Department of Artificial Intelligence

22AIE201: Fundamentals of AI

Project Report

SMART ATTENDANCE SYSTEM

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DECLARATION

We, hereby declare that the project entitled is the record of the "Smart attendance system" the work done by our team under the guidance of Mr.Prajeesh C B, Amrita School of Artificial Intelligence, Coimbatore. To the best of our knowledge, this work has not formed the basis for the award of any degree/ diploma/ associate ship/ fellowship/ or a similar award to any candidate in any University.

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ABSTRACT

The **Smart Attendance System** is an innovative solution designed to streamline the attendance-taking process in educational institutions using **AI-based facial recognition technology**. The system captures real-time video streams, detects student faces, and matches them with pre-stored images, marking their attendance automatically without the need for manual intervention. Once a student is recognized, the system updates the attendance record and sends an email notification to the student's parents, confirming their presence. Additionally, an attendance report is generated and sent to the staff at the end of the day for efficient tracking and record-keeping. The system is built with **Flask** for the web interface, **OpenCV** and **face_recognition** for facial detection and recognition, and **SMTP** for email communication. This approach ensures accuracy, reduces human error, and significantly improves the efficiency of attendance management, providing a seamless solution for both students and faculty.

1. INTRODUCTION

The **Smart Attendance System** is an innovative solution designed to simplify the process of tracking attendance in educational institutions. Traditional attendance methods, such as manual roll calls or paper-based systems, are time-consuming and prone to errors. This system utilizes **AI-driven facial recognition technology** to automatically identify students as they enter the classroom, marking their attendance based on the recognition of their facial features. By using **real-time video feeds** from a camera, the system compares the captured face with a database of pre-registered student images to verify identity and record attendance. This approach eliminates the need for manual intervention and reduces the chances of fraud or errors, making attendance management faster, more accurate, and hassle-free.

In addition to the automatic marking of attendance, the system is equipped with features that enhance communication and accountability. **Email notifications** are automatically sent to parents whenever their child's attendance is marked, ensuring transparency and enabling better parent-teacher coordination. Furthermore, the system generates comprehensive **attendance reports**, which can be shared with staff members for monitoring and record-keeping. By integrating facial recognition with real-time data processing, the **Smart Attendance System** offers an efficient, user-friendly solution that reduces administrative workload while improving accuracy and reliability in attendance tracking. This technology is not only a time-saver but also a step toward digital transformation in educational institutions.

2. LITERATURE REVIEW

Face Recognition System Technology by *Sagar et al* [1] discussed biometric and face recognition as a domain that begins with face detection and extraction of features. It explained the scope and benefits of the project along with related works and challenges in face recognition due to limited datasets. It concludes that face recognition is an emerging technology that will only become more accurate and efficient.

A deep neural network and set-based face recognition method was proposed by *Prathama et al* [2]. since ageing alters facial features and affects recognition. They regard each subject's collection of photographs captured at various points in time as a single set and contrast it with collections of images of other subjects. It has been discovered that set-based recognition outperforms singleton-based recognition for both identification and verification, and that utilizing set-based recognition, it is simpler to distinguish between older and younger people.

A novel approach to facial recognition incorporating advanced feature extraction techniques was proposed by *Husein et al* [3]. The system uses the OpenCV cascade classifier to detect faces and the distinctive characteristics extracted from the set of facial data to distinguish between the facial images. The authors also assess the android device's battery life, processor power, and memory usage. The results demonstrate 93% accuracy in favourable lighting. The paper concludes by discussing the benefits and limitations of face recognition in android.

Facial Recognition for Attendance and Management by *Baskar et al* [4]
proposed a facial identification and recognition system to automate attendance records in classrooms. The system involved an enrolment process, recognition, and authentication procedures. They used machine learning models and classifiers to identify and label faces, and record attendance accordingly. The paper concludes with the implementation results and areas for improvement.

Udit's "Image Processing Using OpenCV" [5] This study investigated the application of OpenCV, a free computer vision toolkit, to image processing tasks. The paper provides an overview of OpenCV and its features, including its ability to handle real-time image processing, detect and track objects, and recognize faces.

3. PROBLEM STATEMENT

Managing attendance in traditional classroom settings is a time-consuming and error-prone task. Manual methods, such as roll calls or paper-based systems, are vulnerable to inaccuracies, and students can easily manipulate attendance records. This not only compromises the integrity of the attendance system but also leads to inefficiencies in tracking student engagement. Furthermore, these systems do not provide real-time updates to parents, leaving them unaware of their child's attendance until after the fact.

The manual process also burdens teachers and administrative staff, detracting from time that could be spent on teaching and student interaction. As class sizes grow, this problem becomes even more challenging. Thus, there is a need for a more efficient, accurate, and transparent solution.

The **Smart Attendance System** addresses these issues by using **AI-based facial recognition technology** to automatically mark attendance. This eliminates the need for manual input and ensures tamper-proof, real-time attendance tracking. Additionally, the system sends instant attendance notifications to parents, improving communication and transparency. By automating the attendance process, the system reduces administrative workload, allowing teachers to focus more on instruction.

4.METHODOLOGY

The **Smart Attendance System** integrates multiple technologies such as facial recognition, Flask web framework, and email automation to create an efficient and automated solution for attendance tracking. The following steps describe the methodology in detail:

1. Database Preparation

- A **CSV file** (students.csv) acts as the central database containing key information about students, such as:
    - **Name** of the student.
    - **Email** addresses for both the student and their parents.
    - **Role** (e.g., staff or student).
- Each student has a corresponding **image file** stored in a dedicated folder (images). These images serve as the input for generating face encodings used in facial recognition.
- **Data validation** is performed during initialization to ensure the completeness and accuracy of the CSV data and associated images

2. Pre-processing and Face Encoding

- The **face_recognition** library is used to extract unique facial features from the student images:
    - Images of students are loaded and processed to generate **face encodings**, which are numerical representations of unique facial structures.
    - These encodings are stored in a list along with the corresponding student names, creating a reference dataset for comparison during real-time detection.
- If a student image is missing or fails to generate an encoding, the system handles it gracefully by logging the issue for later correction.

3. Real-time Facial Recognition

- The system uses a **webcam** to capture live video for face detection and recognition:
    - Each video frame is resized and converted to the RGB format to optimize processing.
    - The **face_recognition.compare_faces()** and **face_recognition.face_distance()** functions are used to identify whether the faces detected in the frame match the stored encodings.
    - If a match is found, the student's name is displayed on the video feed, and their attendance is marked.
- To maintain efficiency, the system processes every 5th frame, reducing computational load while ensuring accurate recognition.

4. Attendance Logging and Management

- **Attendance Record Keeping**:
    - The system uses a **pandas DataFrame** to maintain an updated log of attendance, including:

        - Student's name.
        - Date and time of attendance.
        - Attendance status (e.g., "Present").

    - Duplicate attendance entries for the same student within the session are avoided by maintaining a unique set of recognized names.
- **Excel Export**:

    - The updated attendance log is periodically saved to an **Excel file** (Attendance.xlsx) for backup and reporting purposes.
    - Any errors during the saving process are logged for troubleshooting.

5. Parent Notification via Email

- When a student's attendance is recorded, the system automatically sends a **confirmation email** to the parent:

    - The parent's email is fetched from the database.
    - The email includes the student's name and the date and time of attendance.

- The email-sending process is managed using the **smtplib** library:

    - The system uses a Gmail account for email automation with SMTP configurations.
    - A **MIME-formatted email** is created with a clear subject and message body.

- To prevent delays, email sending is handled in a **separate thread**, ensuring smooth real-time face recognition.

6. Automated Staff Report

- After a session, the system compiles the attendance data and sends it to the staff member via email:

    - The **staff email** is extracted from the database.
    - The attendance Excel file is attached to the email and sent automatically after a pre-defined delay (e.g., 1 minute).

- The system ensures that staff receives timely updates without manual intervention.

7. Flask Web Interface

- A **Flask application** provides a user-friendly interface for administrators:

    - **Homepage**: Displays the project logo and a brief description of the system with a "Start Attendance" button.
    - **Attendance Page**: Streams the real-time video feed, showing recognized faces and attendance marking.
    - **Report Management**: Automatically sends attendance reports to staff and provides access to the saved Excel file.

8. Concurrency with Multithreading

- The system employs **multithreading** to manage tasks concurrently:

    - Face recognition and video streaming run on the main thread.
    - Email notifications and attendance logging are handled in separate threads.

- This approach ensures that heavy tasks, like sending emails or saving files, do not interfere with the real-time performance of the facial recognition system.

9. Error Handling and Debugging

- The system includes robust error handling mechanisms:

    - Missing or incorrect data in the CSV file or images triggers warnings.
    - Issues during email delivery or Excel saving are logged for troubleshooting.

- The system is designed to continue functioning even if non-critical components fail.

10. Outputs

- The system provides the following outputs:

    - Real-time video feed with recognized student names.
    - Updated attendance records saved in an Excel file.
    - Email notifications sent to parents and staff.

- These outputs ensure that the attendance process is automated, transparent, and reliable.

This step-by-step methodology ensures that the **Smart Attendance System** operates seamlessly, combining advanced facial recognition with practical automation features to save time, improve accuracy, and simplify attendance management.
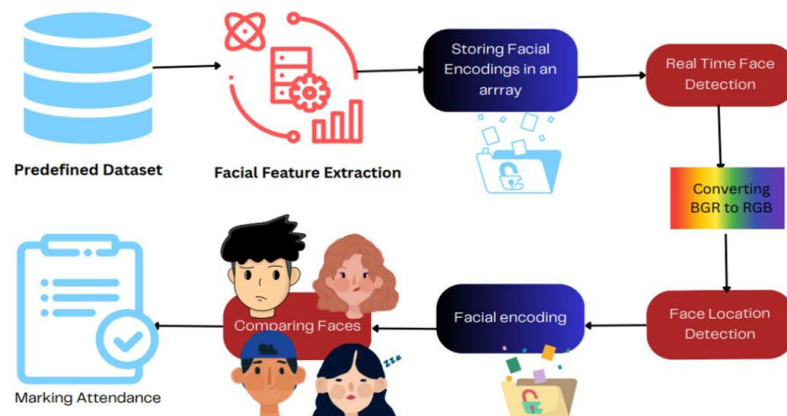

Figure 1. Block diagram describing the design of our algorithm for face recognition

5. RESULTS

Dataset and Environmental setup :

In this work, a dataset comprising 8 human face images was utilized. These images were obtained from students and teachers affiliated with Amrita Vishwa Vidyapeetham, showcasing a diverse range of facial expressions. These images serve as the dataset for training and evaluating our face recognition system [Figure 2].

The images were originally in JPEG and JPG formats and possessed a resolution of 1209 x 1620 pixels, as depicted in Figure 2. Subsequently, the images were pre-processed by cropping them to isolate the facial area and resizing them to a consistent size. This resizing ensured that the resulting output images were one-fourth the width and height of the original input images.

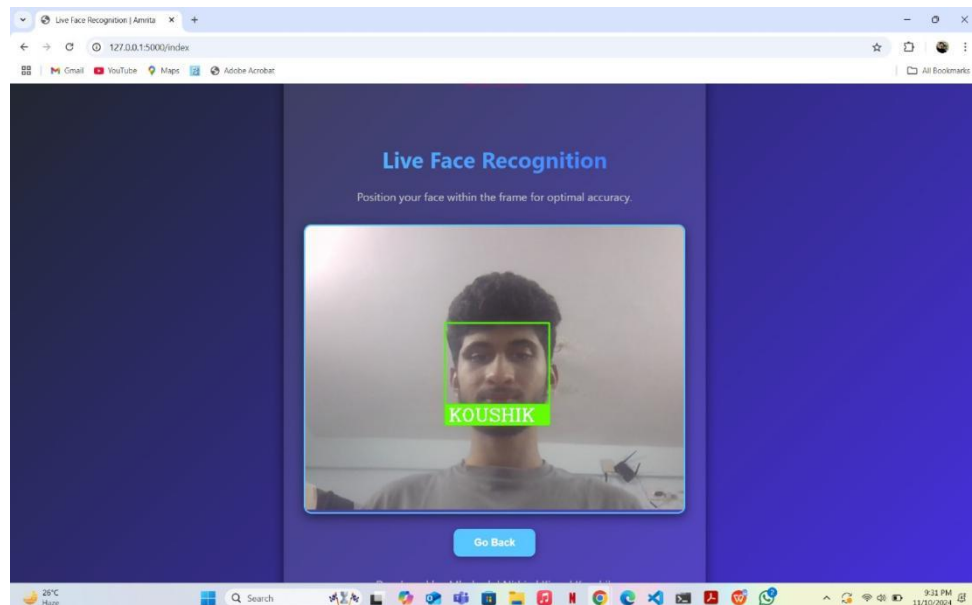**Figure 2.** Sample images collected from students

Figure 3. Real time face capture and recognition

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The live face recognition system shown above demonstrates real-time facial detection and identification. By positioning the user's face within the designated frame, the system accurately recognizes the individual and displays their name. This technology leverages facial recognition algorithms, which compare live images to a pre-stored dataset to authenticate identities. Such systems have a wide range of applications, including security, attendance management, and personalized user experiences.

	A	B	C	D
1	Name	Date	Time	Status
2	KOUSHIK	2024-11-1	17:08:23	p
3	MHOKESH	2024-11-1	17:08:24	p
4	NITHIN	2024-11-1	17:09:18	p
5				

Figure 4. Recorded attendance stored in an excel file

The attendance record shown above displays the captured data stored in an Excel file, listing the names, dates, times, and attendance status of individuals. Each entry reflects a real-time recognition event, with timestamps indicating when each person was identified. This format allows for easy tracking and management of attendance, making it suitable for use in institutions, workplaces, and events. By automating attendance recording, this system enhances efficiency and accuracy, reducing the need for manual entry and minimizing errors.

We also send a confirmation mail to Parents with Timestamp and the Complete Excel sheet of Attendance to the respective Staffs after the session ends. This Enhances our project even more effectively .

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6.FUTURE SCOPE

· **Integration with Institutional Systems :**

- Seamlessly link with Learning Management Systems (LMS) or Enterprise Resource Planning (ERP) platforms for automated attendance management and reporting.

· **Enhanced Accuracy with Advanced Algorithms :**

- Incorporate advanced deep learning models to improve facial recognition accuracy, even under challenging conditions like poor lighting or partial visibility.

· **Cloud and Mobile Accessibility :**

- Store data on the cloud for scalability and real-time access, and develop a mobile application for easy attendance monitoring and notifications.

· **Support for Virtual and Hybrid Learning :**

- Enable attendance tracking through video conferencing platforms for remote and hybrid learning environments.

· **Advanced Analytics and Insights :**

- Provide detailed reports and predictive analytics on attendance trends to help identify patterns and support administrative decisions.

7.CONCLUSION

The Smart Attendance System leverages advanced technologies such as facial recognition, real-time video processing, and automated email notifications to revolutionize attendance management. By eliminating manual processes, it enhances efficiency, reduces human error, and ensures accurate record-keeping. The system demonstrates a seamless integration of AI and automation, offering a user-friendly interface that caters to educational institutions and workplaces alike.

With its ability to provide timely attendance reports and notify stakeholders, the system not only simplifies administrative tasks but also fosters accountability and transparency. As technology continues to advance, the Smart Attendance System holds the potential to evolve further, adapting to diverse environments and emerging requirements, ultimately paving the way for smarter, more efficient institutional processes.

8.REFERENCES

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