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Automated Attendance System with AI and Real-Time Camera Access using Facial Recognition

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Abstract:

The project focuses on developing an advanced attendance management system with deep learning and biometric technology to allow precise student attendance monitoring. The system works by providing live camera feeds for the clear photographic presentations of students when marked present and then going through with modern facial recognition algorithms out of a huge

database containing already registered students. The system marks the student's presence in nearly real-time manner, alerted by mail, SMS, or mobile applications whenever a positive match occurs. The system employs automation in this attendance- marking that reduces errors and the tiring workload associated with it. The teacher continuously receives information on present attendance trends on a macro or micro scale, which help them to spot any upward or downward trends in student engagement patterns with this information used for data-driven decision-making going forward. Besides that, it incorporates sufficient encryption and access mechanism, which guarantees the security and confidentiality of student records, thus rendering the solution genuinely reliable and efficient for just about any modern educational establishment. It boasts of features uniquely so geared in dynamic model training and update operations, which smoothly adjust to varying lighting condition changes and subsequently incorporate student appearance variation so as to guarantee a high level of accuracy and reliability. This new attendance system has great future use in educational institutions, offices, and other fields which consider attendance checking to be very important.

Introduction: An effective Attendance Management System (AMS) for recording student attendance is an absolute necessity for monitoring academic performance and high accountability in the prevailing conditions of education today. Old-fashioned ways of conducting attendance by calling names or physically marking registers are never only time-consuming, but also inaccuracyprone and insecure. Many automatic human identification systems, such as fingerprint scanners and card reading systems, face limitations in the form of forgotten passwords and misplaced cards. These issues can lead to unauthorized entry onto premises and wrong attendance registers. The embracing of facial recognition technology in attendance monitoring systems assures a viable solution to surmount all these problems.

Objectives: The Smart Attendance System utilizes AI-powered facial recognition technology to enhance student attendance management. The system connects the CCTV cameras with the faculty mobile cameras allowing the faculty to choose between either method of attendance recording. For the CCTV cameras, it would automatically detect and identify the face of every student when entering an attendance crook. This entire process occurs without the need for manual intervention. While staff are free to record attendance via their mobile cameras and the system is secure and synchronized through IMEI or faculty login.

Methods: The attendance system combines advanced technology for real-time automated attendance- marking with the intended outcome of reducing human error. The system begins streaming video frames from an RTSP (Real Time Streaming Protocol) camera that runs continuously to capture live video. The YOLO (You Only Look Once) object detection algorithm is then used to detect faces in the frames.

Results: This integrated system employs facial recognition features, along with deep learning procedures such as convolution neural networks and VITs, to develop an automated attendance management system. The object detection algorithm of YOLO will thus enable real-time image processing for the accurate identification of students in biometric verification. The attendance system can be accessed through CCTV cameras and mobile camera access so that faculty can take attendance through classroom cameras that capture student faces or via the faculty's own mobile devices. The RTSP protocol is used to request video feeds, and these are processed through machine learning models that detect and identify students' faces. These recognized faces are saved securely in a SQLite database through a Python full-stack web application developed using Flask. Automatic generation of an Excel report and notifications to the faculty in real-time preserved through a secured communication link will be implemented. Designed to be scalable and efficient, this solution minimizes manual attendance errors, enhances classroom management, and improves the overall academic monitoring system.

Conclusions: Our automated attendance system for facial recognition offers a quick, accurate, and easy way to track student attendance. The integration of CCTV cameras and mobile devices allows the teacher to mark attendance with great ease, removing as much manual work from the equation as possible. The system provides real-time processing, stores attendance records in a secure manner, automatically generates reports, and increases accuracy and reliability with the help of deeplearning and object-detection techniques.

Keywords: Facial Recognition, Convolutional Neural Networks (CNNs), YOLO Algorithm, Vision Transformers (VITs), Real-Time Image Processing, Computer Vision, RTSP (Real-Time Streaming Protocol).

1. Introduction

An effective Attendance Management System (AMS) for recording student attendance is an absolute necessity for monitoring academic performance and high accountability in the prevailing conditions of education today. Old-fashioned ways of conducting attendance by calling names or physically marking registers are never only time-consuming, but also inaccuracy-prone and insecure. Many automatic human identification systems, such as fingerprint scanners and card reading systems, face limitations in the form of forgotten passwords and misplaced cards. These issues can lead to unauthorized entry

onto premises and wrong attendance registers. The embracing of facial recognition technology in attendance monitoring systems assures a viable solution to surmount all these problems. This automated system would ensure that a student gets identified accurately while entering the classroom and hence reduce reliance on roll calls, thereby increasing data security and saving time. With respect to facial recognition, this very invention will improve educational efficiency, keep accurate attendance, offer monitoring use ably in real time, and sort the children appropriately. The effective modern-day AMS, by using facial recognition, simply serves to smoothen operations in any educational institution, fostering accountability as well as an environment conducive to academic excellence. [1], [2].

Attendance Management Systems, in essence, are utilized widely in various educational institutions and organizations, improving both the speed and accuracy involved in attendance tracking. Mostly through schools, colleges and universities, AMS have entirely automated the student attendance marking process. Features include real-time monitoring, notifications to parents of a student's present or absent status and generated reports that show a trend of attendance over time for teachers. Besides their use in the education sector, AMS is applied in corporate settings as tools for attendance management for monitoring employee attendance, allowing organizations to maintain staff records and monitor applications for leaves in a responsible way. Most AMS packages work in conjunction with Learning Management Systems; teachers now upload lecture notes and assignments along with attendance records to improve academic delivery alongside parental participation. These common applications of AMS have enjoyed growth with the emergence of mobile technologies, where teachers mark attendance with smartphones or tablets, and notifications are given in real-time to the parents. Again, AMS equally turns to data analytics to give families insight into general patterns to guide institutions in making informed decisions in resource allocation and curriculum planning. With this system that automates the notification about attendance, the school and parents communicate more reliably; hence parental involvement and the problem of truancy is effectively quelled. In brief, the broad scope of the application of Attendance Management Systems is by and large affirmative with respect to the special political systems and environments, revealing efficiency in both communication mode and decision-making process. [5].

Several current attendance management systems rely on age-old technologies that suffer from numerous other disadvantages. Most of these systems are slow and inefficient due to the lag in attendance tracking and reporting. Traditional biometric systems like fingerprint scanners or older facial recognition technique often show inaccuracies and hence this imprecision property brings about some concern, since for such an arrangement misidentifications or failure to recognize legitimate students or employees could occur, undermining the authenticity of attendance records. On top of the limitations, many of these systems can hardly recognize a specific number of faces at once, hence a problematic situation in environments with dense population, especially in classrooms or corporate events. This means that given the attendance is taken where multiple-person recognition is required, the procedure slows down and leads to potential errors. It is apparent that reliance on outdated technologies govern present attendance management systems and remain unfit, hence become slow and inaccurate especially in dynamic setups where fast and accurate identification becomes an essential requirement. With all of the updated technologies that focus on performing real-time face recognition and absentee tracking, we have built ourselves an advanced attendance system. YOLO (You Only Look

Once) is used for object detection, and Vision Transformers (Vits) are utilized behind the scenes for image classification, thus allowing detection and classification of multiple faces in real time. The system goes about taking video frames at some interval, extracting single objects out of the video frames, processing these, then classifying them at high speed via intelligent algorithms. This allows for faster access, on-the-spot face recognition, and accurate attendance tracking. RTSP (Real-Time Streaming Protocol) provides real-time access to cameras from the application so that integration can be done seamlessly with quick notifications for absentee tracking, which is why the approach is reliable and scalable at the same time. [6].

2. Objectives

The solution strives to veer away from the shackles of conventional case attendance through manual means, thus reducing errors and minimizing administrative workload. It allows for instantaneous processing with security of data while ensuring high accuracy in identifying students. Through easy access via a web interface, faculty members can monitor attendance records, generate reports, manage data effectively and its scalable nature allows multiple classrooms, branches, and faculty members to use the system, thus providing a feasible and competent attendance management tool for educational institutions. This project provides better efficiency and accuracy of attendance monitoring with a seamless user experience through an AI-based facial recognition interface, secure data handling as well as multi-device support.

- **Auto attendance marking:** Automated attendance via facial recognition with no human intervention.
- **Multi-camera-mode integration:** Faculty can switch between CCTV cameras for auto attendance recording and mobile cameras for manual attendance recording.
- **Simple faculty control:** Access to a mobile camera via secure authentication (IMEI or distinctive faculty ID).
- **Real-time processing:** View recorded videos in real-time to extract attendance information and store it as data.
- **Data Security and Accuracy:** Data security can be assured to a much better extent through methods like data encryption. AI models with high accuracy can work as a reliable identification method with better data codification.
- **User-friendly interface:** Ensure easy Web-integrated programs to facilitate faculty in their attendance and reporting.
- **Scalability and flexibility:** Work with multiple classes, branches, and faculties under one centralized system.

3. Literature Survey

John et al. proposed a lightweight facial detection system optimized for embedded devices such as the Jetson Nano while focusing entirely on real-time speed in highly constrained environments. The authors applied the Haar Cascade algorithm using OpenCV in Python, utilizing Haar-like features and the Viola-Jones framework for multi-scaled face detections. Tests were carried out on a dark and bright

background. While the system performed consistently yielding 90% accuracy under controlled illumination, performance dropped under uncontrolled settings. The images were processed at 15 FPS, a trade- off between accuracy and speed for embedded applications. The methodology used herein aims to enable simple, low-cost facial detection for resource- constrained applications. Although the system is effective in static scenarios, its response to spatial- temporal lighting changes and occlusions can be further improved. The authors concluded that a Haar Cascade- based system could be effectively employed in embedded devices with an adequate performance level in stable conditions, serving as a departure point for subsequent improvement in dynamic environments. [7].

Any mobile student attendance system based on Android developed by Sunaryono and others integrates facial recognition with QR code scanning whereby students will take a capture of their face and QR code by a smartphone to mark their attendance. For the facial recognition process, this program utilizes Linear Discriminant Analysis for face recognition with an accuracy of 97.29% while processing face images in no longer than 0.000096 seconds-a remarkable achievement, ensuring high efficiency as well. Double Authentication allows for the application of modern facial recognition along with QR code technology for user-friendly attendance management. The conclusions of the study reveal that the system is practical, reliable, and suitable in an educational setting and offers an improvement earlier methods attendance taking. [8].

This paper elaborates on biometric identification techniques focusing on their principles and applications. Different biometric modalities discussed are fingerprint, face, iris, voice, etc., and strengths and weaknesses of each modality are analyzed for the appropriateness of use in various scenarios. They give the view of multi- biometrics combining different modalities of biometrics and its advantages of security and accuracy in this talk. The authors managed to highlight the growing commercial importance of biometrics and the changing trends in product markets and business opportunities in this arena. They made a thorough comparative analysis of these technologies on the basis of magnitudes such as accuracy, cost, speed, user-friendliness, and scalability. They evaluated the performance of several biometric systems through case studies and real-life examples. They conclude that no single biometric will meet all applications; nevertheless, multi-biometrics do show promise to overcome the limitations of single biometric systems. They underlined the rising commercial demand of biometrics in security, health, and finance. Some recommendations for future research include enhancing multi-modal integration of biometrics to allow greater scalability for widespread application. To sum up, the multi-biometrics system emerged from this paper as the next interesting area of focus for developing secure and effective identification systems. [9]

4. Methods

The attendance system combines advanced technology for real-time automated attendance- marking with the intended outcome of reducing human error. The system begins streaming video frames from an RTSP (Real Time Streaming Protocol) camera that runs continuously to capture live video. The YOLO (You Only Look Once) object detection algorithm is then used to detect faces in the frames. The face images identified are then sent to the Vision Transformer (Vit) classifier or Mobile Net model for feature extraction; these classifiers are pre- trained to classify the face according to relevant features. In turn, the classification results go to the attendance management system, which marks attendance from this result and subsequently records data into the database. In this way, the database

makes sure of the correct storage and retrieval of attendance data, while also assuring the successful updating of records. Thereafter, the system further ensures the activation of the notification mechanism in tandem to notify students, teachers, and other associated organizations of updates on attendance status in real time. So, this is a completely automated workflow making use of object detection and deep learning models and hence becomes quite robust and effective for institutions of modern educational settings and organization.

The system integrates real-time video streaming, face detection, and classification to automate attendance, ensuring records are updated in the database and notifications are sent seamlessly. This approach highlights efficiency and accuracy in managing attendance workflows.

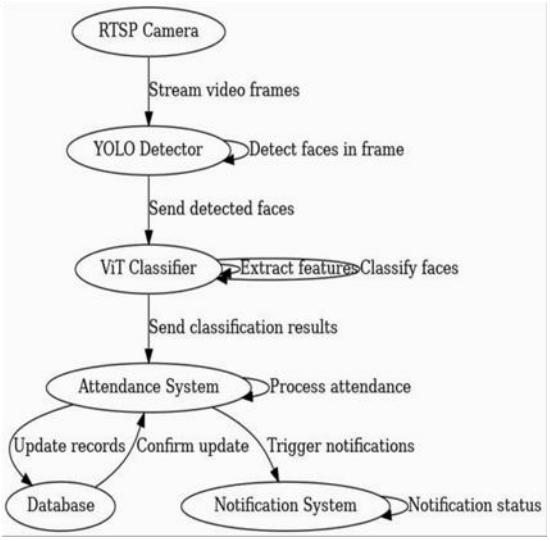

Fig. 1: Flowchart of Face Detection

The faculty will be given a choice of use of attendance based on CCTV surveillance or based on mobile kamera surveillance. The system captures live video frames that are further processed by a cascade of YOLO and Vision Transformers (ViTs) for detection of faces and matching them with members of the student database. Attendance is then automatically marked into the database and updated

in real-time. Notice will be issued by e-mail, SMS, or a mobile app. Finally, the attendance record is stored and can be exported to Excel for faculty access, thus ensuring a system that is efficient and free from error.

A. DATA COLLECTION

- The image files of students are gathered and stored in an organized database.
- Each student's images are stored in a separate folder named after their Roll Number.
- On average, at least 20 images per student are collected with regard to variations in lighting, angles, and expressions for recognition accuracy.

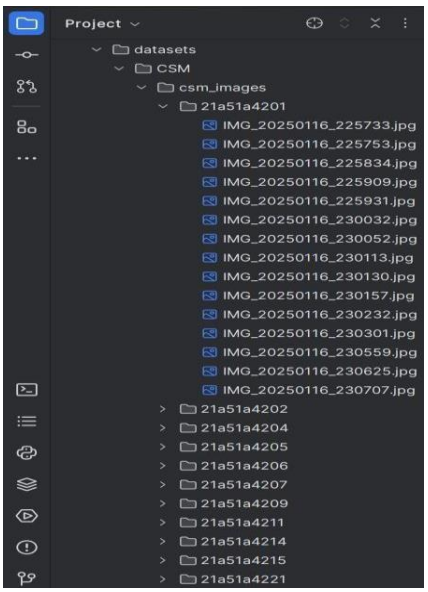

Fig. 3: Storing images in respected folder with roll number

B. DATA PREPROCESSING

- Resizing and normalization allows images to be resized to a standard dimension while achieving normalization for better training.
- The face is detected either by MTCNN for Multi- Task Cascaded Convolutional Networks or using Haar Cascade.
- Face Alignment-This way, it further improves the accuracy by setting standard positions for facial features.
- Data augmentation techniques include flipping, rotation, and adjusting brightness in order to make the model more robust.

C. STORING EXTRACTED DATA

- Grasp this operation rather as the set of numerical representations corresponding to student images by using already trained deep learning models: Face Net, VGGFace, or ResNet-50.
- An embedding is a numeric vector that is representative of an individual by a unique set of distinctive characteristics.
- To do efficient face recognition, it is expected to first extract the embeddings from the subject ever since it was taken and save it in a ".pkl" (pickle) file.

• A Support Vector Machine (SVM) or K-Nearest Neighbours (KNN) classifier is trained on the labelled face embedding data in order to map roll numbers to detected faces. The trained model is saved for real-time face recognition.

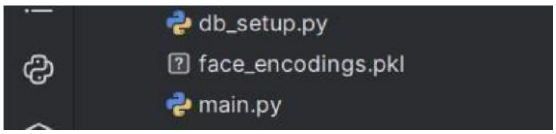

Fig. 4: Storing encodings in pickle file

D. MODEL TRAINING

• Five frames had been extracted from the uploaded video and stored inside the directory extract-frames by the system. Among these, frame_2.jpg was selected for face detection. The algorithm for face detection then processed the frame and found 45 faces.

• Finally, a successful POST request was logged in the system confirmation of the video upload and face detection completing without incident.

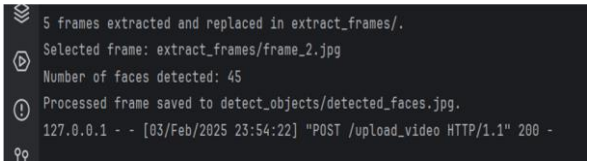

Fig. 5: Detecting Faces

5. Results & Discussions

A. REAL-TIME FACE RECOGNITION

• Users can upload recorded videos from the camera (CCTV, mobile camera, or webcam).

• The system extracts 5 frames from each video for face detection.

• Haar Cascade or YOLO object detection identifies multiple faces in each frame.

• The detected faces will be cropped and processed for recognition.

• Each detected face is then compared against the embeddings of the trained models.

• The system compares the detected faces against the already stored student face encodings. In case of a match, the Roll Number is displayed above the bounding box on the image.

Fig. 6: Identifying faces in a frame

B. ATTENDANCE MARKING & STORAGE

- The wide-sensed identification numbers of all identified students are noted and logged into the database.
- A student marked as present should be able to show at least person's presence in 3 out of 5 frames.
- Attendance data can be saved in CSV files or directly into the database for further reference.
- The system marks each student by roll number as "Present".
- The date, time, and session details are logged in the system.
- If identified absent by the system, they are given the mark "Absent" or "Late", depending on the rules laid down.

	A	B	C	D	E
1	**Roll-No**	**Name**	**Status**	**Time**	
2	21a51a4204	Balivada Venkata Sharmila	Present	12:35	
3	21a51a4252	Chinatda Vamsi	Present	12:35	
4	21a51a4205	Gurana Pravallika	Present	12:35	
5	21a51a4221	Rosuva Meghana	Present	12:35	
6	21a51a4206	Banna Yogeswara Rao	Absent	12:35	
7	21a51a4251	Yajjala Prem Kumar	Absent	12:35	
8					
9					
10					

Fig. 7: Storingin an Excel sheet

6. Conclusion

In this study, we proposed a new improved attendance system that is free from all the defects and limitations prevalent in traditional methods. The obtained attendance systems generally do not enable real-time operations and are not adaptable to meet the changing needs of the present.

The present research employs deep learning techniques to improve the efficiency and accuracy of the system. Video frames are captured at irregular intervals from a live video feed and processed using the YOLO (You Only Look Once) framework for object detection. Each frame is processed and compared to a set template for matching students and staff with an existing database of previously registered individuals. Each detection undergoes further validation through trained deep learning models so that accuracy and reliability might be ensured. Eliminating errors with the use of processed image frames from video feeds will reduce administrative overhead while remaining futuristic and scalable to meet the demands of modern learning and work environments.

The application of real-time video processing along with training the dataset to achieve intelligent face matching enhances overall efficiency for attendance tracking. Future directions may comprise cloud compatibility, mobile application use, and a multi-camera setup for broader usability.

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