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APAS: AI-Powered Automated Student Attendance System Using Face Recognition

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Abstract: This paper introduces APAS (AI-POWERED ATTENDANCE SYSTEM) , an AI-driven mobile application designed for automated classroom attendance utilizing computer vision and deep learning methodologies. Teachers can take a picture of the classroom, and the system uses YOLO for face detection and a custom neural network for face recognition to identify students and keep track of attendance based on academic factors like year, branch, and subject. It has separate interfaces for teachers and students that allow for multi-level access. This makes it easier to keep track of attendance and subjects. Python, OpenCV, and TensorFlow/Keras are used to build the backend, and MySQL is used to manage the data. Flutter is used to make the mobile frontend responsive. APAS provides a solution that is scalable, accurate, and efficient, greatly reducing the amount of work that needs to be done by hand and making attendance systems more reliable.
Keywords: Artificial Intelligence, Computer Vision, Face Detection, Face Recognition, MobileNet, YOLO, Deep Learning, Mobile Application, Chatbot Integration, Attendance Automation.

I. INTRODUCTION

Many schools still keep track of attendance by hand, which takes a lot of time, is prone to mistakes, and doesn't work well, especially in big classrooms. Automated attendance systems have gotten a lot of attention because of the growth of AI and computer vision, but the ones that are already on the market still have a lot of problems.

Traditional automated methods, like attendance systems that use CCTV, need constant video monitoring, which uses a lot of power, costs more for hardware, and processes data that isn't needed. Also, these kinds of systems often have trouble with real-time accuracy because of changes in lighting, camera angles, and obstructions. Other methods that use face recognition depend on taking pictures of each student's face one at a time, which is boring and takes a long time, making them less useful in real classrooms.

To solve these problems, the APAS project suggests an attendance system that is both efficient and scalable. It uses a single image of a classroom to find and identify many students at once. The system uses YOLO to find faces and a deep learning-based neural network to recognize them. This lets you mark attendance quickly and accurately without having to keep an eye on it all the time.

The system also has a manual override feature that lets teachers fix attendance when predictions are missed or wrong through the app, which makes it more reliable overall. The system has an easy-to-use interface with multiple levels of access, in addition to automation. Teachers can easily take attendance and, if they need to, change the default attendance rules for certain classes or students. Students can easily check their daily attendance and performance in each subject through an easy-to-use portal.

In general, APAS is a useful and dependable answer that gets around the problems with current systems and makes things more efficient, scalable, and easy to use in today's schools.

II. PROBLEM DEFINITION

Current classroom attendance practices have a lot of big problems:

1) Manually taking attendance and signing in takes a lot of time and takes away from valuable teaching time.
2) Mistakes made by people when recording attendance lead to wrong data.
3) It's hard to find proxy attendance, which is when one student marks another as present.
4) It's not very efficient to make reports and get data from paper records.
5) Institutions don't have a centralized, scalable way to manage attendance.

There is a clear need for a technologically advanced system that ensures accuracy, efficiency, and ease of operation while being accessible via commonly available hardware such as smartphones.

III. EXISTING SOLUTIONS AND LIMITATIONS

There are a few automated ways to keep track of attendance, but each has its own problems:

1) Face Recognition Using CCTV: This method uses cameras that are always on and process video all the time. It works well, but it costs a lot to install and keep up. Institutions with limited resources can't use continuous video processing because it needs a lot of computing power and resources.
2) Attendance with QR Code: To mark attendance, students scan a QR code that only works for a short time. However, codes can be shared from a distance, which lets people attend as proxies. The method also takes a long time for big groups of students because each student has to scan the code on their own.
3) Biometric Attendance (Fingerprint / Iris Scanner): Biometric devices are good at verifying identity, but they need expensive hardware that can break down. These systems don't work well for big groups because each student has to use the device on their own, which causes lines and delays.

APAS gets around these problems by only needing a standard smartphone camera, which lets all of the students be identified in one picture at the same time.

IV. LITERATURE REVIEW

Recent developments in Artificial Intelligence and Computer Vision have made automated attendance systems much more efficient and practical. These systems mainly rely on two important tasks: detecting faces and recognizing them, which allows students to be identified in real-time within a classroom. For detecting faces, models like YOLO (You Only Look Once) [1] are commonly used because they are both fast and accurate. YOLO can detect multiple faces at once, making it ideal for classroom environments where many students need to be identified simultaneously. When it comes to recognizing faces, FaceNet [2] is a widely used deep learning model. It converts facial images into unique numerical representations (called embeddings), which makes it possible to accurately identify individuals even if there are changes in lighting, facial expressions, or angles. In the past, techniques like Principal Component Analysis (PCA) and Eigenfaces [3] were used for face recognition. However, these methods are not very reliable in real-world situations compared to modern deep learning approaches. Even with these advancements, many existing attendance systems still have limitations. Some depend on continuous CCTV monitoring, which increases power usage and computational cost. Others require capturing each student’s image individually, which can be time-consuming and not practical for large classrooms.

To overcome these issues, the proposed system combines YOLO-based face detection with FaceNet embeddings and a neural network classifier. This allows the system to recognize multiple students from a single classroom image efficiently, making the attendance process faster, more scalable, and easier to use.

V. PROPOSED SYSTEM & OBJECTIVES

APAS is designed to make the attendance process simple, fast, and practical for real classroom use. The main goals of the system are:

1) To create a mobile app that automatically marks student attendance using facial recognition, so there is no need for manual attendance or biometric devices.
2) To allow teachers to log in securely, upload a single classroom photo, and get attendance marked instantly without extra effort.
3) To give students access to their attendance records, where they can easily check their overall attendance as well as subject-wise details.
4) To reduce overall costs by using regular smartphone cameras and cloud-based processing instead of expensive hardware.

Overall, the system handles everything—from capturing the image to confirming attendance—in one smooth process, making it easy to use and suitable for real classroom environments.

VI. SYSTEM ARCHITECTURE

The proposed APAS system follows a modular architecture consisting of three primary layers: the frontend interface, backend processing layer, and the deep learning–based recognition module, integrated with a database for attendance management.

1) Frontend Layer (User Interface)
   - Developed using Flutter
   - Provides separate portals for:
     - Teachers → Capture/upload classroom images, mark attendance
     - Students → View attendance status and subject-wise performance
   - Sends image data and metadata (year, branch, subject) to backend

2) Backend Layer (API & Processing)
- Built using Flask (Python)
- Handles:
  - Image upload from frontend
  - Request validation
  - Communication with AI models
- Returns:
  - Present student list
  - Absent student list
  - Attendance statistics

3) AI Processing Layer (Core Intelligence)

This is the most critical component of the system:
- ➢ Face Detection (YOLO)
  - Detects multiple faces from a single classroom image
  - Extracts bounding boxes for each face
- ➢ Feature Extraction (FaceNet)
  - Converts each detected face into a 512-dimensional embedding vector
  - Ensures robust feature representation
- ➢ Face Recognition (Neural Network)
  - Custom-trained classifier maps embeddings → student roll numbers
  - Uses softmax classification + confidence filtering

4) Database Layer
- Implemented using PostgreSQL
- Stores:
  - Student details
  - Attendance records
  - Subject-wise data
- Supports:
  - Attendance history
  - Query-based retrieval

5) Output Layer
- Displays attendance results in:
  - Mobile app (Flutter UI)
- Provides:
  - Present/Absent lists
  - Attendance statistics

VII. METHODOLOGY

Table I : Technology Stack Used

Layer	Technology	Purpose
Frontend	Flutter	Cross-platform mobile UI
Backend	Flask (Python)	RESTful API & business logic
Face Detection	YOLO	Detect faces in class photo
Face Recognition	Custom NN	Identify individual students
Libraries	OpenCV, TensorFlow, NumPy	Image processing & ML inference
Database	PostgreSQL	Attendance & profile storage

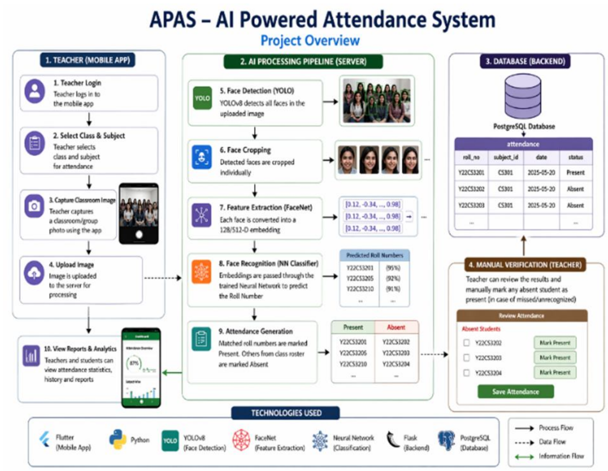

Figure 1: Architecture

A. Data Collection

A dataset is created by collecting 10–20 images per student, stored in a structured directory format:

```
TRAINING_DATA/
  ├──Y22CS3201/
  ├──Y22CS3202/
  ├── ...
```

Each folder represents a student roll number(class label).

This folder-based labeling is directly used during training without manual annotation .

B. Data Preprocessing & Feature Extraction

Unlike traditional CNN training, your system uses FaceNet embeddings instead of raw images.

Pipeline:

Image Loading & Resizing

Each image is resized to 160×160 pixels

Face Embedding Extraction

A pretrained FaceNet model (keras_facenet) is used

Each image is converted into a fixed-length embedding vector (512-dimension)

Feature Dataset Creation

Instead of images → you store:

X=embeddings

y = roll numbers

C. Model Training (Neural Network Classifier)

This project does NOT train MobileNet.

Instead, it trains a fully connected neural network on embeddings.

Architecture:

Input: 512-dimensional embedding

Layers:

Dense (512 neurons, ReLU)

Dropout (0.5)

Dense (256 neurons, ReLU)

Dropout (0.5)

Output Layer (Softmax → number of students)

- From this code:

Dense(512,activation='relu')
Dense(256,activation='relu')
Dense(num_classes, activation='softmax')
Training Details:
Loss: Categorical Crossentropy
Optimizer: Adam
Train-Test Split: 80% / 20%
Labels encoded using LabelEncoder
The trained model is saved as:
face_classifier_model.h5
label_encoder.pkl

D. Attendance Marking Pipeline

The attendance system follows a two-stage AI pipeline:

Step 1 — Image Input

A classroom/group image is uploaded (in your case via Colab upload interface).

Step 2 — Face Detection (YOLO)

YOLOv8 face model (yolov8n-face.onnx) is used
Detects bounding boxes for all faces in the image
results = yolo_model.predict(source=image_path, conf=0.5)

Step 3 — Face Cropping

Each detected bounding box is used to crop individual faces:
person_crop = img[y_min:y_max, x_min:x_max]

Step 4 — Feature Extraction (FaceNet)

Each cropped face is:
Resized to 160×160
Converted into embedding using FaceNet
emb = get_embedding(face)

Step 5 — Classification (Neural Network)

Embedding is passed to trained classifier
Model predicts:
Roll number
Confidence score
probs = model.predict(...)
roll_id = le.inverse_transform([pred_idx])

Step 6 — Attendance List Generation

All predicted roll numbers are collected into a list:
roll_ids.append(roll_id)
These represent present students
Remaining students can be marked as absent (logic to be added separately)

Step 7 — Manual Verification and Override

To handle real-world challenges such as missed detections, occlusions, or incorrect predictions, the system incorporates a manual verification mechanism through the teacher interface.

After the automated attendance process is completed, the predicted present and absent student lists are displayed in the mobile application. The teacher is provided with the ability to:

- Review the attendance results
- Manually mark absent students as present in case of missed or unrecognized faces
- Correct any incorrect predictions

This human-in-the-loop approach ensures higher reliability and practical usability of the system, especially in complex classroom environments where automated models may occasionally fail.

VIII. BENEFITS AND FEATURES

APAS offers several practical benefits compared to traditional attendance methods:

1) It is cost-effective, as it only requires a smartphone camera and an internet connection—there's no need for expensive or specialized devices.
2) It saves time by marking attendance for the entire class from just one photo, and the process takes only a few seconds.
3) All attendance data is stored digitally, making it easy to generate reports and access records whenever needed.
4) The system is flexible and can be used in both small classrooms and large lecture halls without any issues.
5) Students can easily check their own attendance records and even clear their doubts using the chatbot, without depending on teachers every time.
6) Since attendance is based on facial recognition, students must be physically present in the classroom, which helps prevent proxy attendance.

IX. RESULTS AND DISCUSSION

The APAS system was tested in real classroom environments with different group sizes, lighting conditions, and face angles. Experiments were carried out on a dataset of around 20 students, where the system showed strong performance and reliability.

For small to medium-sized groups (up to 20 students), the system achieved an accuracy between 95% and 100%. This high accuracy was mainly due to effective face detection using YOLO and reliable feature extraction using FaceNet embeddings, along with a well-trained neural network classifier. The system was able to correctly recognize most students even when there were slight variations in pose and facial expressions.

However, when the number of students increased, a small drop in accuracy was observed. In larger classroom settings, especially under poor lighting conditions, some detected face regions were not very clear during the cropping stage. As a result, the extracted features were not always accurate, which led to a few missed detections or incorrect predictions. In such cases, the system achieved an average accuracy of around 88% to 93%.

In terms of speed, the system performed very efficiently. The entire process—from uploading a classroom image to generating the attendance list—was completed within a few seconds. This makes the system much faster and more practical compared to traditional manual attendance methods.

The mobile application also worked smoothly on both Android and iOS devices, making it accessible and easy to use for both teachers and students.

Although the results are promising, there is still room for improvement. The system can be enhanced by improving its performance under extreme lighting conditions, increasing the size and diversity of the training dataset, and adding liveness detection to prevent misuse, such as using printed images to mark attendance.

Overall, the APAS system proves to be an efficient, scalable, and practical solution for automating attendance in modern classrooms.

X. CONCLUSION

This paper introduced APAS, an AI-powered attendance system that simplifies the traditional process of marking attendance, which is often time-consuming and prone to errors. The system combines YOLO for face detection, FaceNet for extracting facial features, and a neural network classifier to accurately identify students from a classroom image. Along with a Flutter-based mobile app and a Flask backend, it offers a solution that is efficient, scalable, and easy to use.

APAS helps remove issues like proxy attendance, reduces the workload for teachers, and allows both teachers and students to access attendance records in real time. To make the system more reliable in real-world situations, it also includes a manual verification feature, where teachers can correct any missed or incorrect detections.

Another key advantage is that the system works using regular smartphone cameras and lightweight AI models, showing that expensive biometric devices or continuous CCTV monitoring are not necessary. Overall, APAS provides a practical and modern approach to managing attendance in educational institutions.

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