Facial Recognition Attendance System Using Deep Learning Models

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***Abstract :* This paper presents the development of "Presence," a real- time web-based facial recognition attendance system designed to automate the attendance tracking process for educational institutions. Using ResNet50, a state-of-the-art deep learning model, the system provides accurate and efficient attendance recording while minimizing human intervention. The system improves record-keeping, reduces errors, and integrates seamlessly with classroom infrastructure. With real-time processing, Presence is tailored for ease of use and scalability, offering institutions an advanced solution for managing attendance.**

There is a need for an automated system that provides: Accuracy: Reducing human error in attendance marking.

Efficiency: Saving time by automating the attendance process. Real-time Reporting: Enabling immediate updates on attendance records.

Scalability: Adapting to different class sizes and institutional requirements.

Presence addresses these issues by using facial recognition technology to automate attendance tracking, providing an efficient and scalable solution that improves the overall administrative workflow of educational institutions.

1. INTRODUCTION

Tracking attendance is an integral part of academic institutions, yet it remains a time-consuming task that often leads to human errors. Manual attendance tracking methods are prone to mistakes and manipulation, making them inefficient for modern, large-scale educational environments. To address this challenge, we propose "Presence," a facial recognition-based system that automates attendance-taking, improves accuracy, and saves time. Presence uses a deep learning model—ResNet50—that recognizes faces in real-time and records attendance without the need for human intervention. The system integrates with a webcam to capture student faces during attendance checks and updates the records in real-time. By employing machine learning for facial recognition, the system ensures fast, reliable, and secure attendance processes.

1.3 Objectives

The objectives of the Presence system are as follows:

1. To implement a facial recognition-based system that automates attendance tracking.
2. To ensure high accuracy using deep learning models for facial recognition.
3. To offer real-time attendance recording and monitoring.
4. To simplify the attendance management process with a user- friendly interface.
5. To provide a scalable solution that can be integrated with existing

Learning Management Systems (LMS).

* 1. Background

Attendance is a critical aspect of educational institutions for both administrative and pedagogical purposes. Traditional methods of attendance tracking, which usually involve manual roll calls or paper based logs, are not only time-consuming but also prone to errors and potential manipulation. For large institutions, this process becomes even more cumbersome, leading to inefficiencies in record-keeping, analysis, and monitoring. With advancements in artificial intelligence and machine learning, facial recognition technology offers a promising solution to automate the attendance process. Facial recognition technology has evolved significantly, with deep learning models showing great potential in identifying individuals based on facial features. By applying these techniques in the context of classroom attendance, we can ensure accurate, fast, and secure attendance tracking. Presence, the system developed in this project, leverages these technological advancements to simplify and enhance the attendance management process. It eliminates the need for human involvement during attendance marking and provides real-time results, which are particularly beneficial in large educational settings.

* 1. Problem Statement

The current manual methods of attendance tracking are inefficient, prone to manipulation, and difficult to manage in large-scale institutions. Teachers often spend valuable instructional time taking attendance, which could be better utilized for educational activities. Additionally, manual systems are prone to errors, leading to inaccurate records, which complicates the task of tracking student attendance patterns and enforcing accountability.

1. LITERATURE REVIEW

Facial recognition technology has been widely studied and applied in various domains such as security, surveillance, and commercial applications. In the field of education, facial recognition for attendance systems has gained attention for its potential to automate processes that traditionally require manual input.

* 1. Evolution of Facial Recognition Models

Various facial recognition models such as VGG16, ResNet50, and Inception V3 have been employed in numerous applications. These models have demonstrated high accuracy in recognizing individuals, especially when trained on large datasets such as the Labeled Faces in the Wild (LFW), which contains over 13,000 images of more than 5,700 individuals.

Studies have shown that VGG16, a convolutional neural network model with 16 layers, excels in feature extraction but tends to have higher computational costs. ResNet50, with its residual connections, mitigates the vanishing gradient problem in deep networks, making it more efficient for real-time recognition tasks. Inception V3, with its multi-filter architecture, is known for capturing various aspects of an image at different scales, providing a versatile approach to image recognition.

However, most existing facial recognition attendance systems are either too complex for practical use in educational environments or fail to provide real-time processing. These systems are often designed for security and surveillance purposes, where accuracy is prioritized over speed. Educational institutions require a more balanced approach that emphasizes both speed and usability, especially in classroom settings where fast, real-time processing is critical.

* 1. Gaps in Existing Research

Many existing solutions do not consider the unique requirements of educational institutions, such as:

Real-time performance: The need for fast, accurate recognition that fits within the short time available for attendance in classrooms.

User-friendliness: Interfaces that are simple and intuitive for educators, who may not have technical expertise.

Integration with existing systems: Seamless integration with administrative tools such as learning management systems (LMS) and student information systems (SIS).

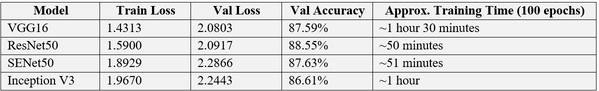
Presence seeks to address these gaps by offering a solution tailored specifically for educational settings, with a focus on usability, scalability, and real-time performance.

1. METHODOLOGY
   1. Overview of the System Architecture

The Presence system is designed as a web-based application that captures student images through a webcam and uses deep learning for facial recognition. The architecture consists of three key components:

1. Frontend: A user-friendly interface developed using HTML, CSS, and JavaScript, where educators can manage subjects, start attendance sessions, and view historical attendance records.
2. Backend: Implemented using Python and Flask, this handles the facial recognition logic and manages the interaction between the frontend and the machine learning models.
3. Machine Learning Model: The ResNet50 model serves as the core engine for facial recognition. It is pre-trained on the LFW dataset and fine-tuned for optimal performance in real-world classroom environments.
   1. Model Selection and Training

Several models were considered for this project, including VGG16, ResNet50, SENet50, and Inception V3. Each model was evaluated based on its accuracy, training time, and efficiency in real-time processing. The models were trained on the Labeled Faces in the Wild (LFW) dataset, which consists of 13,233 images of 5,749 individuals. Data augmentation techniques such as cropping and flipping were applied to improve the generalization ability of the models.



* + 1. ResNet50 Performance

ResNet50, a 50-layer deep convolutional neural network, was chosen for its balance between accuracy and computational efficiency. The residual connections in ResNet50 allow the model to train deep networks without the vanishing gradient problem. After fine-tuning over 500 epochs, the model achieved a validation accuracy of 88.57%. Key metrics for the model training process included:

Training Loss: Decreased steadily over the training process, showing that the model was learning effectively. Validation Accuracy: Improved after fine-tuning, demonstrating the model's ability to generalize well to new data.

* 1. System Workflow

The system operates as follows:

1. Camera Integration: When a class session begins, the system activates the camera to capture images of students.
2. Facial Detection and Recognition: The captured images are processed using the ResNet50 model, which detects and recognizes student faces in real-time.
3. Attendance Recording: Once a student is recognized, their attendance is automatically recorded and stored in a CSV file.
4. Real-time Updates: The system provides immediate feedback, updating the attendance record in real-time for the educator to review.
   1. Tools and Technologies

The following tools were used in the development of Presence: Frontend: HTML, CSS, JavaScript

Backend: Python, Flask

Machine Learning: PyTorch, TensorFlow for model implementation

Data Storage: Attendance data is stored in CSV format for easy access and integration with other systems.

1. RESULTS AND DISCUSSION
   1. System Evaluation

Presence was evaluated in real-world classroom environments to test its recognition accuracy, processing time, and usability. The system was tested under different lighting conditions and varying classroom sizes to ensure robustness.

Key results included:

Recognition Accuracy: The system achieved an average accuracy of 88.57%, which is sufficient for real-time attendance tracking in typical classroom settings.

Processing Time: The system processed each student’s face in less than 1 second, making it practical for use in large classes. Scalability: Presence was able to handle attendance for classes of up to 100 students without significant performance degradation.

* 1. User Feedback

User feedback from educators and administrators highlighted the following:

Ease of Use: Teachers found the interface intuitive and easy to use, requiring minimal technical knowledge to operate.

Efficiency: The system saved significant time during attendance sessions, especially in large classes, by automating the process.

Real-Time Monitoring: The real-time updates were particularly appreciated, allowing educators to view attendance records instantly.

* 1. Challenges

The primary challenge encountered was in optimizing the system for varying lighting conditions, which sometimes affected the facial recognition accuracy. Future iterations will focus on enhancing the system’s robustness to such environmental factors by implementing additional data augmentation techniques during model training.

1. CONCLUSION
   1. Summary

The Presence system offers a novel solution for automating attendance tracking using facial recognition technology. By leveraging the ResNet50 deep learning model, the system achieves a balance between high accuracy and real-time processing, making it suitable for educational settings. The system is easy to use, scalable, and adaptable, providing institutions with a modern, efficient tool for attendance management.

* 1. Contributions

The key contributions of this work are:

The development of a scalable facial recognition attendance system tailored for educational institutions.

The application of the ResNet50 model for real-time facial recognition with high accuracy.

An easy-to-use interface that simplifies attendance tracking for educators.

* 1. Future Work

Future enhancements to the system may include:

Mobile Application: Developing a mobile version of the system to allow for even greater flexibility. Integration with LMS: Integrating with Learning Management Systems (LMS) to streamline attendance tracking and reporting.

Improved Robustness: Enhancing the system’s performance under challenging conditions, such as poor lighting or occluded faces.

Advanced Analytics: Offering insights into student attendance trends and participation using data analytics tools.

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