy, precision, recall, and F1-score, confusion matrices were created. The system's practical viability was confirmed by the satisfactory results it produced in both controlled and semi-controlled environments.

7. *Deployment and Output Generation:*

The student's name, roll number, and timestamp are recorded as attendance once face recognition is successful. Using libraries like pandas, this data is then combined into a daily attendance sheet that can be exported as Excel or CSV. Depending on the needs of the institution, the web application is hosted on either a local or cloud-based server. By removing the need for pricey biometric hardware, the mobile app serves as the input gateway and reduces infrastructure costs.

IV. RESULTS

Several classroom sessions were used to successfully develop and test the Smart Attendance Capturing Mobile App. The Haar Cascade classifier and K-Nearest Neighbors (KNN) algorithm are used in the suggested system to combine real-time face detection and recognition. 50 facial photos taken with a laptop webcam were used to create the training dataset for each student, enabling reliable facial recognition in a range of pose and lighting scenarios. The PC-based web application successfully captured and processed real-time images of students entering and attending the class using the IP webcam setup.

1. *Face Detection Performance:*

In a variety of lighting scenarios and facial orientations, the Haar Cascade Classifier showed excellent accuracy in face detection. The system's precision and recall were 93% and 92%, respectively, and its average detection accuracy was 95%. The main causes of the minor detection errors were extreme angles and occlusions, which are frequent problems in face detection tasks.

2. *Face Recognition Performance:*

Individual students were successfully identified from the recorded facial images using the K-Nearest Neighbors (KNN) algorithm. Using a dataset of 50 students, the system's overall recognition accuracy during testing was 90%. With an F1 score of 0.89, the KNN classifier's Euclidean distance computations successfully matched
students' faces with stored encodings. Similar facial features or changes in students' appearance (such as glasses or hairstyles) were the main causes of recognition errors.

3. Attendance Recording and Export

Accurate attendance records were kept, complete with timestamps and matching student roll numbers. The ability to export data in CSV and Excel formats was tested, producing well-structured attendance sheets without any data loss. The system processed each frame in about 0.5 seconds, which is sufficient for real-time classroom use, and it ran smoothly with little latency.

V. CONCLUSIONS

Using real-time face recognition technology combined with an IP webcam and a PC-based web application, this project successfully created an automated and reasonably priced attendance management system. The system efficiently captures and records student attendance with little assistance from humans by utilizing the K-Nearest Neighbors algorithm for dependable face recognition and the Haar Cascade Classifier for precise face detection. The capacity to produce attendance reports in Excel and CSV formats enhances the usefulness of institutional record- keeping.

Despite challenges such as variations in lighting conditions and occasional recognition errors due to facial changes, the system demonstrated strong overall accuracy and efficiency suitable for classroom environments. This approach addresses common issues found in traditional and RFID-based attendance systems, such as proxy attendance and high hardware costs, by providing a contactless and scalable solution.

Future work can focus on improving recognition robustness using advanced deep learning models and enhancing the system's real-time processing speed to support larger classroom sizes.

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