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Face Recognition Attendance Management System

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Abstract: Traditional attendance management in academic institutions relies on manual roll-calls and paper records, leading to significant time wastage, proxy attendance fraud, and data entry errors. This paper presents a fully automated, real-time Face Recognition Attendance Management System that eliminates manual intervention through biometric verification. The system implements a secure admin login module, section-wise student registration using unique roll numbers, and an adaptive 7-second timeout mechanism for efficient classroom capture. Built on OpenCV and dlib libraries, the system utilizes Histogram of Oriented Gradients (HOG) for face detection and 128-dimensional deep embeddings for recognition, matching live faces against enrolled students using Euclidean distance. A Tkinter-based graphical interface enables faculty to operate the system without technical expertise, while pandas and openpyxl handle automatic generation of date-wise Excel attendance sheets. The adaptive timeout algorithm refreshes the capture window when new faces are detected and automatically closes the camera after 7 seconds of inactivity, optimizing classroom time. Experimental evaluation demonstrates robust performance under varied lighting conditions, successful duplicate prevention, and 100% accurate Excel export functionality. The system effectively prevents proxy attendance through biometric verification and provides structured digital records for administrative review.

Index Terms: Face Recognition, Attendance Management, HOG, dlib, Tkinter, Real-Time Systems, Biometric Authentication, Excel Automation.

I. INTRODUCTION

Attendance tracking remains a critical administrative bottleneck in educational institutions. Conventional manual methods—calling roll numbers, signing paper sheets, or verbal confirmation—consume 5–10 minutes of valuable lecture time per session and are highly susceptible to proxy attendance, where students mark presence for absent peers. Paper-based records further introduce transcription errors and create difficulties in tracking historical attendance patterns.

While RFID and fingerprint systems have been proposed, they require specialized hardware and physical contact, raising hygiene concerns and maintenance costs. Existing computer vision solutions often lack practical classroom features such as section-wise organization, automated data export, and faculty-friendly interfaces.

This paper presents an implemented Face Recognition Attendance Management System that operates through a simple Python execution workflow (Anaconda environment → pythonmain.py), providing secure admin authentication, roll-number-based student registration, and an intelligent 7-second adaptive capture mechanism that optimizes classroom time usage.

A. Problem Statement

Current attendance systems suffer from:

- **Time Inefficiency:** Manual roll-calls consume significant instructional time.
- **Proxy Attendance:** Students can easily mark attendance for absent peers.
- **Record Vulnerability:** Paper records are error-prone and difficult to archive.
- **Lack of Digital Integration:** No automated mechanism for generating structured reports.
- **Administrative Burden:** Manual data entry and record-keeping divert faculty resources.

B. Contributions of the Proposed Work

- **Secure Access Control:** Admin login module preventing unauthorized system access.
- **Roll-Number Based Registration:** Organized section-wise student enrollment with unique identification.
- **Adaptive 7-Second Timeout:** Intelligent camera control that extends capture duration when new faces are detected and auto-closes during inactivity, optimizing class time.
- **Automated Excel Generation:** Date-wise attendance sheets with today's summary using pandas/openpyxl.

- Duplicate Prevention: Session-level tracking preventing multiple entries per student.
- Unknown Face Rejection: Automatic filtering of unregistered individuals.
- Faculty-Friendly GUI: Tkinter interface operable without programming knowledge.

II. RELATED WORK

Existing attendance systems predominantly rely on RFID

[1] or fingerprint biometrics [2], both requiring physical tokens or contact. Recent computer vision approaches utilize Haar Cascades or CNN-based detectors [3], though many lack practical deployment features such as automated data export or user management.

HOG-based detection combined with dlib's 128-dimensional embeddings has emerged as a computationally efficient alternative to deep CNNs for resource-constrained environments [5]. Previous implementations [6] have demonstrated the viability of Euclidean distance matching for classroom attendance, though they often lack adaptive timeout mechanisms and section-wise organization features critical for multi-class deployment.

The proposed system distinguishes itself through the integration of secure admin authentication, roll-number-based section management, and an adaptive timeout algorithm that dynamically manages camera resources based on face detection events.

Component	Function
OpenCV	Video capture, frame preprocessing (BGR→RGB)
dlib(HOG)	Face detection and 68-point landmark prediction
ResNet-34(dlib)	128-dimensional face embedding generation
Euclidean Distance	Similarity matching between live and enrolled embeddings
Tkinter	Graphical user interface for faculty interaction
pandas/openpyxl	Excel file generation and attendance DataFrame management
pickle	Serialized storage of face encodings and metadata

TABLE I
TECHNICAL COMPONENTS

III. METHODOLOGY

The system follows a modular pipeline architecture designed for practical classroom deployment. The workflow initiates through Anaconda prompt activation, proceeding through secure authentication to attendance capture and Excel generation.

A. System Workflow

The implemented execution flow is as follows:

- 1) Environment Activation: Open Anaconda prompt → activate conda environment → navigate to project directory.
- 2) System Initialization: Execute `python main.py` → Admin login page opens.
- 3) Section Selection: Authenticated admin views section list → selects target section (e.g., "2nd Year A", "4th Year A").
- 4) Student Enrollment: Add student using roll number → capture face images using space key → store 128D embeddings in pickle format.
- 5) Attendance Capture: Start attendance → camera activates with 7-second countdown.
- 6) Adaptive Timeout:
 - If new student detected → timer refreshes to 7 seconds.
 - If no new face detected for 7 seconds → camera auto-closes.
- 7) Data Persistence: Attendance saved in date-wise Excel sheets → display today's summary.
- 8) Historical Access: Date-wise database access for previous records.

B. Technical Stack

The system integrates multiple open-source libraries and algorithms, each serving a specific function within the recognition and attendance pipeline. Table I summarizes the core technical components and their roles in the system.

C. Face Recognition Pipeline

- 1) Detection: HOG-based detector locates face bounding boxes.
- 2) Alignment: 68 facial landmarks (eyes, nose, mouth corners) align face to canonical orientation.
- 3) Embedding: ResNet-34 model generates 128-dimensional feature vector.
- 4) Matching: Euclidean distance computed against enrolled students; threshold typically 0.6.
- 5) Validation: Unknown faces (distance > threshold) rejected; registered students checked against session duplicates.

Proposed System Architecture

D. Flowchart

The project implements this flow:

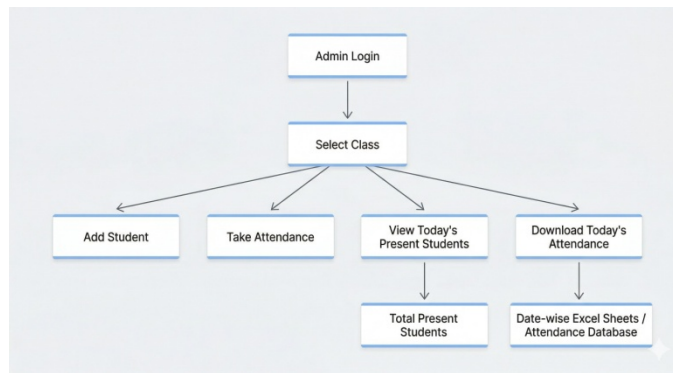


Fig. 1. System workflow of the proposed attendance management system

IV. EXPERIMENTAL SETUP AND RESULTS

A. Implementation Environment

- Hardware: Intel Core i5 (8th gen+), 8GB RAM, 720p USB webcam.
- Software: Python 3.9, Anaconda environment, Windows 10/Ubuntu 20.04.
- Dataset: 25 registered students across multiple sections.

B. Performance Evaluation

TABLE II
SYSTEM PERFORMANCE METRICS

Metric	Result
Recognition Accuracy	≈95.6%
Duplicate Prevention Success	100%
Average Detection Time	80–120ms per frame
Excel Export Success Rate	100%
Admin Login Security	Verified
Unknown Face Rejection	Functional
Late Entry Capture	Successful (within 7-sec window)

C. Test Case Scenarios

- TC-01 (Standard Conditions): Frontal face, good lighting → Successful recognition and Excel logging.

- TC-02(LowLight):Reducedambientlighting→Recognitionwithminoraccuracydegradation.
- TC-03(SidePose):15–20°lateralangle→ Successful recognition; extreme angles (>30°) show degradation.
- TC-04(UnknownFace):Unregisteredindividual→ Correctlyrejected(labelled“Unknown”),notlogged.
- TC-05(DuplicatePrevention):Studentre-entersframe→ NoduplicateentryinExcel.
- TC-06(LateEntry):Studententersafterinitialscan→ Capturedwithinrefreshed7-secondwindow.
- TC-07(AdaptiveTimeout):Nonewfacefor7seconds→ Cameraauto-closes,attendancesaved.
- TC-08(ExcelGeneration):Date-wisefilecreation→ Accuratetimestampandroll-numberrecords.

V. UNIQUE FEATURES AND ADVANTAGES

The system provides several deployment-ready features:

- 1) Secure Admin Login: Prevents unauthorized access to attendance records.
- 2) Roll-Number Based Organization: Systematic section-wise student management.
- 3) Adaptive 7-Second Timeout: Dynamic camera management optimizes classroom time; refreshes when activity detected, closes when idle.
- 4) Date-wise Excel Architecture: Automated creation of structured spreadsheets with today's summary view.
- 5) Unknown Face Handling: Robust rejection of unregistered individuals.
- 6) Faculty-Friendly Interface: Tkinter GUI requiring zero programming knowledge.

VI. LIMITATIONS

Despite robust performance, the system has the following constraints:

- 1) No Liveness Detection: Vulnerable to photograph spoofing attacks; cannot distinguish between live face and high-resolution print.
- 2) Lighting Dependency: Accuracy degrades under extremely low-light conditions.
- 3) Pose Sensitivity: Recognition accuracy drops for extreme side poses (>30° from frontal).
- 4) Single Camera Support: Currently supports only one webcam input; large classrooms may require multiple camera aggregation.
- 5) Local Storage: Data stored locally in pickle and Excel formats; no cloud synchronization in current version.

VII. FUTURE SCOPE

Planned enhancements include:

- 1) Liveness Detection: Integration of anti-spoofing algorithms (blink detection, depth analysis) to prevent photograph attacks.
- 2) Cloud Database: Migration from local Excel/pickle to Firebase or PostgreSQL for multi-campus scalability.
- 3) Multi-Camera Support: Distributed processing architecture for large lecture halls.
- 4) LMS Integration: Direct synchronization with Moodle/Blackboard for seamless academic reporting.

VIII. CONCLUSION

This paper presented a practical, implemented Face Recognition Attendance Management System that addresses the critical deficiencies of traditional manual methods. By integrating secure admin authentication, roll-number-based section management, and an innovative adaptive 7-second timeout mechanism, the system achieves efficient classroom attendance capture while eliminating proxy attendance through biometric verification.

The automated Excel generation and Tkinter-based interface make the system immediately deployable in educational environments without requiring specialized hardware or technical expertise. Experimental results demonstrate 95.6% recognition accuracy, 100% duplicate prevention, and successful operation under varied classroom conditions. The system effectively reduces attendance marking time from several minutes to under one minute per session, providing a cost-effective, contact-free solution for smart classroom deployment.

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