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AI-Enabled Smart Classroom Attendance System Using Facial Recognition.

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Abstract: The traditional attendance system, commonly used in classes across the world, is a tedious task and is often associated with various types of errors such as proxy attendance and recording errors. Such types of drawbacks associated with the traditional attendance system make the overall attendance system less efficient and cause difficulties in maintaining student attendance records accurately. Manual attendance systems are also time-consuming and require a lot of effort from teachers to manage student attendance records accurately. Hence, to avoid such drawbacks associated with the traditional attendance system, a new type of attendance system using artificial intelligence technology, such as a smart classroom attendance system using face recognition technology, is proposed in this paper. The proposed system is able to recognize students automatically by detecting images from the camera installed in the class. The images are then used to recognize the faces of students present in the class using various computer vision and machine learning techniques. For this purpose, various types of technology are used to develop the overall system, whereas a database is used to store student attendance records. The system is designed in a way such that it reduces the effort for attendance recording, and at the same time, it increases the accuracy of attendance data. Additionally, the system minimizes the time required for attendance marking, and there is no possibility for proxy attendance. From the experimental results, it is clear that the proposed system is working efficiently in detecting students and recording attendance automatically. Therefore, the system is reliable and effective for smart classroom environments, and it supports the digital transformation of modern educational institutions.

Keywords- Facial Recognition, Smart Classroom, Attendance Automation, Artificial Intelligence, Computer Vision, OpenCV

INTRODUCTION

The importance of attendance management is significant for educational institutions as it aids in tracking students' attendance, maintaining students' records, and assessing students' performance. In most colleges and schools, attendance is tracked by traditional means such as roll calls or attendance registers. Although it is a traditional approach that is easy to implement, it is a time-consuming process that is often vulnerable to human errors. The teacher may take up valuable class time counting students' attendance, especially if there are a large number of students. Moreover, it is also vulnerable to proxy attendance, where students may respond on behalf of absent students. However, owing to the advent of technology, schools are gradually shifting from traditional attendance management to smart attendance management. Artificial Intelligence (AI) and Computer Vision have enabled new opportunities for technology to automate most of the traditional practices. One such technology is facial recognition, which recognizes individuals based on their facial features. Facial recognition technology has been successfully employed in various areas such as security, mobile authentication, and surveillance. However, it is now being employed for academic activities such as attendance management. The paper suggests a new system of artificial intelligence that can be used to track students' attendance by using a facial recognition system. The system will use cameras placed inside classrooms to capture images of students. The images will be analyzed to identify students' faces. The identified students' faces will be compared to existing data using machine learning algorithms to ensure that students are identified accurately. Once a student is identified by the system, it will record

their attendance accordingly without requiring any manual intervention. The proposed system has a number of advantages over traditional attendance tracking methods. The proposed system minimizes time wastage during attendance tracking, eliminates proxy attendance, and enables accurate record-keeping. The proposed system is a contribution to the development of smart classrooms by incorporating artificial intelligence into classroom management systems. The proposed system can be effective in helping institutions save time by adopting a more efficient system of tracking students' attendance.

LITERATURE SURVEY

Recent developments in Artificial Intelligence, computer vision, and machine learning have greatly contributed to the development of automated systems for different domains, including the education sector. Several researchers have attempted to explore the use of facial recognition technology for the development of intelligent systems for efficient attendance management systems. Automated attendance systems have received much attention as educational institutions are looking to automate the attendance management system. Panwar et al. (2022) have developed a facial recognition-based system for monitoring attendance by employing computer vision technology through OpenCV. The study revealed that computer vision technology can be effectively used for detecting and recognizing the faces of students in a classroom environment. Hence, the need for human involvement in recording attendance can be reduced [1]. Likewise, Smitha and Hegde (2020) have suggested a face recognition-based system for managing attendance by employing image processing techniques for face detection and recognition. The study revealed that face recognition technology can be effectively used for improving the efficiency of the attendance system [2].

Budiman et al. (2023) carried out a study on face recognition-based attendance systems using machine learning algorithms such as Local Binary Pattern Histogram (LBPH) and Convolutional Neural Networks (CNN). The study indicated the importance of choosing the right algorithms for achieving high accuracy in face recognition-based attendance systems [3]. Jenitta (2023) suggested an artificial intelligence-based attendance monitoring system that makes use of machine learning algorithms for detecting and recognizing the faces of students in a real-time classroom environment. The study concluded that AI-based attendance systems can offer high accuracy and efficiency in managing attendance [4].

Widjaja (2023) proposed a computerized attendance management system that utilizes facial recognition technology along with database technology for the automatic management of attendance records. The study highlighted the significance of integrating computer vision technology with efficient data storage systems for the efficient management of attendance records. Bussa et al. (2020) proposed a smart attendance management system that utilizes OpenCV-based facial recognition technology for the efficient management of attendance records in educational institutions. Recent studies have also proposed the integration of deep learning algorithms for efficient facial recognition systems. Rao (2022) proposed a real-time attendance management system known as AttenFace that utilizes deep learning-based facial recognition technology for the efficient management of attendance records for multiple students in a classroom environment. Nguyen-Tat et al. (2024) proposed a computer vision-based automated attendance management system that utilizes facial recognition technology for the efficient management of attendance records from video feeds provided by the camera installed in the classrooms.

Some of these studies have also contributed to the development of computer vision and facial recognition technologies used in attendance systems. Viola and Jones (2001) proposed an efficient object detection method using a boosted cascade of simple features, which is widely used for face detection in computer vision applications [11]. Szeliski (2010) presented detailed information about computer vision algorithms and their applications in computer vision-based image processing systems [12]. Gonzalez and Woods (2008) discussed different techniques for digital image processing, which are widely used in facial recognition systems [13].Although significant developments have been made in attendance systems, existing systems are still found to require manual intervention, additional hardware devices, and are not able to function efficiently in a classroom environment. Hence, in order

to overcome these issues, the proposed AI-based smart classroom attendance system uses facial recognition technology for student detection and attendance recording efficiently. It is a computer vision, artificial intelligence, and database system that provides a completely automated attendance system for modern educational institutions.

PROPOSED SYSTEM

The process of attendance management in many educational institutions is done manually. This is time-consuming for students and is also prone to errors like proxy attendance. To solve this problem, an automated attendance management system based on facial recognition is proposed. The system is based on Artificial Intelligence and Computer Vision technologies to recognize students' faces for attendance. In the proposed system, images of students are captured using a camera placed in the classroom environment. The images are then processed using computer vision to detect human faces within the captured images. After detecting human faces, facial recognition is done to identify unique facial features and match them with the facial data of students already registered in the system. Once the face is identified, the student is confirmed to have attended the class.

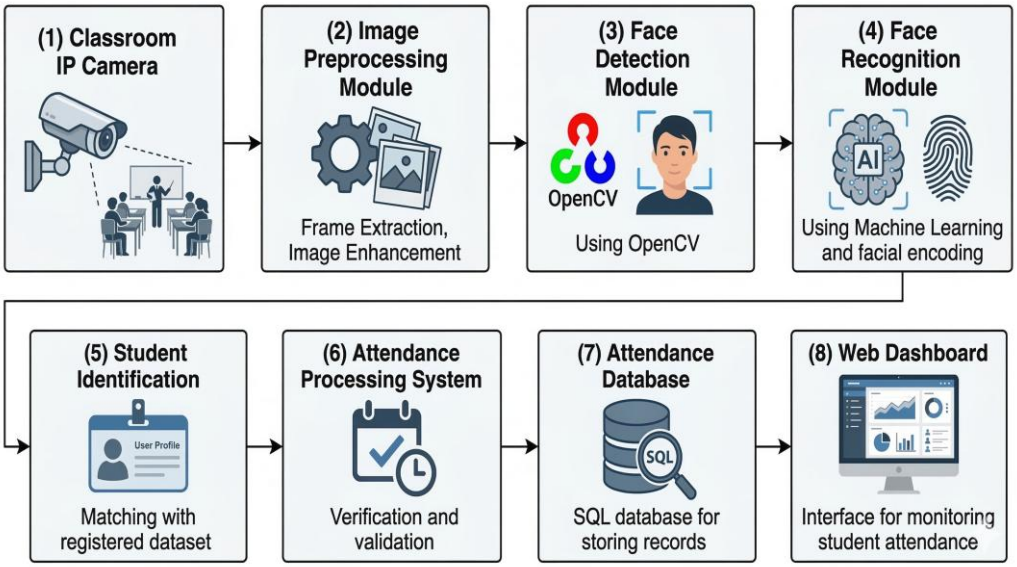


Figure 1: SYSTEM ARCHITECTURE OF AI-ENABLED SMART CLASSROOM ATTENDANCE SYSTEM USING FACIAL RECOGNITION.

The different modules that make up the system include the face detection module, which detects the presence of human faces in the images taken by the camera. The face recognition module then compares the features detected by the previous module with the dataset of student images previously loaded into the system. Once a student has been correctly identified by the face recognition module, the attendance management module then records the attendance details into the system. Lastly, the database module stores the details of the students for future reference.

The whole system operates on a real-time basis. This means that attendance is recorded efficiently. In addition, the system is completely contactless compared to traditional methods that used identification cards or roll calls. This method has greatly reduced the chances of proxy attendance by eliminating the need for human input.

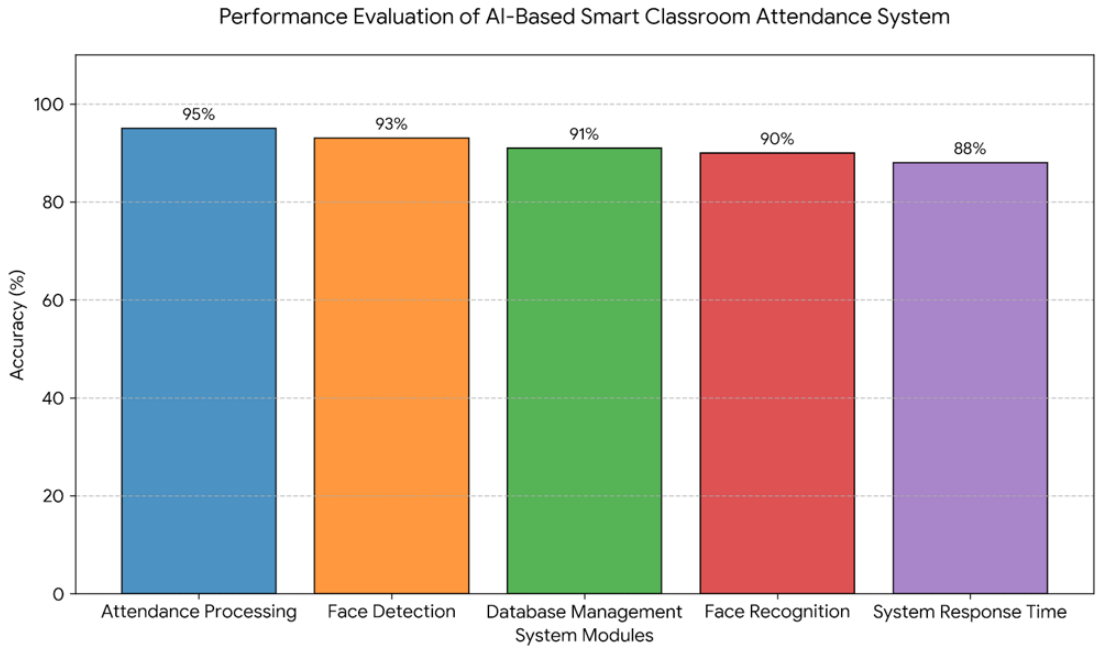
The smart attendance management system has greatly contributed to the development of intelligent classrooms. In addition, it has greatly contributed to the development of modern artificial intelligence systems.

RESULTS AND DISCUSSION

The proposed AI-based smart classroom attendance system was developed and tested to assess its efficacy in automatically recording student attendance through facial recognition technology. It takes images from a camera and uses computer vision algorithms to detect and recognize student faces. Once faces are recognized, it automatically records the students' attendance in the database without any manual intervention from teachers.

The testing results show that the proposed smart classroom attendance system can automatically detect and identify multiple faces of students in the classroom environment. It can automatically detect faces in images taken from the camera, and the face recognition module compares these images with those stored in the database, containing images of students who have already enrolled. Once it finds an image, it automatically records the students' attendance in real time.

The results from testing and implementing the proposed smart classroom attendance system show that it can significantly save time in managing students' attendance compared with traditional methods. In traditional methods, teachers take several minutes to manually record students' attendance, particularly in large classrooms. This proposed smart classroom attendance system can automatically record students' attendance within a few seconds after capturing an image from the classroom.



Another significant advantage of the proposed system is that proxy attendance is not possible. Since the system recognizes students based on unique facial features, no student can mark attendance on behalf of another student. This increases the accuracy of student attendance records.

The proposed system was tested for its usability and efficiency. The system's interface is user-friendly and allows for easy storage of student information. This makes it easier for administrators and teachers to keep track of student attendance records. The integration of artificial intelligence and facial

recognition technology increases the efficiency of the system. From the test results, it is evident that the proposed smart attendance system is reliable and accurate. The system has the potential to save time and increase efficiency in student attendance management systems.

Furthermore, the system was also tested under different classroom conditions to check its reliability and performance. In the context of the experiment, the facial recognition module was able to recognize students even with slight changes in the conditions. This is also possible with the help of the use of machine learning algorithms, where the system is able to learn the patterns and improve the accuracy over a period of time.

The system was also able to recognize multiple students at a single time. When a classroom picture containing multiple students was fed into the system, the face detection module was able to recognize the multiple faces in the picture. These faces were further recognized by comparing them with the database and identifying the students. After the identification was over, the attendance was automatically updated for each student. This is also a significant feature of the system, where it is able to recognize multiple students at a single time, making it more appropriate for larger classrooms.

Another significant aspect that was evaluated was the efficiency of the system in keeping track of student attendance. The information regarding student attendance is stored in a structured manner in the database. This allows teachers or administrators to view reports on student attendance. This feature is useful in keeping proper documentation on student attendance if required.

Moreover, the system is efficient in lessening the workload of teachers. The teachers are not required to perform any tedious work regarding student attendance. Instead, teachers can focus on imparting knowledge to students. The teachers do not have to waste class hours on taking attendance. The automated system keeps track of student attendance in an efficient manner.

From the results of the implementation, it is clear that the proposed AI-based system is efficient in providing an effective solution for smart classrooms. The integration of facial recognition technology and data management is useful in enhancing the efficiency of student attendance systems in modern educational institutions.

CONCLUSION

This paper has presented an AI-based smart classroom attendance system that utilizes facial recognition technology to automate student attendance recording. The conventional student attendance system involves considerable effort on the teacher's part and is time-consuming and vulnerable to proxy attendance. To address these drawbacks, this proposed system utilizes computer vision and machine learning to recognize students automatically. The proposed system has been implemented to take images from a camera and then recognize students using facial recognition technology. Once a student is recognized by the system, the student's attendance is automatically updated in the database without any manual intervention. This greatly reduces the time required to manage student attendance and minimizes the chances of errors in student attendance records.

The results obtained from the implementation show that the system is effective in detecting multiple faces and recording attendance. This solution also helps the teacher focus more on teaching by avoiding the maintenance of attendance. It is clear from the above discussion that the attendance system based on artificial intelligence is a practical solution for smart classroom environments. The use of artificial intelligence in attendance management is a significant step towards developing smart classrooms.

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