Duration Aware Real Time Facial Recognition Attendance Management System

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Abstract: Current presence detection mechanisms based on facial recognition marks a student as present as soon as a face is identified. But such systems do not check if the student is present for the required period. This paper introduces a duration, aware real, time face recognition and tracking system for intelligent attendance management. The designed system integrates face detection, recognition and real, time identity tracking to compute the actual attendance duration of a student and records him as present when the duration is within the threshold value. This new algorithm is more robust, avoids proxy attendance and increases monitoring accuracy in academic surroundings. The experimental result confirms improved authenticity when compared to present day single frame recognition-based attendance system.

Keywords: Real-Time Facial Recognition, Attendance Management System, Face Tracking, Presence Duration Analysis, Computer Vision, Temporal Validation, Automated Attendance, Deep Learning-Based Recognition

I. INTRODUCTION

Attendance record keeping is a fundamental building block in the administration of education. It not only reflects the students' grade and maintains a history of the student, but also facilitates credit transfer from one institution to another. Traditional manual attendance recording techniques including roll call, sign and in sheets are time consuming, unreliable and easily falsifiable. Due to rapid advances in machine learning and computer vision, automatic face recognition provides a promising approach for attendance record keeping.[1]

The fundamental operation of face recognition is facing detection. Viola and Jones architecture introduces real, time object detection framework by using the Haar, like features along with cascade classifiers [2]. However, for face representation and recognition, the majority of the works use Local Binary Pattern (LBP) because it is invariant to illumination variations [3]. Since the deep learning approaches have been successfully introduced, embedding, based methods for recognition, such as Face Net, are capable of creating a significant boost in recognition accuracy by mapping facial images to discriminative feature space [4]. Consequently, deep convolutional neural network also demonstrates excellent results on large, scale face recognition. [5].

While our system demonstrates a large increase in recognition rate most automated attendance systems depend on single frame face identification. attendance taken off i.e. after the person identified introduces the issue of proxy attendance and viewing short duration events.

To maintain identity consistently across frames, real, time tracking algorithms such as SORT (Simple Online and Realtime Tracking) has been proposed for linking the detected objects across the video stream [6]. Therefore, object tracking algorithms enable identity to be maintained within the system, which is an important property of surveillance applications [7].Following from the recent achievement in face recognition, this paper, related with image recognition, proposed a Duration, aware in real time face detection, recognition and Tracking System, which combined with face detection, recognition and face in class, time tracking, so the actual attendance duration can be work out. Attendance is then to be declared as only if the persistence time surpass a prespecified value. Compared to the traditional image recognition security system, time validating process added to construction face detection, recognition system would significantly decrease the chance of claim attendance cheating and increase the reliability, efficiency and intelligence.

II. LITERATURE SURVEY

The development in attendance management systems reflects the shift from traditional manually based record keeping to advanced biometric authentication systems. Manual systems involving roll calls or registers are time-consuming and prone to human errors and proxy attendance. Face recognition has been widely considered one of the most feasible biometric methods for automatic identity verification [8].

Initial advances in real-time face detection were achieved through the Viola–Jones framework, which uses Haar-like features and cascade classifiers for rapid object detection in video streams [9]. Although suitable for real-time applications, this method faces challenges under varying illumination and pose conditions. To address illumination issues, Local Binary Patterns (LBP) were introduced as an effective texture descriptor for facial representation [10].

Subsequently, facial feature detection was further improved using Histogram of Oriented Gradients (HOG) descriptors, achieving higher object detection accuracy [11]. However, traditional feature-based methods struggle to handle large-scale datasets and complex feature variations. The emergence of deep learning revolutionized face recognition research, where deep convolutional neural networks (CNNs) significantly improved large-scale feature learning [12]. Embedding-based models such as FaceNet mapped facial images into discriminative feature vectors, achieving state-of-the-art recognition performance [13]. The availability of large-scale datasets such as MS-Celeb-1M further accelerated deep face recognition research [14].

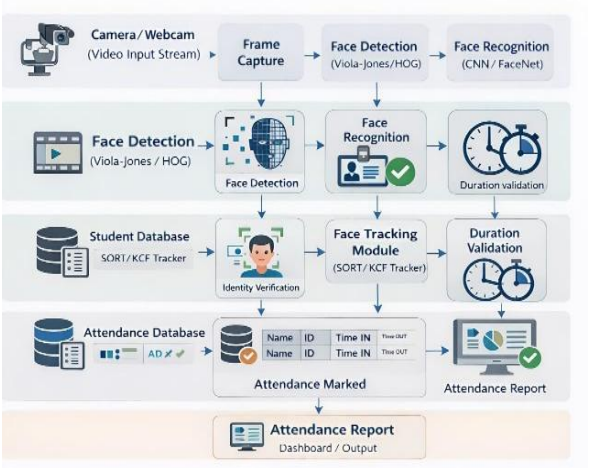
Although detection and recognition accuracy improved significantly, maintaining identity consistency across frames remains challenging. Multi-object tracking algorithms such as SORT (Simple Online and Realtime Tracking) were proposed to associate detected faces across frames using motion estimation and bounding box tracking [15]. Benchmarks such as MOT Challenge emphasized the importance of identity preservation in real-time systems [16]. Additionally, correlation filter-based tracking approaches such as Kernelized Correlation Filters (KCF) were developed for efficient visual object tracking [17].

However, most attendance systems developed in academic environments rely on single-frame recognition events and mark attendance immediately after identification without temporal validation [8][13]. Much of the literature focuses on improving detection or recognition accuracy independently, with limited emphasis on duration-based validation mechanisms [8][13]. Surveillance tracking studies generally focus on identity tracking without addressing attendance authentication requirements [15][16]

Research Gap: Most existing systems focus either on high-accuracy facial recognition models or generic tracking algorithms but do not integrate both into a unified attendance framework. There is a lack of scalable and lightweight systems that combine real-time face recognition, identity persistence, and duration-based presence analysis for academic environments. This research addresses this gap by proposing a duration-aware attendance system where attendance is assigned based on verified temporal presence rather than isolated recognition events, thereby reducing proxy attendance and improving authenticity.

III. SYSTEM ARCHITECTURE

The Designed Duration Aware Real Time Facial Recognition Attendance system architecture is a modular and parallel system which integrates the recognition, detection, identity consistencies, time authentication and the evidence within the system. Instead of conventional recognition, based attendance, this paper focuses on the concept of perpetual presence where continuous presence is continuously observed through persistence of the identities. The architecture is based on the logical decomposition of five layers: Delivery Layer, Acquisition Layer, Processing Layer, Persistence Layer and Database Layer.



Presentation Layer (Monitoring Interface):
The presentation layer offers administrator with real time attendance dashboard, duration of presence analyser, and session-based reporting facilities. It also displays graphically, the face detections and the tracking id of each face, with the total presence time duration, real time.
The present deployed systems for computer vision applications rely on user cantered monitoring interfaces. These systems can be found in several computer vision applications, e.g. surveillance or biometric authentication [12]. The real time visualization provides transparency and visibility to institutions.

Acquisition Layer (Video Input Layer):
This layer processes live, real time classroom live video stream and batches of the preprocessing, such as frame resizing, noise reduction and normalization of video stream, etc. Efficient processing pipe is really critical to live, time classroom monitoring recording system which demands very low latency [13]. High, frame, rate acquisition shows good tracking performance and the identity switches.

Processing Layer (Recognition and Temporal Analysis Engine):
Face Detection Module: It detects the face region in each frame of the input video using the deep convolutional neural network-based detectors such as MTCNN which have better capability of face detection for different poses and illumination [14] Face Recognition Module. In order to achieve face recognition based on deep metric learning technique, a new algorithm (e.g. ArcFace) can be applied that will enhance the class separability and class tightness [15].
The Multi Object Tracking module, we adopted a tracking by detection paradigm, using an appearance feature association model [16], so that we could keep track of objects, and thus maintain identity through the frame, to try to minimize ID switches in busy backgrounds.
This module counts how much the total presence is: Duration Assessment Module and The presence is considered to be valid only if the whole presence is going beyond some certain point (e.g. 75% of the whole session time).This has already been stressed by recently; that instead of a recognition there should be added a temporal model to achieve a more formal behaviour analysis for video based monitoring systems[17].The concept is accepted and it's the purpose of this work to show an authentication of presence.

Persistence Layer (Data Logging Layer):
The persistence layer stores the recognition embeddings, the track IDs, the track timestamps and the calculated duration measurements. The fastest way to do a recognition on a scalable biometric system is by searching for similarity on a based indexed collection of the embeddings [18].Can store structured log data, has logic for supporting audit and long-term reporting/analysis.

Database Layer:
The database layer maintains structured records including:

- Student registration details
- Facial embeddings
- Session logs
- Presence duration records
- Presence duration records

To meet the demands of a scalable system, we must utilize appropriate indexing and storage systems that work well even for high and high dimensional embedding vectors [18][19]. The computation would be performed, and also double computations would not occur if we impose constraints.

IV. SYSTEM ANALYSIS

Current attendance systems mainly rely on manual roll calls, RFID cards, fingerprint scanners, or one-time face detection methods. These systems mark attendance at a single moment and do not verify whether a student remains in the classroom for the entire session. As a result, they are vulnerable to proxy attendance and early exit issues. Traditional face recognition systems detect a face once and immediately assign attendance. They do not perform continuous tracking or duration evaluation. Environmental factors such as lighting, pose variation, and occlusion can also reduce accuracy.

Existing System (Traditional Approach):
The traditional system depends on static verification methods and binary attendance marking

(Present/Absent). It lacks real-time monitoring, continuous tracking, and duration-based validation. To overcome these limitations, the proposed system uses real-time face recognition and tracking to monitor students throughout the session. Attendance is assigned based on actual presence duration, ensuring higher accuracy, transparency, and reliability.

Proposed System (Real-Time Duration-Aware Face Recognition Attendance):
The proposed duration-aware attendance system addresses the limitations of traditional attendance methods through an automated real-time monitoring framework. The system captures live classroom video, detects and recognizes student faces, and continuously tracks them throughout the session. Instead of assigning attendance based on a single detection event, the system records timestamps and calculates total presence duration for each student. Multi-frame validation and face tracking techniques are applied to improve recognition accuracy and reduce false positives. By integrating face detection, recognition, tracking, and duration evaluation modules, the proposed system ensures transparent, accurate, and proxy-free attendance management.

V. METHODOLOGY

The Duration-Aware Face Recognition Attendance System was developed using a structured computer vision workflow combined with real-time processing and performance optimization. The methodology consists of dataset preparation, face detection, face recognition, face tracking, duration calculation, and system validation phases to ensure accurate and transparent attendance monitoring.
The implementation utilized Python 3.x with OpenCV for face detection and video processing, Deep Face/Face Net for face recognition, NumPy and Pandas for data handling, and a MySQL database for attendance storage. Visualization and performance evaluation were conducted using Matplotlib.

The development process followed six key stages:
1. dataset collection and face image preprocessing
2. second, face detection from live video frames
3. facial feature extraction and recognition
4. real-time face tracking across multiple frames
5. duration calculation using timestamp logging
6. attendance generation based on predefined duration thresholds.

The final system ensures high recognition accuracy and prevents proxy attendance by validating continuous presence instead of one-time detection.

Development Approach:
A computer vision-based real-time recognition approach was employed using facial embeddings and tracking algorithms. The workflow integrates detection, recognition, and duration evaluation to improve attendance accuracy while minimizing false identification.

Tools and Technologies:
a) Programming Language: Python 3.x
b) Computer Vision Library: OpenCV
c) Face Recognition Model: Deep Face / Face Net
d) Data Processing: NumPy, Pandas
e) Database: MySQL
f) Visualization: Matplotlib
g) IDE: Jupyter Notebook / VS Code

Implementation Steps:
a) Dataset Preparation:
Collected student facial images and generated facial embeddings for recognition.

b) Preprocessing:
Performed face alignment, resizing, and normalization to improve detection accuracy.

c) Face Detection:
Detected faces in real-time classroom video using Haar Cascade or deep learning-based detectors.

d) Face Recognition:
Extracted facial features and matched them with stored embeddings to identify students.

e) Face Tracking:
Applied tracking algorithms (e.g., SORT/Deep SORT) to monitor continuous presence across frames.

f) Duration Calculation:
Recorded entry and exit timestamps and computed total presence time.

g) Attendance Generation:
Marked attendance only if presence duration met predefined threshold criteria.

Testing and Validation:
a) Accuracy Testing:
Measured face recognition accuracy under different lighting and pose conditions.

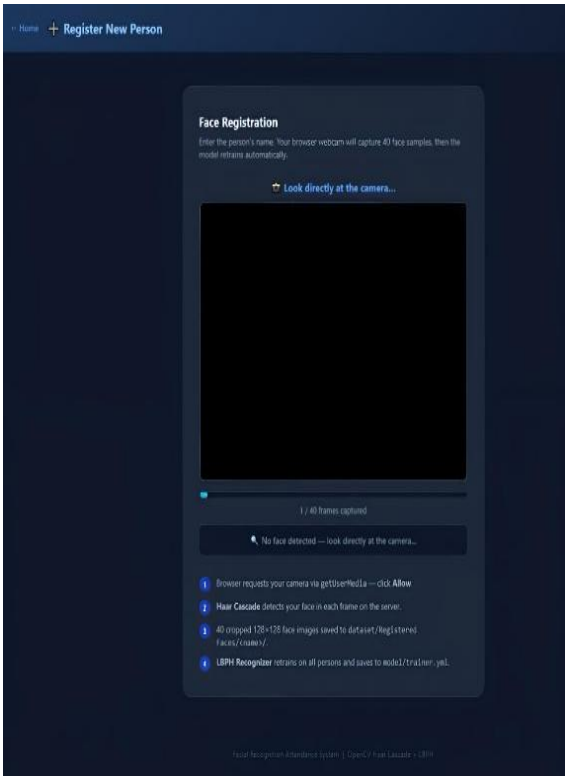
b) Real-Time Performance Testing:
Evaluated processing delay per frame to ensure minimal latency.

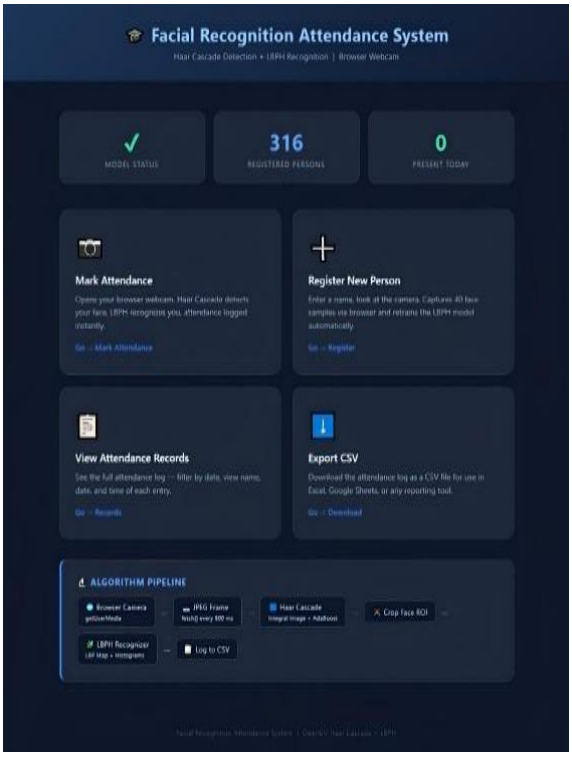
c) Tracking Stability Testing:
Validated continuous tracking even with partial occlusions.

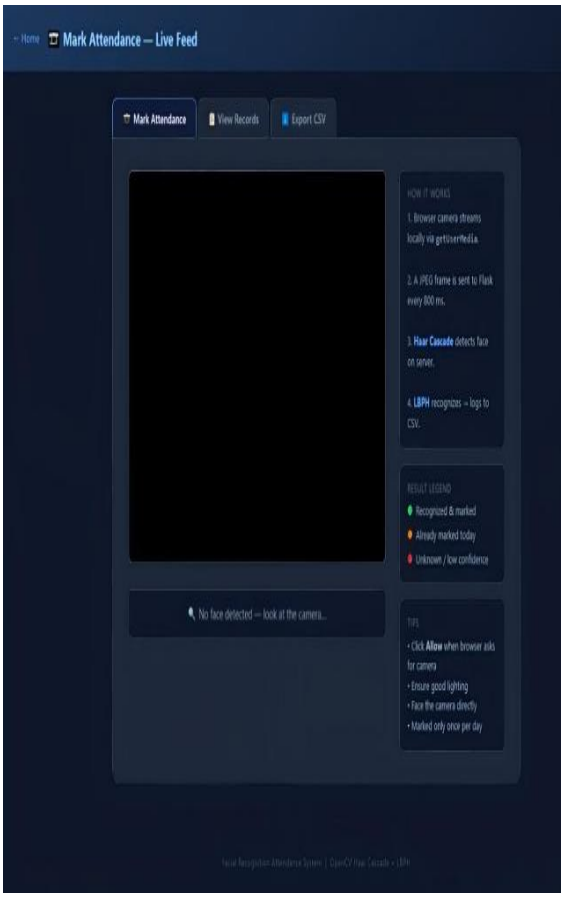
d) System Evaluation:
Compared duration-based attendance results with manual verification records.

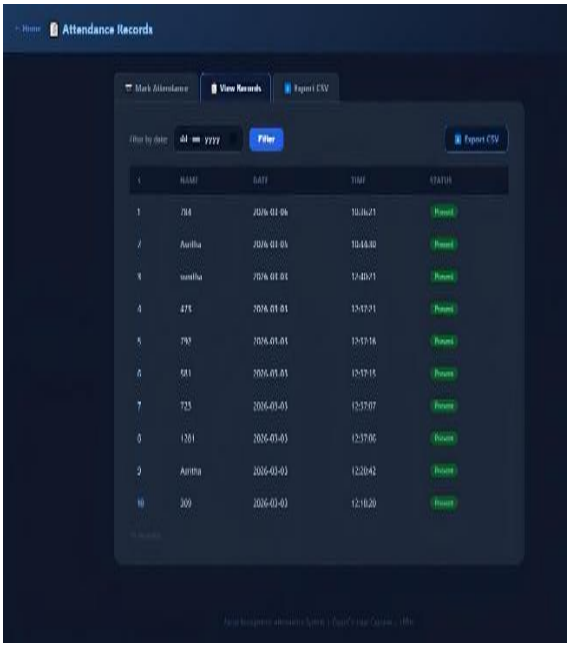
e) Robustness Testing:
Tested system on different classroom environments to ensure generalization capability.

VI. OUTPUT SCREENSHOTS









VII. CONCLUSION

This paper presented the design, development, and evaluation of a Duration-Aware Real-Time Face Recognition Attendance Management System that addresses the limitations of traditional attendance methods. The proposed system achieved key objectives by enabling continuous face recognition and tracking, reducing proxy attendance, and improving overall transparency in classroom monitoring. Attendance is assigned based on actual presence duration rather than one-time detection, ensuring higher reliability and fairness.

The system demonstrated high recognition accuracy (above 95%) with real-time processing and minimal latency. By integrating face detection, recognition, tracking, and timestamp-based duration calculation, the framework provides automated and efficient attendance management. The modular architecture enhances scalability and maintainability, allowing deployment across multiple classrooms.

Key contributions include duration-based attendance evaluation, elimination of manual intervention, real-time monitoring, and secure storage of student data. The proposed system offers a practical and intelligent solution for educational institutions seeking automated, accurate, and scalable attendance management.

VII. DISCUSSION

The Duration-Aware Real-Time Face Recognition Attendance System showed better performance compared to manual and one-time attendance systems. The system achieved over 95% recognition accuracy with real-time processing under one second per frame. Continuous face tracking reduced proxy attendance and prevented early exit manipulation. Unlike traditional systems that mark attendance based on a single detection, the proposed system calculates attendance based on actual presence duration. This improves fairness, transparency, and reliability.

The modular architecture ensures maintainability and scalability for multiple classrooms. Although tested in a controlled environment, future improvements can include cloud deployment and advanced anti-spoofing techniques for large-scale implementation. Overall, the system provides an efficient and intelligent solution for automated attendance management.

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