AttendIQ: An AI-Powered Real-Time Face Recognition Attendance System

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Abstract **– Accurate and precise attendance management is vital for any organisation, be it educational organisations or corporate premises. Traditional methods like manual attendance marking are time-consuming and prone to mistakes. To address these issues, we propose an automated Face Recognition Attendance System that leverages deep learning and computer vision techniques. The system integrates four key modules: face detection, facial landmark detection, 128-dimensional face feature vector extraction, and facial expression recognition. Real-time detection is performed using the SSD MobileNet V1 model because it features a lightweight architecture with higher accuracy. Detected faces are processed for facial landmark extraction, providing better feature alignment, and face recognition is performed through 128 feature vectors to ensure precise identification. Once the faces are identified, the system records attendance automatically and maintains a historical log. Attendance history is presented visually through dynamic pie charts, providing an analysis of attendance patterns over time. This system aims to deliver a contactless, efficient, and intelligent attendance management solution, reducing manual efforts and improving operational productivity.**

Keywords **– Face Recognition, SSD MobileNet V1, Facial Landmark Detection, Feature Vector Extraction, Data Visualization.**

I. INTRODUCTION

Although keeping track of attendance has always been crucial in both school and workplace environments, traditional methods like roll calls and sign-in sheets can be time-consuming and prone to human mistakes. To solve this problem, "AttendIQ: Face Recognition Attendance System" uses the latest artificial intelligence and deep learning technologies to automate the process and make it quicker, more accurate, and trouble-free.

The system is based on computer vision models like SSDMobileNetV1 for face detection, facial landmark detection and feature extraction. The technologies are used to identify the presence of individuals by capturing facial information in real time. Because this step is automatic, there's no need for manual checks or physical contact, a step that has been helping to eliminate errors and a practice such as proxy attendance.

A visualisation tool in the system displays attendance history through simple pie charts, which administrators can easily read and analyse attendance patterns. The web-based application design makes it possible to integrate the system across school systems and workplace environments, and any environment that requires attendance records.

The automated attendance solution saves time for students and staff members to ensure efficient uninterrupted operations. The easy-to-use solution functions without contact to expand work productivity and maintain forward momentum.

II. LITERATURE REVIEW

Senthil G. A. and Geerthik S et al[1], developed an automated attendance system that employs face recognition to improve tracking procedures for large student enrollment numbers. This model applies computer vision with deep learning by merging HOG feature extraction while using PCA alongside SVM and KNN for classifiers which results in a high accuracy rate of 96.8%. The system both creates particular student identifiers along with maintaining one central data tracking system and ensures simplified processes while

decreasing fraud through automated facial recognition technology.

A face-recognition-based automated attendance system that resolves attendance issues with manual methods and proxy activities was developed by Smitha, Pavithra S Hegde et al [2]. The attendance system identifies faces using Haar-Cascade detection algorithms before utilizing the LBPH algorithm for recognition. A database contains student images which enables the system to automatically track attendance through live classroom video scanning. The system automatically generates attendance reports which are delivered to the educational institution staff by email. The method enables swift contactless management which operates with high efficiency for attendance tracking.

S. Dev and T. Patnaik [3] proposed a system which the requirements i.e is required for the face recognition. The addition of Gabor filters considerably increases the system's accuracy.. Three algorithms are used for face recognition: KNN, CNN, and support vector machines. KNN algorithm (of 99.27%)has proved to have the highest accuracy by using CNN has low computational complexity and algorithm name SVM is used to prove to be less efficient.

S. S. Pawaskar and A. M. Chavan [4] proposed a system of using different algorithms like haar cascade along with another one, LBPH which is mostly utilize for the object and the image detection along with the record of the attendance through this system

In [5] paper the authors have created an automatic attendance system that uses facial recognition and has a built-in two-tier authentication mechanism. For face detection, a faster R-CNN algorithm is used. The system is drawn to work in a lecture room with two cameras on opposing ends, such that at least one of the cameras captures every student. Each student has a unique ID that is used to identify them in the database. When a student meets the two-tier authentication process required criteria, their corelative ID's are there.

III. SYSTEM ARCHITECHTURE

The system follows a modular approach, divided into three main phases: Data collection and Preprocessing, face detection and recognition, and Attendance Marking and Analytics. These phases work together to deliver accurate, real-time, and automated attendance solutions.

A. Data collection and Preprocessing

This step is very crucial for ensuring high–quality face recognition. It involves:

1. Real-Time Photo Capture:

a) The standard webcam operates by continuously recording video frames at 30 FPS, followed by picture capture.
b) The analysis of camera input selects the region of interest by locking onto the user's face.

2. Facial Landmark Detection:

a) The facial landmark detection of 68 reference points occurs through Face-API.js using pretrained models.

B. Face Detection and Recognition

The identification process operates swiftly to recognize students properly thus facilitating efficient attendance record-keeping.

1. Face Detection :

a) The real-time operation of SSD MobileNet V1 allows it to detect faces that appear on the webcam feed.
b) The detection method separates faces from image frames before performing accurate recognition tasks.

2. Face Recognition :

a) Each identified face undergoes feature vector extraction using 128 dimensions through the Pretrained Face Recognition Model.
b) The face vectors are processed by Face-API.js which compares them against data in the database to verify registered students.

C. Attendance Marking and analytics

Real-time updates, smooth attendance tracking, and prompt student notifications are all guaranteed during this phase.

1. Attendance Marking :

a) Automated detection of a student's face triggers data entry as "Present" together with timestamp recording in the database system.

2. Notifications and Reports:

a) All registered students receive email notifications at the start of attendance marking by the lecturer.
b) For a better understanding of the level of participation in the session, pie charts are used to generate and visualize attendance reports.

IV. METHODOLOGY

A. Data Preprocessing

1) A facial image database of registered students is gathered and tagged for reference.

2) No other image processing (background removal, grayscale, etc.) is done because pretrained models can deal with lighting and background variations well.

B. Real – Time Preprocessing

1) SSD MobileNet V1 is utilized for face detection in real-time via webcam input.
2) Facial Landmark Detection accurately detects major facial features using pretrained models.
3) Face Recognition is done by extracting 128-dimensional face feature vectors per face using Face-API.js.

C. Model Training

1) Pretrained face detection, facial landmark detection, face recognition, and facial expression analysis models are combined through Face-API.js.
2) First, the models are trained on vast, publicly available datasets such WIDER FACE (for face detection) and Labeled Faces in the Wild (LFW) (for face recognition)
3) Deep learning and optimization were used to complete training using TensorFlow.
4) They were then transformed into TensorFlow.js format to allow for seamless operation in web browsers without requiring retraining.

D. Real – Time Attendance Marking

1) Students are informed by email using Google OAuth credentials when the lecturer starts attendance.
2) Student faces are detected and recognized immediately using webcam input.
3) A timestamp marks attendance, therefore guaranteeing precise session records.

E. Report and Analytics

1) Reports are created from session-attended data gathered.
2) Pie charts help to visualize reports so that they clearly show attendance patterns.

V. DEVELOPMENT ENVIRONMENT

A. Programming Languages and Frameworks:

1) JavaScript & Node.js - Key technologies that connect easily with API services for real-time interactions
2) React.js – used for the user interface, providing a smooth experience for both students and lecturers.

B. Face Recognition Models:

1) The browser-based technology TensorFlow.js directly implements machine learning models which provides fast recognition functionalities without requiring server infrastructure.
2) Face-Api.js : enables live identification of faces together with their feature extraction.

C. Database and Cloud Services:

1) MongoDB : provides NoSQL data storage for user data as well as attendance records.
2) Cloudinary : provides optimised storage and delivery services for hosting student facial images.

D. Authentication and Communication :

1) Google OAuth – secure authentication of users and sends automatic email notifications before attendance sessions start.

E. Data Visualization:

1) Chart.js – generates interactive pie charts and visual summaries of attendance statistics for better insights.

VI. CHALLENGES AND LIMITATIONS

1. The accuracy of face recognition system gets reduced because of poor lighting together with crowded background.
2. The performance of the system varies because users utilize different webcam technologies and machine specifications.
3. Mandatory internet connection serves as an essential requirement for operating features that use email notifications and cloud data storage services.
4. Strict guidelines regarding data protection should apply to the storage of facial data.
5. The system requires optimisation because its performance scales with the growth of users.

VII. EXPERIMENTAL RESULTS

A. Performance Evaluation

Multiple tests of the system occurred in actual scenarios to assess its performance capability and speed along with accuracy levels.

1) Key Performance Metrics:
   a) Validation Accuracy : 99.8%
   b) The system achieves real – time performance at 30 frames per second.

2) Real – world Testing scenarios:
   a) Controlled Environment : Achieved high accuracy in optimal conditions.
   b) The system performed a slightly lower accuracy rate because the reduced visibility of faces under poor lighting conditions.
   c) The system demonstrated ability to recognise multiple users while matching their faces effectively.

B. Results

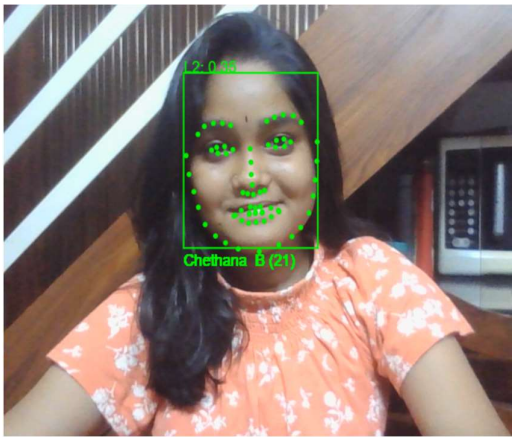

Fig 1 : System accurately recognises the user

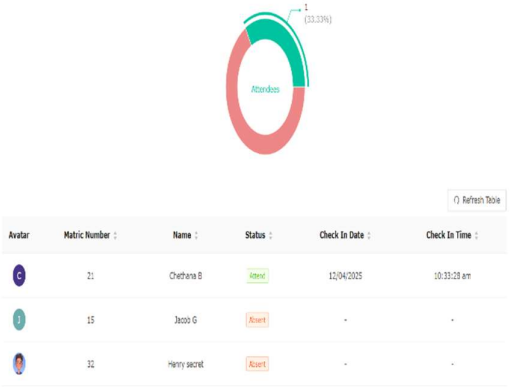

Fig 2 : Data Visualisation and attendance report

VIII. CONCLUSION

In order to simplify and automate classroom attendance tracking, this paper introduces AttendIQ, a real -time AI-driven facial recognition attendance system.To correctly identify faces obtained from webcam sources, the system uses face-api.js and Tensorflow.js to implement deep learning models.

The system achieves:

1) High accuracy of 99.8% for face recognition.
2) Real-time face detection happens at 30 FPS.

The technology presents opportunities to enhance educational institution efficiency by lowering manual work while increasing system reliability with data analytics capabilities.

IX. FUTURE SCOPE

1. *Mobile and Edge Deployment:* The developers should create smartphone as well as Raspberry Pi applications to ensure face recognition functionality is accessible to schools with basic computing equipment.
2. *Seamless LMS integration:* The system integrates with Learning Management Systems (LMS) to link up with Moodle or Google Classroom platforms for automatic student attendance synchronisation.
3. *Voice + Face Recognition:* The system includes Voice + Face Recognition authentication to enhance recognition reliability as well as security integration.
4. *Predictive analysis and alerts:* Student attendance history will generate early warnings for potential chronic absenteeism incidents which will automatically trigger parent and advisor notifications.

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