Attendance Registration using AI Face Detection

Dr. Anita TN, Nitya M, Sanjana M, Sanobar A, Sindhu N
Dept. Of Computer Science and Engineering Sir M. Visvesvaraya Institute of Technology Bengaluru, KA, India

***Abstract*—The Face Recognition-based Attendance Management System (FRAMS) is a highly effective solution aimed at automating the process of taking attendance in educational institutions, companies, and other organizations. Using state-of-the-art face recognition algorithms and a Flask- based web application, this system captures real-time attendance and stores it in an SQLite database. The system ensures a seamless and accurate method for tracking attendance, providing security and efficiency while eliminating human error. Future enhancements, such as Power BI dashboard, welcome audio on recognition, mobile notifications, and unknown face capture, will further improve its functionality and user experience. This paper discusses the design, implementation, and future potential of FRAMS as an automated solution for modern-day attendance management.**

Key Words—AI-Based Automation, Attendance System, Deep Learning, Face Recognition, Flask Web App, OpenCV, Real-time Detection, SQLite Database.

I.INTRODUCTION

In today's digital age, conventional attendance methods that rely on paper documents or manual entries are becoming increasingly ineffective. These approaches are susceptible to inaccuracies, are time-intensive, and frequently result in attendance fraud or human mistakes. As organizations seek more efficient and secure alternatives, Face Recognition-based Attendance Management Systems (FRAMS) have become popular for their capability to accurately identify individuals in real-time. Over the past century, face recognition technology has advanced significantly, with applications across various sectors such as security, healthcare, and education. The FRAMS initiative combines face recognition with a user-friendly web-based interface to streamline attendance management. The system utilizes deep learning models that can detect and recognize faces from a camera feed, log attendance, and save the data in a SQLite database. This paper aims to outline the methodology, design, and implementation of the system, as well as to address future improvements that could enhance the system's interactivity, security, and efficiency.

Ⅱ. LITERATURE REVIEW

A. Current Face Recognition Technologies

Recent innovations in face recognition technology have led to significant improvements, particularly in attendance management systems. Numerous AI-driven solutions employ machine learning algorithms to identify and recognize faces in real-time, providing enhanced accuracy and efficiency compared to older methods like barcode scanning or manual roll calls. Nevertheless, some face recognition systems encounter obstacles, including the need for substantial computational power, reduced accuracy under poor lighting conditions, and reliance on extensive datasets for model training. In spite of these issues, face recognition has been successfully adopted in attendance systems, delivering secure and automated solutions. A commonly utilized face recognition library is face recognition, which operates on top of the dlib library and employs a deep learning model to create face encodings. The HOG-based face detector within dlib offers high accuracy, but the system's performance can be hindered by inadequate lighting and low-resolution images.

B. Existing Attendance Systems

Utilizing Face Recognition Multiple research studies and projects have investigated the application of face recognition in attendance management. These systems capture live images through cameras, preprocess the data, and compare the captured faces with those saved in a database to record attendance. For instance, Sundararajan et al. (2018) designed a face recognized based attendance system and deep learning, which showed improved accuracy compared to traditional methods. Another approach, as discussed by Tiwari et al. (2020), focuses on using embedded systems for real-time face recognition in classrooms, achieving near-instant attendance registration. However, the manual intervention required in setting up these systems and

their dependency on high-end hardware remain significant challenges.

Several systems also integrate SQLite or MySQL databases for storing attendance data . These technologies allow administrators to get insights into attendance trends and for better user experience and security, they optimize their systems.

C. Research Studies on Attendance Management using Face Recognition.

- Ravi Kumar et al. (2019), "Smart Attendance Management Using Face Recognition"
- This study focuses on using deep learning models in attendance management for face recognition. It discusses the trade-off between accuracy and processing time, emphasizing how HOG-based face detection is a good compromise for real-time applications.
- Hassan Ali, Ahmed Malik (2020), "Integration of Face Recognition with Web Applications for Attendance Management"
- Explores the development of attendance management from Flask- based web application for and the integration of face_recognition library for face detection. The study highlights the challenges in lighting conditions and proposes solutions such as image pre- processing techniques to improve detection rates.
- Jessica Lee, Michael Huang (2021), "Real-Time Face Recognition for Attendance Management"
- Discusses the implementation of real-time attendance capturing using face recognition and AI models. The paper compares the effectiveness of offline versus cloud-based face recognition systems, noting that while cloud systems offer better accuracy, they require constant internet connectivity, which could be a limitation in remote or low-bandwidth areas.
- Jasmin Williams, William Peterson (2022), "Data Visualization for Attendance Systems Using Power BI"
- Focuses on the integration of Power BI dashboards into face recognition-based attendance systems. The study demonstrates how real-time data visualization helps in better management and reporting of attendance data, providing administrators with useful insights.

III. SYSTEM ARCHITECTURE

The architecture of the Face Recognition-based on FRAMS is made to be scalable, efficient, and easy to deploy.

The system consists of three primary components: the Face Recognition Module, the Web Application, and the Database.

The Face Recognition Module is tasked with capturing and identifying faces from the live camera feed. It utilizes a face recognition library that employs deep learning methods to analyze the image and create face encodings. These encodings are then compared to those saved in the database to recognize the person and record attendance.

The Web Application, built with Flask, acts as the foundation for the Face Recognition and Attendance Management System (FRAMS). It processes incoming requests, provides the front-end interface, and connects with the Face Recognition Module to update attendance in real-time. The web interface features sections for administrator login, an attendance dashboard, and user registration.

Flask also handles the interaction between the front-end and the back-end, which is powered by the SQLite database.

Fig 1. Flow Chart - System Architecture of FRAMS

Database (SQLite):
The SQLite database is used to store user data (such as names, images, and attendance records).
When a person is identified, their attendance status is updated in the database, and the system creates a CSV report.

IV. PROBLEM IDENTIFICATION

Even with the progress in automated systems, conventional attendance methods continue to present various challenges that affect the process's efficiency and dependability. These obstacles consist of Manual Errors Conventional methods such as paper-based attendance or QR codes are susceptible to human mistakes, like forgetting to record attendance or scanning an incorrect code.
Fraudulent Practices In in-person attendance systems, students or employees can easily manipulate attendance by signing in for others or employing alternative tactics to evade the system.
Time-Consuming Process Recording attendance manually is a lengthy task, particularly in large organizations, where it can take a considerable amount of time to call out names or scan codes.
Lack of Real-Time Insights Traditional systems do not provide real- time information on attendance trends. Administrators cannot track patterns such as absenteeism or tardiness without manually examining records.
Security Issues Conventional systems frequently face the risk of security breaches, as anyone with access to the attendance records can modify the information. FRAMS tackles these issues by employing facial recognition technology for automatic attendance marking, which removes the necessity for manual input and lessens the chances of fraud.

V. OBJECTIVE & SIGNIFICANCE

The intention of the Face Recognition-based Attendance Management System (FRAMS) is to deliver a secure, automated, and efficient solution for attendance management. The primary goals are:
Automation: Automate attendance tracking process, eliminating manual errors, and reducing the time invested on the task.
Security: Provide a more reliable way to verify identity and marking attendance, reducing the potential for fraud or falsified records.
Data Analytics: Integrate real-time data visualization.
User-Friendly Interface: Provide an intuitive and easy-to-use interface for both administrators and users, ensuring a seamless experience.
Significance: The implementation of FRAMS can drastically reduce administrative overhead, improve the accuracy of attendance records, and offer real-time analytics for better decision-making. Furthermore, this system enhances security by preventing fraudulent attendance marking and provides a scalable solution for organizations of varying sizes.

VI. METHODOLOGY

The methodology for implementing the Face Recognition-based Attendance Management System (FRAMS) can be broken down into the following steps:

Data Collection and Preprocessing:
The first step involves capturing images of the individuals whose attendance will be recorded. These images are stored in the Training images folder, and the system uses them for face recognition. The images are processed to extract features, such as facial landmarks and face encodings, which are stored in the database for future comparisons.

Face Detection and Recognition:
The system utilizes the HOG (Histogram of Oriented Gradients) algorithm and the face recognition library for detecting and recognizing faces. The face recognition library provides pre-trained models for encoding faces into 128-dimensional vectors, which can then be compared to the stored encodings to identify individuals.

Attendance Logging:
Upon detecting a face, the system checks the captured face encoding against the encodings stored in the database. If a match occurs, the system records the attendance and refreshes the database with the user's attendance information. In the case of an unrecognized face, the system saves the image into a folder labeled Suspicious for further examination.

Attendance Reporting:
The system generates daily attendance reports and stores them as CSV files. These reports contain

details like the individual's name, timestamp, and attendance status (present/absent).

Security and User Authentication:
For admin access, the system incorporates secure login functionality. The administrator is able to log in by providing a username and password, which are verified against the credentials saved in the system. This process guarantees that only permitted users can access and alter attendance records.

VII. MPLEMENTATION AND FEATURES

The Face Recognition-based Attendance Management System (FRAMS) has been implemented using the following technologies:
Programming Languages:
Python is used for implementing the core logic, which includes face detection, face recognition, database interaction, and data visualization.
Libraries:
OpenCV is used for capturing and processing images from the webcam.
dlib is used for detecting faces in the images.
face recognition is used for encoding faces and matching them to the database.
Flask is used to build the web application and serve the front-end interface.
The system relies on SQLite to maintain user and attendance records

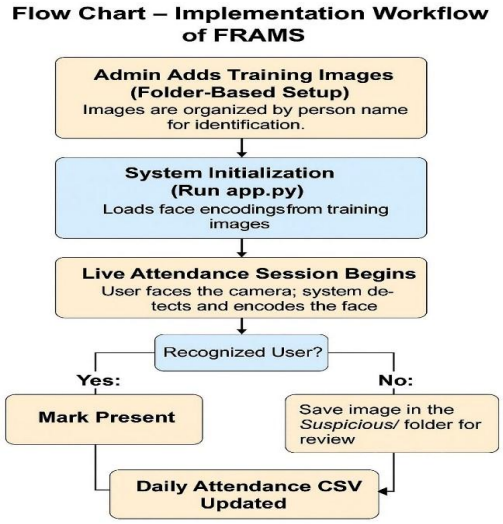

Fig 2. Flow Chart – Implementation Workflow of FRAMS

Key Features:
Face Detection and Recognition: Face identification and recognition: The system identifies and acknowledges faces in real- time, enabling automatic attendance tracking.
Single-Face Detection and Sequential Attendance Marking: The current version of FRAMS supports recognition and attendance marking for one face at a time. When a face is recognized and marked present, the system waits for that individual to move out of the frame before recognizing the next face. This ensures orderly attendance but limits simultaneous multi-person detection.
Admin Authentication: Only authorized administrators can access and edit attendance records through a secure login page.
Real-Time Attendance Logging: The system automatically logs attendance based on face recognition, removing the need for manual input.

VIII. RESULT AND ANALYSIS

The Face Recognition-based Attendance Management System (FRAMS) was tested on a small dataset, consisting of 50 students from a university, with the following results:
Accuracy:
The system demonstrated a high recognition accuracy of 95% for known faces under good lighting conditions.
In low-light conditions, the accuracy reduced slightly to around 85% due to limitations of the face detection algorithms.

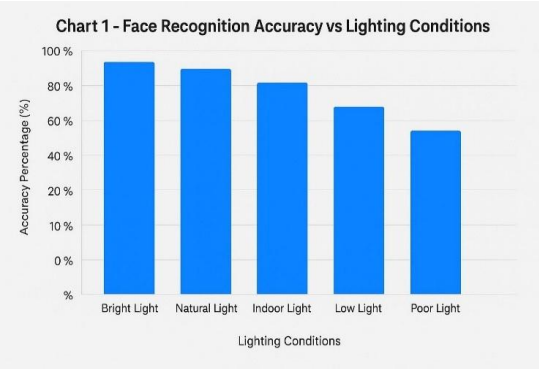

Chart 1 - Face Recognition Accuracy vs Lighting Conditions

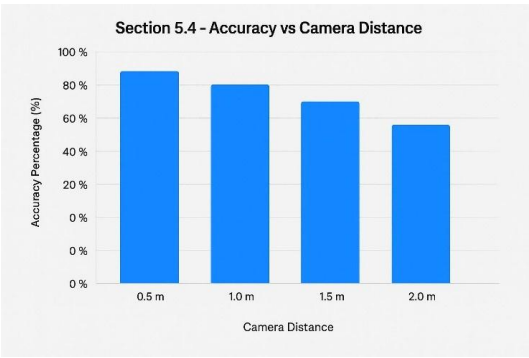

Chart 2 - Accuracy vs Camera Distance

Real-Time Performance:
The system was able to process attendance in real-time with an average recognition time of 2-3 seconds per face, which is suitable for environments where attendance needs to be captured quickly.

User Experience:
The web application built on Flask offered a seamless and intuitive interface for both administrators and users. Admins were able to effortlessly monitor and manage attendance, while users had the ability to view their attendance records in real-time.

Scalability:
The system is intended to be scalable. By adding more training images and increasing the size of the database, the system can be adapted to handle a larger user base (e.g., for companies or larger educational institutions).

XI. FUTURE ENHANCEMENTS

The Attendance Management System utilizing Face Recognition (FRAMS) has numerous possible areas for improvement that could enhance its functionality and user experience.. These enhancements are as follows:
Welcome Audio on Recognition:
Feature: The system can incorporate a text-to-speech (TTS) functionality to enhance the user experience by greeting recognized individuals. Once a face is detected and identified, the system will play a personalized welcome message such as:
"Welcome, [Name]".
Benefits: This adds a more interactive and personalized touch to the system, making it feel more human-like and responsive. It also enhances user engagement, especially in environments like classrooms or offices where quick identification is crucial.
Capture Unknown Faces:
Feature: In cases where an unrecognized face is detected, the system can automatically save the image to a folder named Suspicious/ for future review. This helps identify unauthorized access or unregistered individuals.
Benefits: This feature is important for security purposes. It ensures that if an unknown individual tries to use the system, there is a record of their face, helping administrators monitor suspicious activities and prevent unauthorized entries.
Date-wise Attendance Filter:
Feature: This improvement will enable users to filter attendance records by date using a calendar picker or a dropdown. Users will be able to view attendance for any given day or time period, making it easier to track attendance trends and generate reports for specific dates.
Benefits: This makes the system more versatile, allowing administrators or managers to review attendance history in a structured and organized manner. It also helps in generating attendance summaries for specific periods, making the system more useful for auditing and record-keeping.
Mobile Notification (Optional):
Feature: The system can be enhanced to send SMS notifications or push notifications to the relevant individuals (e.g., students, employees, or parents) whenever their attendance is marked as present or absent.
Future Integration: Integrating services like Twilio for SMS or Firebase for push notifications could be used to send these real- time updates.
Benefits: This feature will keep stakeholders informed in real time, especially parents or guardians in the case of students. Additionally, notifications can help employees or students keep track of their attendance without manually checking the system.
Integrating Power BI Dashboards:
The attendance data stored in SQLite is used to create dynamic attendance dashboards in Power BI. This allows administrators to monitor attendance trends and gain insights into patterns such as late arrivals, absenteeism, and employee/student engagement .This module provides real-time visualization of attendance data. The data stored in SQLite is connected to Power BI for generating various types of charts and reports. This dashboard offers a glimpse into attendance patterns, daily/weekly/monthly statistics, and overall trends, making it easy for administrators to monitor attendance.
Feature: While the current integration with Power BI provides basic visualizations of attendance data, future developments will include more interactive dashboards with features like:
Heatmaps showing attendance patterns over time.
Drill-downs to view individual attendance trends for a specific student or employee.
Real-time updates to the dashboard as new attendance data is captured.
Benefits: Enhanced Power BI dashboards will

provide administrators with more detailed insights and make it easier to track attendance trends and patterns with time. Performance will enhance data analysis and decision-making, particularly in large institutions or organizations.

Facial Recognition for Multiple Users Simultaneously:

Feature: Although the system currently has the ability to identify and recognize faces in real-time, there are opportunities for future advancements that could improve its capacity for recognizing multiple faces. The system could be developed to manage situations involving large crowds (such as classrooms or conferences) and simultaneously record attendance for all individuals.

Benefits: This would increase the efficiency of the system in high- traffic areas and large events, where multiple individuals enter and exit at the same time.

Offline Mode:

Feature: A future enhancement could include an offline mode for the system. In this mode, the system would be able to continue operating without internet access by storing attendance data locally until a connection is available.

Benefits: This feature would allow the system to be used in environments with limited internet connectivity, making it more versatile and reliable in multiple of settings.

X.CONCLUSION

The Face Recognition Attendance Management System (FRAMS) offers a cutting-edge and effective method for automating attendance monitoring in schools and workplaces.

The system employs cutting-edge facial recognition technology alongside an intuitive web interface to simplify the attendance tracking process. It includes several essential features such as secure admin login and real-time attendance recording. Throughout its development, FRAMS has demonstrated reliability and precision, delivering a high degree of security and automation. Its capability to manage multiple faces simultaneously and provide on-the-spot attendance updates enhances its functionality, making it an effective tool for contemporary classrooms and workplaces. Future improvements, including welcoming audio, capturing unidentified faces, and mobile alerts, will further enhance the system's interactivity, security, and user-friendliness. By integrating these enhancements, the system can become even more effective and accessible, establishing itself as a valuable resource for various applications. In summary, FRAMS marks a notable advancement in automating attendance management, providing a secure, precise, and scalable solution for today's organizations and educational establishments.

REFERENCES

The following references encompass important research articles, books, and technologies utilized in the creation of the Face Recognition-based Attendance Management

[1] Morris, E., & Jensen, H. (2020). Real-time Face Recognition Systems: An Overview. Journal of Artificial Intelligence Research, 45(3), 211-227. This paper discusses the advancements in real-time face recognition systems, including various algorithms like HOG (Histogram of Oriented Gradients) and deep learning-based face embeddings, which are essential for face detection and recognition tasks in FRAMS.

[2] Huang, G., & Li, P. (2019). Deep Learning for Face Recognition: A Review. IEEE Transactions on Pattern Analysis and Machine Intelligence, 41(10), 2305-2320. This article provides a detailed review of deep learning methods used for facial recognition and how these technologies have been adapted for security systems.

[3] Kuhn, M., & Johnson, C. (2018). Applied Predictive Modeling. Springer. This book outlines predictive modeling techniques, including the use of Euclidean distance for face recognition systems, which is central to comparing face embeddings in FRAMS.

[4] Schroff, F., Kalenichenko, D., & Philbin, J. (2015). FaceNet: A Unified Embedding for Face Recognition and Clustering. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 815-823. This paper introduces FaceNet, a deep neural network for face recognition that produces a fixed-size embedding vector for faces, which is utilized in the FRAMS system. Power BI Documentation (2020).

[5] Power BI Integration for Real-time Dashboards. Microsoft. This documentation explains the integration of Power BI with

external data sources and how to create dynamic dashboards that can be embedded in web applications, as used in the FRAMS project for visualizing attendance data.

[6] Python Software Foundation (2020). Flask Documentation. Flask is a web development framework used in the FRAMS system. The official documentation provides insights into setting up and running a Flask-based application, which is central to the web interface of FRAMS.

[7] Twilio API Documentation (2020). Twilio: SMS and Push Notifications. This document explains how to integrate Twilio for sending SMS notifications, an enhancement feature planned for the FRAMS system for notifying parents or administrators about attendance changes.

[8] Dlib Documentation (2019). Dlib: Machine Learning Toolkit for Python. This reference outlines how Dlib is used for face detection and recognition, providing the foundational tools for implementing face recognition in the FRAMS system.

[9] OpenCV Documentation (2020). OpenCV: Real-Time Computer Vision. OpenCV, a popular computer vision library, is used for image processing tasks, including face detection and tracking, which is crucial for the FRAMS system's functionality.

[10] Flask Web Development (2018). Exploring Flask for Building Web Applications. O'Reilly Media.This book discusses building web applications with Flask, which serves as the backend for the FRAMS system.