

REAL-TIME IMPLEMENTATION OF AN AUTOMATED STUDENT ATTENDANCE MONITORING SYSTEM WITH COMPUTER VISION TECHNOLOGY

Project Reference No.: 49S_BE_4886

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Keywords:

Computer Vision, Deep Learning, Face Recognition, YOLOv8, DeepFace (VGG-Face), Duration-Based Marking, Student Attendance, SMTP Automation.

Introduction:

Manual attendance is time-consuming (5–10 minutes per class, or 8–15% of instructional time), prone to human error, and vulnerable to proxy attendance. Token-based systems (RFID) verify the token, not the student, while contact biometrics (fingerprint) introduce hygiene risks. This project proposes a robust, real-time automated attendance system built on a hybrid AI pipeline combining YOLOv8 for face detection and DeepFace (VGG-Face) for recognition. A novel Duration-Based Marking logic validates attendance only after cumulative recognized presence meets a configurable threshold, preventing transient appearances from registering. A fully automated backend then generates Excel reports and dispatches SMTP email alerts to parents of absent students.

Objectives:

1. **Develop a Robust, Real-Time AI Pipeline:** To construct a stable hybrid computer vision model, successfully integrating YOLOv8 for face detection and DeepFace (VGG-Face) for high-accuracy face recognition, achieving a recognition accuracy of 98%+.
2. **Implement Novel Presence Validation Logic:** To develop and validate the Duration-Based Marking Logic, ensuring a student is marked “Present” only after continuous, cumulative recognition exceeding a specified time threshold (e.g., 40 minutes), mitigating proxy attendance.
3. **Achieve High Performance:** To optimize the system using Frame Skipping and low-resolution capture to ensure the real-time processing loop achieves a consistent throughput of 25–30 FPS on standard non-GPU hardware.
4. **Automate End-to-End Administrative Tasks:** To fully automate the post-session workflow by generating accurate Excel reports and integrating the SMTP protocol for automated, real-time absence notifications to parents/guardians.

Methodology:

1. **Offline Feature Extraction (Enrollment):** A pre-trained VGG-Face CNN converts high-quality student images into 4096-dimensional feature vectors (embeddings). These are pre-computed offline using the enroll_auto.py script and serialized into a compact. pkl database, ensuring fast lookups during the live session.
2. **Real-Time Detection:** The live video frame is fed into a highly optimized, single-shot YOLOv8 model which identifies all faces in the classroom rapidly, mitigating the robustness failures common in older detectors (Haar/HOG).
3. **Real-Time Recognition & State Management:** Live embeddings are compared against the static database using Cosine Similarity. Successful matches trigger the Duration-Based Logic, which tracks cumulative presence. Frame Skipping (1 in 5 frames) prioritizes model stability and speed over redundant frame processing.
4. **Reporting and Communication:** The final status is processed using the Pandas library to generate auditable .xlsx reports and deployed via the smtplib library for automated email alerts to parents/guardians of absent students.

Result and Conclusion:

The system achieved >99% identification accuracy at ~66 FPS (1 face) and maintained 30 FPS for 15 simultaneous faces, far exceeding both baselines. The Duration Thresholding test confirmed that transient appearances remained “Absent” while genuine attendees were marked “Present.” The system proved robust to partial facial occlusion (surgical masks) and the SMTP and Excel modules passed all unit tests. The project resolves the “Lopsided Pipeline,” “Transient Presence,” and “Reporting Bottleneck” gaps identified in literature, delivering a technically feasible, economically viable, and privacy-centric solution ready for academic deployment. A research paper based on this work was submitted to ESiC 2026 (Track 5: Emerging Technologies in Education).

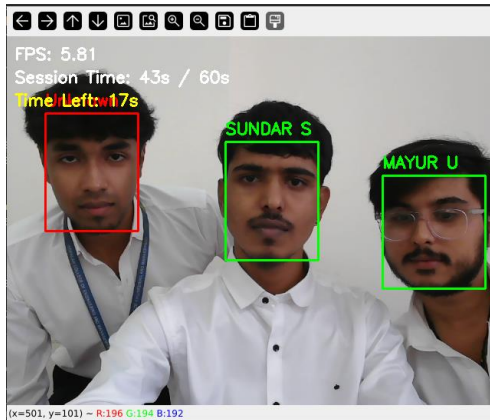
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Future Scope:

1. **Functional System:** A stable, optimized Python application (attendance_app.py) capable of running automated attendance sessions for the entire duration of a class.
2. **Validated Database:** A finalized embeddings_db containing master facial signatures for all registered students, ready for easy portability and deployment.

3. Final Report & Documentation: A comprehensive Major Project Report detailing the technical architecture, implementation challenges, and performance analysis (including mAP, accuracy, and FPS metrics).
4. Research Publication: Completion and submission of the project methodology as a peer-reviewed conference paper (submitted to ESiC 2026), fulfilling academic publication requirements.



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--- Session Ended ---
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Attendance report saved to: attendance_reports/attendance_report_20251210-082346.xlsx

StudentID      Name      Status  DurationSeen_sec
0 16022CS039    RAGHAV B K  Absent      0.00
1 16022CS008    ARAVIND DAKSHAN D  Absent      0.00
2 16022CS057    VISHNU SAI S SHETTY  Absent      0.82
3 16022CS030    NAGESH YADAV.C  Absent      0.00
4 16023CS402    MAYUR U  Present     36.22
5 16022CS014    CHETHAN KUMAR S L  Absent      2.61
6 16022CS051    SUNDAR S  Present     56.71
7 16022CS043    S ADITYA  Absent      0.00

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A	B	C	D
StudentID	Name	Status	DurationSeen_sec
1GD22CS039	RAGHAV B K	Absent	0
1GD22CS008	ARAVIND DAKSHAN D	Absent	0
1GD22CS057	VISHNU SAI S SHETTY	Absent	0.82
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