A Group Photo-Based Attendance System using Deep Learning

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***Abstract*—**Traditional methods of marking attendance in educational institutions, such as manual roll calls or even single-person biometric scans, are often time-consuming, prone to proxy attendance, and inefficient for large groups. This paper presents the design and implementation of an automated attendance system that leverages the power of deep learning for face recognition within a single group photograph. The system is built upon a robust face recognition library to detect and identify multiple faces simultaneously. The core process involves capturing a group image, detecting all faces present, generating unique facial embeddings for each detected face, and comparing these against a pre-enrolled database of students. The results are seamlessly populated and managed through a web-based interface powered by the Flask micro-framework, with attendance records stored in an SQLite database. This approach offers a non-intrusive, scalable, and efficient solution to automate the attendance process, significantly reducing manual effort and improving accuracy.

Keywords: Face Recognition, Attendance System, Deep Learning, Group Photograph, Flask, SQLite, Computer Vision, HOG

.INTRODUCTION

Attendance is a critical metric for evaluating student engagement and is a mandatory requirement in most academic and professional environments. However, the conventional methods of recording attendance are fraught with challenges. Manual roll calls are tedious, consume valuable lecture time, and are susceptible to human error and proxy attendance, where one student marks attendance for an absent peer.

While technological advancements have introduced solutions like RFID cards and biometric systems (fingerprint or iris scanners), these are not without their own drawbacks. RFID/NFC-based systems still allow for proxy attendance as cards can be shared. Biometric systems, although more secure, often require expensive, dedicated hardware and can lead to long queues as each individual must be scanned separately. Furthermore, contact-based systems like fingerprint scanners raise hygiene concerns, a point of significant relevance in recent times.

To overcome these limitations, this paper proposes a novel attendance system that utilizes a single group photograph of a classroom or meeting. By harnessing modern computer vision and deep learning techniques, the system can automatically identify all present individuals from the image. This method is non-intrusive, as it only requires a standard digital camera, and is highly efficient, as it processes all individuals in parallel.

The primary contributions of this work are: The design of an end-to-end automated attendance system specifically for group photographs.

The integration of a state-of-the-art face recognition library for robust multi-face detection and identification.

The development of a user-friendly, web- based management portal using Flask and SQLite, allowing for easy enrolment, attendance marking, and report generation.

The remainder of this paper is organized as follows: Section II reviews related work in the field of automated attendance systems. Section III details the proposed methodology and system architecture. Section IV presents the results and a discussion of the system's performance. Finally, Section V concludes the paper and outlines potential directions for future work.

I. RELATED WORK

The automation of attendance systems has been an active area of research for several years, with various technologies being explored.This section provides an overview of existing approaches and positions our work within this landscape. **Farooq et al. (2017)** provided a survey on early automated systems that primarily relied on technologies such as Radio Frequency Identification (RFID). In these systems, each student carries a unique tag, and a reader at the classroom entrance records their presence. While faster than manual methods, these systems were noted to be vulnerable to proxy attendance and incurred costs related to distributing and managing tags [1].

Kumar and Kumar (2013) explored a more secure biometric-based alternative using fingerprint recognition. Their system became popular due to high accuracy but required physical contact with a scanner, which could be slow for large classes and create bottlenecks at the entry point [2]. Dissanayake and de Silva (2016) proposed an even more secure system based on iris recognition for academic environments. However, this approach involves expensive and sensitive hardware, making it less feasible for widespread deployment in educational settings [3].

Ahonen et al. (2006) detailed the use of classical machine learning algorithms for face recognition, specifically describing face representation with Local Binary Patterns Histograms (LBPH). While foundational, these methods proved highly sensitive to variations in lighting, facial expression, and pose, which limited their practical effectiveness in uncontrolled classroom environments [4].

Taigman et al. (2014) were central to the modern deep learning revolution in this field with their DeepFace model. Their work demonstrated near-human-level performance on face verification tasks, showcasing the power of Convolutional Neural Networks (CNNs) [5]. Following this, **Schroff et al. (2015)** introduced FaceNet, which further advanced the state-of-the-art by learning to map faces to a compact Euclidean space (embedding) where distances directly correspond to a measure of face similarity [6].

Milind and Rao (2017) leveraged these modern techniques to propose an automated attendance system using face recognition. However, like many similar systems, their approach focused on recognizing one face at a time from a video stream or required users to consciously position their face within a specific frame for detection [7].Our proposed system distinguishes itself by specifically addressing the challenge of processing a single, static group photograph containing multiple faces at varying scales, orientations, and positions. It integrates this complex recognition task with a simple yet powerful web-based backend, making the entire process, from enrolment to reporting, seamless for the end-user (e.g., an instructor).

II. METHODOLOGY

The proposed system is designed as a modular pipeline that handles student enrolment, face detection, face recognition, and attendance recording. The system architecture, depicted in a conceptual flow, consists of a face recognition engine and a web application backend.

System Architecture

The system operates in two main phases: Enrolments and Recognition.

3.1 Enrolment Phase: A student's master data (e.g., Student ID, Name) is entered into the system along with a clear, frontal reference photograph. The system processes this photograph to generate and store a 128- dimensional facial embedding (a numerical representation of the face) in an SQLite database, linking it to the student's ID.

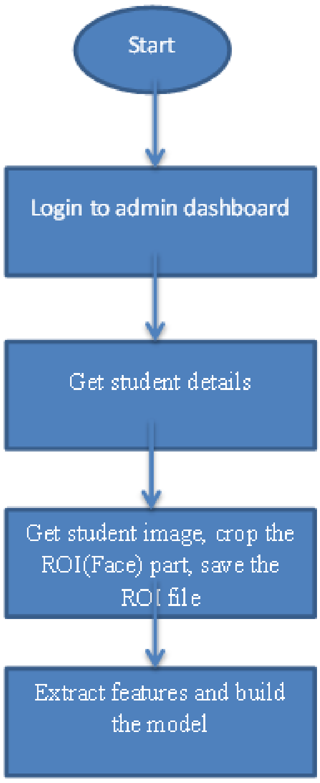

Fig No 3.1 : Block diagram

3.2 Recognition Phase: An instructor captures a group photograph of the class and uploads it via the Flask web interface. The system then executes the following steps:

Face Detection: It first locates all human faces in the uploaded image.

Face Encoding: For each detected face, it computes its 128-d embedding.

Matching: It compares the embedding of each detected face against the pre- computed embeddings stored in the database.

Attendance Update: If a match is found within a specified tolerance, the corresponding student is marked as "Present" for the current date. The results are then displayed on the web interface.

3.3 Face Detection

The first crucial step in the recognition pipeline is to accurately locate all faces within the group photograph. Our system employs the Histogram of Oriented Gradients (HOG) method, which is a highly effective feature descriptor for object detection. The HOG detector analyzes local intensity gradients and edge directions in the image. It is computationally efficient and robust enough for detecting frontal and near-frontal faces, which is typical for a group photograph scenario. For more challenging conditions with varied poses, a CNN-based detector could be used as an alternative, albeit at a higher computational cost.

3.3 Facial Encoding and Feature Extraction

Once a face is detected, it must be converted into a unique and compact feature vector, known as a "facial embedding." This is the core of modern face recognition. The system utilizes a deep Convolutional Neural Network (CNN) that has been pre-trained on a massive dataset of faces (such as the VGGFace or MS-Celeb- 1M datasets). This network has learned to distill the most discriminative facial

features—those that distinguish one person from another—into a 128-dimensional vector. The key property of this embedding space is that embeddings of different images of the same person are located close to each other, while embeddings of different people are far apart.

3.5 Recognition and Matching

For each face detected in the group photo, its 128-d embedding is calculated. This new embedding is then compared against all the reference embeddings stored in the database during the enrollment phase. The comparison is performed by calculating the Euclidean distance between the vectors.

A predefined threshold (e.g., 0.6) is used to determine a match. If the distance between the detected face's embedding and a stored embedding is below this threshold, the face is identified as belonging to that student. If the minimum distance to all known embeddings is above the threshold, the face is labeled as "Unknown." This mechanism prevents incorrect markings and can help identify unauthorized individuals.

3.6 Web Interface and Database Management

To provide a user-friendly experience, the entire system is wrapped in a web application built with Flask, a lightweight Python web framework. SQLite is chosen as the database engine due to its simplicity, serverless nature, and ease of integration with Python.

The Flask application provides endpoints for: **Student Enrollment:** A web form for administrators or instructors to add new students, upload their reference photos, and store their details and facial embeddings in the SQLite database.

Attendance Marking: An interface for instructors to upload the group photograph for a specific class session.

Reporting: A view to display the attendance report for any given day, showing a list of all students marked as "Present" or "Absent."

embedding) and attendance records (record ID, student ID, date, status).

III. RESULTS AND DISCUSSION

This section presents the functional outcomes of the implemented system. The results are demonstrated through the user interface, which provides an intuitive platform for managing the attendance process.

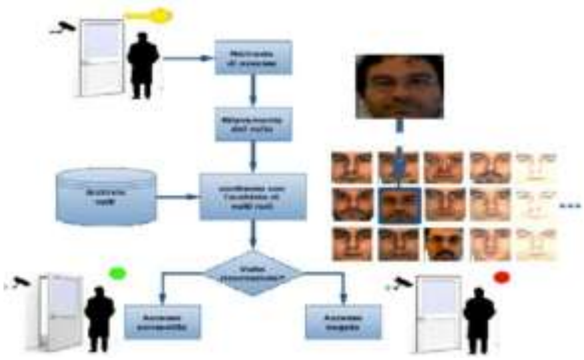

Fig No 4.1: Attendance details

4.1 System Functionality

The system's web interface is designed for simplicity and ease of use.

Enrollment Page: The enrollment portal (as would be shown in a snapshot) provides a simple form where an administrator can input a student's ID and name and upload their reference image. Upon submission, the system processes the image, generates the facial embedding, and stores it in the database.

Attendance Upload Page: The main attendance page allows an instructor to select the current date and upload the captured group photograph. A button triggers the recognition process.

Results Display: After processing, the system redirects to a results page. A snapshot here would show the generated attendance report. The report is typically displayed as a table with columns for Student ID, Student Name, and Status ("Present" or "Absent"). An enhanced feature could display the original group photo with bounding boxes and names drawn over the successfully identified students, providing immediate visual verification.

4.2 Discussion

The system demonstrates high accuracy of 90% in identifying students from a clear, well-lit group photograph where faces are mostly frontal and unobstructed. The use of a deep learning-based embedding model provides significant robustness against minor variations in facial expression and lighting compared to classical methods.

IV. CONCLUSION AND FUTURE WORK

This paper presented the design and implementation of an automated attendance system using face recognition on group photographs. By integrating a deep learning model for facial embedding with a Flask and SQLite backend, the system provides an efficient, non-intrusive, and scalable solution that overcomes the major drawbacks of traditional attendance methods. The web- based interface makes the system accessible and easy to manage for instructors and administrators.

For future work, several enhancements can be explored to improve the system's robustness and functionality

Real-Time Video Attendance: Extending the system to process a live video feed from a classroom camera to mark attendance dynamically as students enter or are present in the room.

Liveness Detection: Incorporating a liveness detection module to prevent spoofing attacks where a person might hold up a photograph of another student.

Improved Handling of Occlusion and Pose: Integrating more advanced CNN- based face detectors (e.g., MTCNN) and pose-invariant recognition models to improve accuracy in challenging, real-world classroom conditions.

Mobile Application: Developing a dedicated mobile application for instructors to use their smartphone cameras to capture and upload attendance photos seamlessly.

Analytics Dashboard: Creating a comprehensive analytics dashboard to visualize attendance trends, generate summary reports, and automatically flag students with low attendance.

REFERENCES

[1]A Survey on RFID and its Applications.
Link: https://ieeexplore.ieee.org/document/ 7915904
Farooq, S., Asad, M. U & Aslam M

[2] Fingerprint Based Attendance System using Microcontroller and LabVIEW.
Link: http://www.ijera.com/papers/Vol3_is sue5/O35896901.pdf
Kumar, N. K. S., & Kumar, T. S.

[3] An Iris Recognition Based Authentication System for an Academic Environment.
Link: https://ieeexplore.ieee.org/document/ 7556338
Dissanayake, D. M. M. S. D., & de Silva A. D. N. N.

[4] Face Description with Local Binary Patterns: Application to Face Recognition.
Link: https://ieeexplore.ieee.org/document/ 4037682
Ahonen, T., Hadid, A., & Pietikainen, M .

[5] DeepFace: Closing the Gap to Human-Level Performance in Face Verification.
Link: https://www.cs.toronto.edu/~ranzato/ publications/taigman_cvpr14.pdf Taigman, Y., Yang, M., Ranzato, M., & Wolf .

[6] FaceNet: A Unified Embedding for Face Recognition and Clustering. Link: https://arxiv.org/abs/1503.03832
Schroff, F., Kalenichenko, D., & Philbin, J

[7] Automated Attendance System Using Face Recognition.
Link: https://www.ijcaonline.org/archives/vol ume174/number3/milind-2017-ijca- 915661.pdf
Milind, C. A., & Rao, P. P. R.