

AUTOMATED ATTENDANCE MONITORING THROUGH CCTV SURVEILLANCE

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Abstract: In the contemporary landscape, both automation and digitalization are now seen as the primary enablers of efficiency, transparency and driven data decision making across multiple industrial sectors. Even with constant advancement in technology around the globe, a significant number of government schools in India's educational framework are still utilizing outmoded manual processes for conducting daily academic and administrative functions. One such activity is the daily attendance capture of students and teachers, which continues to be performed via traditional roll call methods, biometric scanning or physical identity checks – all of which tend to waste valuable time from classroom schedules, and are often fraught with complications such as proxy attendance, data manipulation and reporting inaccuracies. Moreover, a key problem associated with the capture of student/teacher attendance is the inability to conduct structured learning activities during times of teacher absence or when classrooms are left idle during class hours – which can result in loss of academic time and a diluted academic output. In order to help solve some of these long-standing educational issues, there are plans to deploy the Realtime Attendance Monitoring (R.A.M.) System and Smart Curriculum System as an innovative and scalable technology driven system to automate the educational infrastructure of traditional educational systems and transform them into a digitally automated, intelligent and productivity-focused environment. The overall vision of the R.A.M. is the integration of Artificial Intelligence (AI), computer vision, deep learning (DL) and data analytics technologies to develop a non-contact, large-scale, real-time, face recognition- based method for capturing student and teacher attendance in schools.

Keywords— Face Recognition, CCTV Surveillance, Attendance Automation, Computer Vision, Deep Learning, Smart Classroom

1. Introduction

A real-time attendance monitoring system is need of time to bring modernization and automation to the traditional attendance process used in educational institutions. In today's world of digital technology, using traditional attendance systems is not a smart choice. They are often slow and lead to inconsistency in the tracking of the student attendance. In order to tackle the problem, we introduce “R.A.M.” an automated Real-Time face recognition-based attendance system that uses pre-installed CCTV cameras infrastructure of the institution to track student attendance without human interaction. This solution addresses multiple common problems in government institutions by reducing mistakes that occur in manual attendance, preventing students from having others mark their attendance and offering insights to improve classroom management and student performance. The system incorporates the multiple CCTV

cameras installed in classrooms and corridors in order to ensure continuous monitoring, while the live dashboard feature delivers real-time analysis of students and staff performance both in institution and individual level. Additionally, the system also includes the feature of Smart Curriculum Activity that supports learning when teachers are absent. It connects attendance data with student engagement, academic work and participation.

Several studies have explored automated attendance using OpenCV, MTCNN, YOLO, and ArcFace. While these systems improve accuracy, many lack real-time analytics and scalability, which the proposed system addresses. Anand et al. propose an OpenCV-based real-time attendance monitoring system that captures live facial images, extracts unique facial features, and compares them against a pre-saved student database [1]. The automation supports diverse environments such as classrooms and offices, significantly improving accuracy while minimizing impersonation and time delays. The authors highlight that the use of OpenCV for face detection under varying lighting and dynamic classroom conditions results in a stable, user-friendly attendance solution that streamlines institutional record-keeping [1]. Vyshnavi et al. develop an OpenCV-powered smart classroom attendance device using Haar cascades and the LBPH face recognition algorithm [2]. During initial registration, students upload their name, ID, and photograph. Before each class, the system captures images of incoming students, compares them against the trained dataset, and automatically marks attendance for successfully matched faces. Recognized entries are recorded—e.g., updating an Excel sheet hourly—meeting time-management needs and eliminating human errors associated with manual roll calls while increasing efficiency [2]. Sirisha et al. design an automated attendance system built on CCTV infrastructure integrated with deep learning models [3]. Strategically placed CCTV cameras continuously capture live footage of student entry and exit points. The system detects faces using the MTCNN detector and generates FaceNet embeddings for facial comparison with a pre-registered database. Attendance is marked instantly upon successful recognition. The solution also incorporates liveness detection for added security and stores attendance logs in a centralized database, demonstrating high accuracy, scalability, and suitability for large institutions [3]. Mestry et al. introduce a YOLOv8n-based attendance management architecture, capturing high-definition classroom images and applying YOLO to detect student faces in real time [4]. The framework consists of modular units—authentication, face detection, and attendance logging—removing the need for manual entry and allowing teachers to focus on academic activities. YOLOv8n was trained on an augmented dataset of 700 facial images to improve robustness in diverse conditions. 3 Experimental results show improved productivity and efficient replacement of traditional roll-call-based attendance [4]. Patel et al. propose an ArcFace-based deep learning pipeline for real-time attendance recognition [5]. The model employs advanced preprocessing steps such as noise reduction and edge enhancement to improve feature clarity before recognition [5]. ArcFace achieves high performance, detecting over 20 faces per frame at 28–62 FPS with 95.1% accuracy—outperforming FaceNet (94.3%) and VGG-Face (92.5%). Robustness against lighting variation, motion blur, and occlusion enables deployment across diverse educational and corporate environments. The authors also note an edge-optimized lightweight variant suitable for low-resource deployments.

This article introduces automation and digitalization into the educational infrastructure of our country by designing and implementing R.A.M. and a Smart Curriculum System for Indian educational institutions (mostly government schools). With technologies like computer vision, artificial intelligence (machine learning and deep learning) and data science, the system ensures contactless, secure and real-time attendance and performance monitoring. This dual-solution approach has the potential to enhance administrative efficiency, productivity and student exposure to new technology.

2. Methodology

R. A. M's is structured on a multi-layered architectural design that includes AI face recognition, smart learning modules, and advanced analytical dashboards. The first layer captures facial data from CCTV footage (located in classes and hallways). Once captured, frames of footage are analyzed with face detection and recognition algorithms created using TensorFlow, OpenCV, NumPy, Media Pipe, and deep learning encoders. Attendance logs that have been recognized within the footage are saved securely in Firebase and MySQL (based on the requirement) along with synchronization to digital dashboards in real-time for viewing by users. As a result of this process, R.A.M enables mass attendance collection by detecting multiple students at once. This is unlike common biometric or RFID systems, which collect only one individual's information at a time. The second layer of the methodology concentrates on the use of Smart Curriculum and the Virtual/AI Teacher. These two systems are designed to automatically assign digital content/learning activities based on several factors: attendance patterns, performance indicators and engagement analysis, when teachers are absent or activities are on hold. Finally, the centralized dashboard is accessible by students, teachers, administrators, and district officials, providing each user with real-time insights: including attendance history, academic progress graphs, engagement score, lecture planning and historical information. In addition to these aforementioned features, R.A.M has features like Homework Tracking and Timetable Management enhancing the structure of the learning environment and providing stakeholders with an informed understanding of how their students are performing.

3. Results and Analysis

The system design of the CCTV-based Attendance Monitoring System focuses on creating an automated, intelligent and real-time solution for monitoring student and teacher attendance using facial recognition technology. The design integrates artificial intelligence, computer vision, deep learning and database management into a single unified platform. The purpose of the system design is to ensure scalability, accuracy, speed and seamless integration with the existing CCTV infrastructure of educational institutions. The architecture is structured in such a way that video streams from CCTV cameras are continuously captured, processed, analyzed and stored with minimal human intervention. The system follows a layered architectural model. At the foundational level, CCTV cameras installed in classrooms and corridors capture live video feeds. These feeds are transmitted to the central Python-based processing server over a secure network connection. The processing server is designed to extract frames from the video

and perform face detection using models developed with OpenCV, Media Pipe and TensorFlow. Once faces are detected, deep-learning-based encoders generate facial embeddings, which are then matched with the pre-stored database of student and teacher images. This recognition process forms the core logic that determines whether a person is present and marks their attendance automatically. To maintain the accuracy and efficiency of the system, the design incorporates pre-processing components such as noise reduction, face alignment and lighting correction. The backend system is built using Python frameworks like Django, enabling smooth interaction between the recognition module and the database.

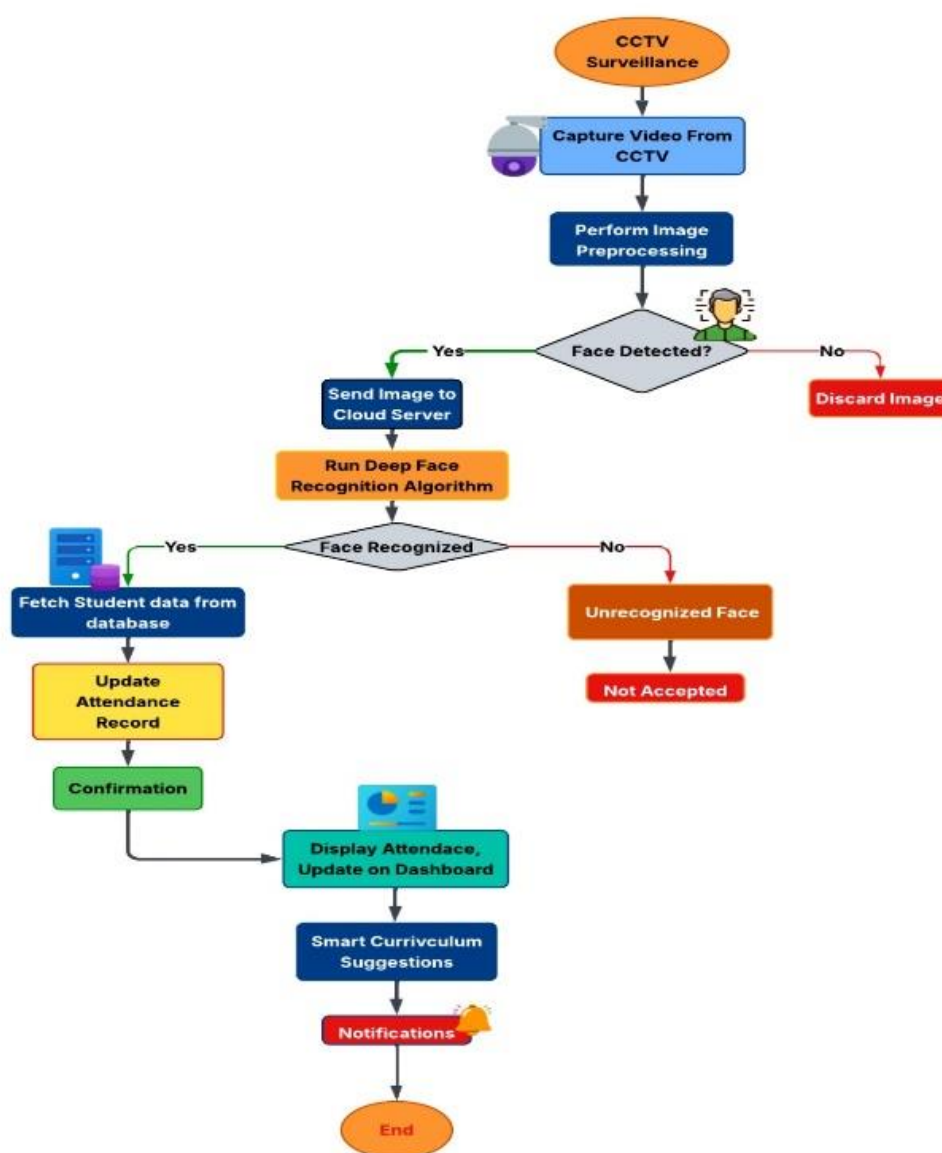


Fig. 1. System Architecture

The system stores attendance records in MySQL and Firebase, ensuring redundancy, real-time synchronization and secure data logging. MySQL handles structured attendance records, while Firebase enables instant dashboard updates for administrators and teachers. The system also

includes a dashboard design that displays attendance summaries, classroom engagement levels, lecture delivery reports and student-specific insights. The dashboard is accessible through secure login roles, ensuring that students, teachers, administrators and district officials can only access relevant information. In addition, the system design supports modular expansion, enabling easy integration of Smart Curriculum features, AI-based learning activities and performance analytics in the future. In terms of specifications, the system requires high-resolution CCTV cameras, a multi-core processing server with GPU support, stable network connectivity and sufficient storage capacity. On the software side, Python 3.8+, OpenCV, TensorFlow, NumPy, Media Pipe, Django, MySQL and Firebase form the main components. Overall, the system design ensures an efficient, secure, and intelligent attendance monitoring environment that transforms traditional educational setups into digitally empowered, automated ecosystems. The system consists of CCTV cameras, a processing server for face detection and recognition, a database layer using MySQL and Firebase, and a web-based dashboard for visualization.

4. Conclusion

The Real-time Attendance Monitoring System is developed with the motive of modernizing, digitalizing and automating attendance processes in educational institutions, especially in government institutes. Current methods of attendance can be considered a traditional system that often proves to be slow and inconsistent and are prone to manipulation. R.A.M. handles these types of challenges by using CCTV-based automated face recognition to provide contactless, secure and real-time attendance tracking along with the feature of access to live performance monitoring. The features like continuous classroom monitoring through pre-installed CCTV cameras, the web-based performance dashboard that is accessible to the students, teachers and other school administrators along with automated timetable tracker and homework scheduler together improve academics and administrative efficiency. Additionally, the Smart Curriculum Activity module helps in ensuring that students have learning continuity even at the times of teacher absences, a factor improving student engagement and academic quality. Overall, these integrated features significantly improve monitoring accuracy and streamline the school management process. Our work lays a very strong base for digital transformation in educational infrastructure; it also contributes meaningfully in taking an important step toward automation, transparency and improvement of learning outcomes in Indian educational institutions to enhance the quality of education.

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