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Automatic Attendance Recorder Using Facial Recognition

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Abstract
A modern school or business firmly understands how challenging it is to track students' attendance. It requires a plethora of effort and time to get the attendance without any mistake and fraud. These days, taking attendance by hand has a number of problems. but this paper discusses an Automated Attendance System (AAS) Made Using One solution to the aforementioned problems is facial recognition technology. We aim to develop and create a seamless and contactless process that facilitates the effective recording of attendance by utilizing state-of-the-art image processing and machine learning technologies to recognize and authenticate people. This system follows some simple basic protocols of how registration of a student works. First the students would go through a registration corpus and have their facial images clicked and with this data an embedding would be formed which would serve as a template for later phases. The template would be a sort of reference for the devices and would allow the students to not be bottlenecked and aid the staff with efficient attendance tracking. The teacher can only log in with a session password encoded through email and while logging in the system requires the teacher to enter his password. Through a student module, the system keeps track of all student information in one location and all student information is easily accessible. The possibility of proxy attendance would be eliminated.

Keywords: *facial recognition, FaceNet, SVM, real-time attendance, machine learning, deep learning, Haar cascade.*

1. Introduction

Repositories of education are becoming ever-increasing in speed and accuracy, which is exactly when good time management becomes a necessity. Keeping in mind the manual attendance systems that were used to be employed in classrooms, it does not take a genius to figure out how inefficient that nascent solution proved to be for moderating classroom proxy technologies. Solutions like RFID and fingerprint recognition had been put in place, but proving to be somewhat disruptive to attendance automation, as they required physical interaction. Furthermore, the ability to process a big group of students simultaneously is sometimes lacking in those systems as well. However, facial recognition technology is capable of providing a passive automatic approach to taking attendance in classes, thus eliminating taking attendance in the first place. Thanks to the developments achieved in the fields of machine learning and deep learning, the accuracy of facial recognition systems in identifying and tracking users within real-time scenarios have increased. This highlights how the need for recording students' attendance in real-time has been met through the development of Automated Attendance recording systems equipped with facial recognition technology. The use of CCTV camera's in combination with automatic attendance systems eliminates the manual approach of marking attendance and allows students

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to see their current attendance online as it will be marked automatically

2. Literature Survey

Automated attendance has been the subject of numerous studies. methods using RFID technology, fingerprint scanning as well as facial recognition. Of the three, facial recognition is perhaps the most popular as a system, as it offers ease of use and accuracy. For example face recognition based systems such as FaceNet in association with SVM classifiers are very reliable in terms of identification. But still the systems available in the market today do not have capabilities for integration with real time reporting and simple interfaces. Ahmed et al. [1] proposed an intelligent system of attendance as termed IATT which makes use of convolutional neural networks (CNN) for the purpose of real time face identification of students in place of the cumbersome manual book system. Their system accommodates all three processes of face detection, face identification and counting utilizing CNN to identify key features and the histogram of oriented gradients (HOG) algorithm to detect faces of the faces and SVM for the classification. Also, a Haar cascade classifier is applied in face counting. The system was able to demonstrate a 99.75 % classification weight which is quiet useful in small settings such as lecture halls. According to these authors, the implementation of an automated system simplifies attendance procedures in terms of accuracy and effort required to fill out forms. Al-Amoudi et al. [2] created an autonomous attendance system that uses facial recognition and deep learning algorithms. The three primary parts of the system are the training phase, student profile management, and the attendance tracking module. Multi-Task Cascaded FaceNet is used for face recognition, while Convolutional Neural Networks (MTCNN) are used for face detection. The technology offers educational institutions a useful and easily accessible solution by processing attendance data and storing it in an Excel sheet after taking pictures of pupils during class. Tested on 908 training and 108 testing photos, the system demonstrated its dependability and cost-effectiveness by achieving 100% accuracy in face detection and 87.03% accuracy in face identification without requiring additional hardware. Rahman et al. [3] introduced an attendance system using biometrics that uses fingerprint recognition to accurately monitor attendance. To ensure safe and accurate identification, the system takes a user's fingerprints and compares them to pre-registered templates using a fingerprint scanner. A GSM function that provides guardians with automated notifications and real-time attendance updates is implemented to improve transparency. By drastically lowering the inaccuracies that come Using more traditional methods such as sign-in sheets, this fingerprint-based technology provides a dependable and safe way to track attendance. The technology also enables institutions to keep thorough attendance records, which promotes guardian involvement and resolves any issues pertaining to attendance. Shrivastava et al. [4] developed an IoT-based RFID-based attendance tracking system, Arduino ESP8266, and Adafruit.io to streamline student attendance tracking within a designated area. nternet of Things-based attendance monitoring system utilizing RFID technology, Arduino ESP8266, and Adafruit.io. By using RFID cards and a scanner to collect student data, the system automates attendance. This data is subsequently posted to the Adafruit cloud, allowing for real-time access to attendance records. By drastically lowering the mistakes and inefficiencies of conventional techniques, this strategy offers a simple, effective solution. The authors stress that by integrating IoT, educational authorities can acquire detailed attendance data and remotely monitor student presence, improving the management process as a whole. Akhilesh et al. [5] unveiled a facial recognition-based real-time attendance management system. The system automates the attendance process by using deep learning algorithms to detect and recognize student faces in real-time. Students are identified by a frontal face detector, and an Excel document is created using the faces that have been identified. During the training phase, the system matches faces to previously recorded data using cosine similarity. which is carried out on Google Colab. The constraints of conventional and biometric techniques, such fingerprint or RFID devices, for usage in organizational and educational settings are addressed by this hands-free and effective solution.

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3. Motivation

Manual attendance recording has long been a tedious and error-prone process in educational institutions. As class sizes grow and administrative workloads increase, relying on traditional methods like roll calls or biometric systems such as RFID cards and fingerprint scanners becomes increasingly inefficient. In addition to wasting valuable class time, these approaches are vulnerable to proxy attendance. and physical wear, especially in a post-pandemic world where hygiene and contactless solutions are a priority. With recent advancements in computer vision and machine learning, facial recognition presents a compelling alternative. It offers a passive, contactless, and real-time approach to attendance tracking, minimizing human effort while maximizing accuracy. This is driven by the need to eliminate manual errors, reduce classroom disruptions, ensure secure and authentic attendance data, and provide centralized, easily accessible reports for faculty and administrators. The system seeks to improve the general effectiveness and dependability of attendance management in contemporary educational settings by utilizing the power of facial recognition.

4. Methodologies

The suggested system creates a reliable, real-time facial recognition-based attendance recorder by fusing web technologies, deep learning, and computer vision. High face recognition accuracy, secure data handling, smooth user interaction, and effective real-time processing are all guaranteed by the methodology.The system begins with student registration, where personal details such as name, USN, branch, gender, and contact information are collected. Alongside, multiple facial Photographs are taken under various lighting conditions and from various angles. These images undergo preprocessing that includes resizing, normalization, and contrast enhancement to ensure uniformity and improve feature extraction performance. After that, a Haar Cascade classifier is used to identify faces in the photos. This algorithm scans the image to locate face regions and crops out non-essential background, focusing solely on facial features. Once faces are detected, they are passed through a FaceNet model, a deep learning algorithm that converts each face into a 128-dimensional embedding. These embeddings act as unique numerical signatures for each face and are stored securely in a NoSQL database (MongoDB), linked with the student's profile for quick access during recognition. During a live class session, the system is activated through a secure teacher login. A webcam continuously captures real-time video of the classroom. Each frame is processed using the same face detection (Haar Cascade) and embedding extraction (FaceNet) pipeline. The real-time embeddings generated are then matched against the database of pre-registered student embeddings using a Support Vector Machine (SVM) classifier. The SVM determines if the face in the frame corresponds to a registered student. If a match is found, the student is marked "Present" in the attendance record. If no match is found or if the face is not detected correctly, the system does not log attendance, thus ensuring proxy prevention. The system maintains a centralized attendance database that stores the date, time, class information, and attendance status for each student. A web interface built using Flask allows teachers and administrators to manage attendance data easily. Reports can be generated in various formats (CSV, PDF, Excel) and even shared via email. The system is also designed to handle cases where multiple students enter the classroom at different times by continuously updating records in real-time. The solution is implemented using Python as the core language, with OpenCV for computer vision tasks, TensorFlow/Keras for deep learning models, and MongoDB for database management. The modularity of the architecture ensures that components such as face recognition, data storage, and report generation can be scaled independently or enhanced in future versions.

5. Experiment Setup and Result

A full experimental setup was made in order to assess the effectiveness of the suggested Automatic Attendance Recorder using Facial Recognition. simulating a real classroom. The experimental setup for the face recognition–based attendance system was designed to ensure both robustness and accuracy under real-world conditions. A dataset was prepared by photographing students under a variety of settings. The images captured included variations in illumination such as normal and low light, along with

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different head orientations and expressions ranging from relaxed to smiling. This diversity within the dataset makes the system more adaptable, enabling it to recognize individuals even when their appearance slightly changes due to environmental or personal factors. Before the images were utilized, they were subjected to preprocessing techniques to standardize their format and enhance their quality. Each image was resized to 224 × 224 pixels, which aligns with the requirements of the FaceNet model, ensuring uniformity and reducing computational overhead. Pixel values were normalized to a scale between 0 and 1 to improve model convergence and efficiency during training. Additionally, contrast enhancement was applied to highlight facial features more distinctly, increasing the effectiveness of both the detection and recognition stages. The recognition pipeline integrates three core technologies—Haar Cascade, FaceNet, and Support Vector Machine (SVM)—that work in sequence to achieve reliable results. Haar Cascade is employed for face detection and functions by scanning the image using a sliding window mechanism. At each stage, Haar-like features such as edges and line patterns are evaluated to determine whether a face is present. These features are calculated quickly through the use of an integral image representation, allowing the algorithm to process multiple regions at different scales in real time. Once a face is detected, the background is discarded and only the relevant facial region is passed forward, which improves the accuracy and speed of subsequent operations. After detection, FaceNet is used to generate embeddings that numerically represent the unique characteristics of each face. Instead of storing entire images, FaceNet maps each facial input to a compact 128-dimensional vector. This representation is highly discriminative, as embeddings belonging to the same individual are positioned close together in the embedding space, while embeddings of different individuals are spaced further apart. The learning process within FaceNet relies on triplet loss, which continuously optimizes the network so that positive pairs (images of the same person) are drawn closer together, and negative pairs (images of different people) are pushed farther apart. This technique makes FaceNet extremely effective even when handling faces that share similar attributes, thereby ensuring precision in recognition tasks. The embeddings generated by FaceNet are then classified using a Support Vector Machine. SVM is a supervised learning algorithm that finds the best hyperplane in a high-dimensional space to divide classes. The embeddings are used as input features in this application, and the SVM gains the ability to differentiate between students based on these vectors. By maximizing the margin between classes, the SVM achieves a high degree of robustness, enabling it to correctly classify faces even when subtle similarities exist between individuals. This combination of FaceNet embeddings and SVM classification forms the backbone of the recognition system, ensuring both speed and accuracy during attendance marking. For smooth functioning, the system relies on specific hardware and software resources. A device with an Intel Core i5 processor or higher, combined with at least 8 GB of RAM, provides the necessary computational power for real-time detection, embedding generation, and classification. An HD webcam is required for capturing clear and detailed images. On the software side, Python serves as the implementation language, with TensorFlow/Keras used for embedding generation through the FaceNet model, OpenCV applied for image preprocessing and detection via Haar Cascade, and Scikit-learn utilized for training and deploying the SVM classifier. The integration of these technologies ensures a seamless workflow from image capture to final recognition. The training and testing phases further validate the system's effectiveness. During training, to create a varied and representative training set for the SVM classifier, embeddings are made for every student in a range of lighting conditions, postures, and facial expressions. When faced with differences in student appearance, this exposure helps the model to generalize successfully. During testing, live images are captured as students mark their attendance, and the system processes these images in real time. The performance is measured by its ability to accurately match live embeddings with those stored in the database, demonstrating the system's reliability. To support visualization and analysis, real-time outputs are also animated using Pygame tools, allowing the recognition process to be observed under different conditions. The real-time attendance system

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successfully fulfills its functional requirements by enabling automated recognition and detection of student faces through an active camera feed. Once a face is captured, it is compared against the stored face records in the database. If a match is identified, the precise time of entry and the student's attendance are automatically recorded. This procedure guarantees accuracy and efficiency in attendance recording while also lowering manual labor. A final report is produced at the conclusion of the recognition process, which contains information like the student's ID or roll number, guaranteeing accurate and comprehensive attendance records. The attendance data is organized and stored systematically within the database. Each attendance session is assigned a unique session identifier, which facilitates easy storage, retrieval, and tracking of historical records. This structured approach ensures that attendance logs from multiple sessions remain well-organized and can be accessed efficiently whenever needed. Authorized personnel such as teachers or administrators can log into the system and retrieve attendance records by selecting the appropriate session. The reports can be viewed within the system or exported into multiple formats, including PDF, Excel, and CSV, providing flexibility for sharing, printing, or archiving. This functionality ensures that attendance data is accessible for both academic and administrative purposes, thereby increasing the system's practical value. To enhance usability, the system also provides sharing capabilities. Reports can be distributed through email integration, which allows the generated attendance data to be directly sent to authorized recipients such as class teachers or departmental heads. In addition, if the system is integrated with a mobile application, authorized users can access attendance reports directly on their devices, making the system highly convenient for real-time monitoring and management. The system interface has been designed with careful attention to both security and usability. Figure 3.1 presents the Admin Login Section of the system, which has been customized with the emblem of Malnad College of Engineering, placed prominently at the center of the screen to establish institutional identity. For secure access, the login page provides input fields for a username and password, along with a login button. Real-time information such as date and time is displayed at the bottom right corner, while the overall arrangement ensures that the page remains both functional and aesthetically consistent with the college brand.

Figure 1 Admin login page of the system

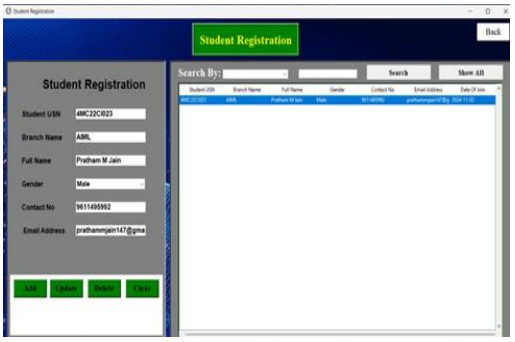

Figure 2 Student registration page of the system

The Student Registration Interface, shown in Figure 3.2, provides an organized method of managing student records. It includes fields for entering a student's USN, branch name, full name, gender, contact number, and email address. Functional buttons are provided for adding, updating, deleting, or clearing records, which allows administrators to manage student data effectively. To the right side of the interface, student records are displayed in a tabular format, listing their USN, branch, name, gender, contact details, email, and date of joining. A search option with a dropdown menu is also incorporated to filter results quickly, along with a button to display all registered students. This structured arrangement simplifies record management and ensures that information remains accessible and easy to update. The Attendance Report interface, depicted in Figure 3.3, enables administrators and teachers to manage student

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attendance efficiently. The interface includes search and filter options, along with buttons to search, delete, or display all attendance records. The attendance data is presented in a tabular format, containing fields such as student ID, USN, name, class, date, time, and attendance status. A back button is included to return to the previous screen, ensuring smooth navigation. The design also incorporates an eye-catching color scheme, making it visually appealing and user-friendly.

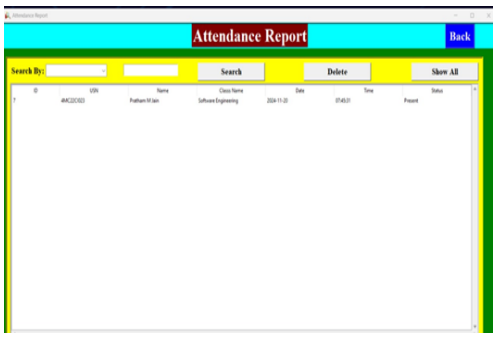

Figure 3 Attendance report of the system

With this arrangement, administrators can quickly review, update, or export attendance details, ensuring seamless management of student records. Through these features, the system demonstrates its effectiveness in providing an intelligent and automated attendance solution. It combines real-time recognition with structured data management and secure access, while also offering flexible report generation and sharing mechanisms. The combination of functionality, usability, and aesthetics ensures that the system not only meets its intended purpose but also provides a practical and reliable tool for academic institutions.

Conclusion

The Automatic Attendance Recorder using Facial Recognition effectively demonstrates the integration of Using machine learning and computer vision to address a recurring administrative issue in educational establishments. Using Support Vector Machine (SVM) for classification, FaceNet for creating face embeddings, and Haar Cascade for face detection, the system ensures accurate and efficient recognition of students in real-time. The automation of attendance marking significantly reduces the workload on educators, eliminates human error, and prevents proxy attendance. Additionally, the system's centralized database and web interface provide streamlined access to attendance records, making the management process both convenient and secure. This project highlights how emerging technologies can be leveraged to enhance operational efficiency in classrooms and pave the way for more intelligent and data-driven academic environments

Future Works

To enhance the system's performance and scalability, several improvements can be introduced. Integrating a mobile application would enable teachers to manage attendance remotely and notify parents about student absences in real time. To address recognition issues under low-light or occluded conditions, models like YOLOv5 or ResNet, or even thermal imaging, can be implemented for improved accuracy. Adding emotion recognition could help evaluate student engagement, offering useful insights to educators. Integration with Learning Management Systems (LMS) such as Google Classroom or Moodle would streamline data synchronization and reduce manual work. Lastly, deploying the system on the cloud would support multi-campus institutions, offering better accessibility and scalability.

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