Face Detection Based Attendance System Using ESP32 Embedded and Python

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***Abstract*—Attendance management is a critical task in educational institutions, and traditional methods such as manual attendance and RFID-based systems are time-consuming, error-prone, and susceptible to proxy attendance. This project presents a Face Detection Based Attendance System using ESP32 Embedded and Python, which automates attendance marking using computer vision techniques. Initially, facial images of authorized students are captured and stored as a dataset. These images are trained using a face recognition algorithm implemented in Python. During real-time operation, a USB web camera scans student faces and compares them with the trained dataset. If a match is found, attendance is marked as present and stored in an Excel sheet with date and time. If a student is absent, an automatic alert message is sent to the parent via GSM. In case of an unauthorized person attempting access, a buzzer alert is activated and warning messages are displayed on an I2C LCD. The proposed system improves accuracy, security, and efficiency in attendance management.**

***Index Terms*—Face Recognition, Automated Attendance System, ESP32 Embedded System, Computer Vision, GSM Alert Notification**

I. INTRODUCTION

The Automatic Attendance Management System Using Face Recognition automates the attendance process using facial recognition technology. A camera captures the faces of individuals and compares them with a stored database to identify them. Once a match is detected, the system automatically records the attendance with date and time. This method reduces manual work, prevents proxy attendance, and improves accuracy and efficiency in attendance management [1].

The IoT-Based Face Recognition Smart Attendance System using ESP32-CAM automates attendance recording using facial recognition and IoT technology. The ESP32-CAM captures facial images and compares them with a stored database to identify individuals. When a match is detected, the system automatically records the attendance and updates it through the network. This approach provides a contactless, accurate, and efficient method for managing attendance [2].

The Face Detection Based Attendance System Using ESP32 automates the attendance process using a camera-enabled ESP32 module. The system captures facial images, detects registered individuals, and records their attendance with date and time. This method reduces manual effort, improves accuracy, and helps prevent proxy attendance [3].

The Face Detection and Recognition using the Viola–Jones Algorithm and Fusion of PCA and ANN identifies individuals from images using computer vision techniques. The Viola–Jones algorithm detects faces in images, while PCA extracts important facial features. These features are then classified using an Artificial Neural Network (ANN) to recognize individuals accurately. This method improves the efficiency and reliability of face recognition systems [4].

The Facial Recognition Attendance System Using Python and OpenCV automatically records attendance by identifying individuals through facial recognition. A camera captures images, and OpenCV in Python processes and compares them with a stored dataset. When a match is found, the system marks attendance with the date and time, improving accuracy and reducing manual effort [5].

II. RELATED WORKS

The Student Attendance Marking Using Face Recognition in Internet of Things (IoT) automatically records student attendance using facial recognition technology. A camera captures student faces and

compares them with a stored database for identification. Once verified, the system marks attendance and updates the data through an IoT network, ensuring accurate and efficient attendance management [6].

The Attendance Management System Using Face Recognition automatically records attendance by identifying individuals through facial recognition technology. A camera captures facial images and compares them with a stored database. When a match is detected, the system marks attendance with the date and time, improving accuracy and reducing manual work [7].

The Face Recognition Based Attendance Updation System automatically records and updates attendance using facial recognition technology. A camera captures facial images and compares them with a stored database to identify individuals. When a match is detected, the system updates the attendance with the date and time, improving accuracy and reducing manual effort [8].

The Performance Evaluation of ESP32 Camera Face Recognition for Various Projects examines the effectiveness of the ESP32-CAM module in face recognition applications. The study evaluates factors such as detection accuracy, processing speed, and performance under different conditions to determine its suitability for embedded and IoT-based systems [9].

The Design of an IoT System Based on Face Recognition Technology Using ESP32-CAM presents a system that combines face recognition with IoT for automated identification. The ESP32-CAM captures facial images and compares them with a stored database to recognize individuals. The system can record data or control access, and the information can be monitored remotely through IoT connectivity [10].

The Facial Recognition Attendance System Using Python and OpenCV automatically records attendance by detecting and recognizing faces using image processing techniques. A camera captures images, and the system compares them with a stored dataset to identify individuals. Once recognized, the attendance is recorded with the date and time, improving accuracy and reducing manual effort [11].

The Face Recognition Based Attendance System Using ESP32-CAM automatically records attendance by identifying individuals through facial recognition. The ESP32-CAM captures facial images and compares them with a stored database. When a match is detected, the system records attendance with the date and time, improving accuracy and reducing manual effort [12].

The Student Attendance Marking Using Face Recognition in Internet of Things (IoT) automatically records student attendance using facial recognition technology. A camera captures student faces and compares them with a stored database for identification. Once recognized, the system marks attendance and sends the data through an IoT network for monitoring and storage [13].

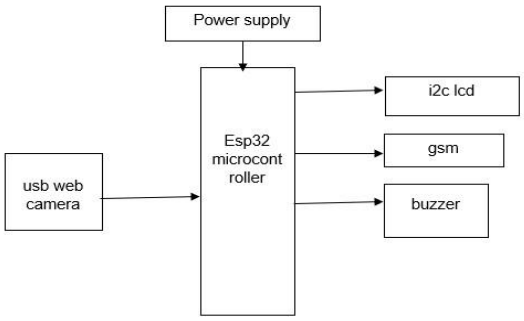
The Student Attendance System Based on the Face Recognition of Webcam's Image of the Classroom automatically records attendance using facial recognition. A webcam captures images of students in the classroom, and the system identifies them by comparing the images with a stored database. Once recognized, the attendance is recorded with the date and time, improving accuracy and reducing manual effort [14].

The Smart Attendance System Using RFID in IoT automatically records attendance using RFID cards and an RFID reader. When a user scans the card, the system verifies the identity and marks attendance with the date and time. The data is then transmitted through IoT for easy monitoring and management [15].

III. PROPOSED METHOD

The proposed Face Detection-Based Attendance System using ESP32 overcomes the limitations of traditional systems by integrating real-time face recognition with embedded control. A USB web camera captures images of individuals, which are processed using Python-based algorithms to identify registered personnel accurately. The ESP32 microcontroller manages the system, interfacing with an I2C LCD to display attendance status, while a buzzer alerts when unregistered individuals are detected. Additionally, the GSM module enables remote notifications, allowing administrators to receive attendance records instantly. Powered by a reliable 12V adapter and securely connected, this prototype enhances accuracy, reduces human error, prevents unauthorized attendance, and provides a scalable solution for modern institutions.

IV. BLOCK DIAGRAM



The block diagram illustrates an ESP32-based monitoring system where the ESP32 microcontroller acts as the central unit. A USB web camera captures real-time images and sends them to the controller for processing. The system displays the detection status on an I2C LCD, while a GSM module is used to send alert messages to users. Additionally, a buzzer provides an audible warning when a specific event is detected. This integrated system enables automated monitoring, real-time alerts, and efficient communication.

V. METHODOLOGY

Principle of Functioning

The proposed Face Detection Based Attendance System using ESP32 Embedded and Python automates the process of recording student attendance through computer vision technology. In the initial stage, facial images of authorized students are captured using a USB web camera and stored as a dataset. These images are then trained using a face recognition algorithm implemented in Python. During real-time operation, the camera continuously scans the classroom and detects faces present in front of it. The detected faces are compared with the trained dataset to identify registered students. When a match is successfully identified, the system automatically marks the student's attendance as present and records the entry with date and time in an Excel sheet. If the system detects an unknown or unauthorized person, a warning mechanism is triggered to ensure classroom security.

Hardware & Alerts:

The system hardware consists of an ESP32 module, USB web camera, I2C LCD display, GSM module, buzzer, and power supply unit. The ESP32 acts as the main controller that manages communication between the camera, sensors, and output devices. The USB camera captures real-time images for face detection and recognition processing through Python. The I2C LCD display shows system status messages such as face detection results and attendance confirmation. When an unauthorized person is detected, the buzzer produces an audible alert to notify the system operator. In addition, if a registered student is absent, the GSM module automatically sends an alert message to the parent or guardian to inform them about the absence.

Power Requirements

The system operates using a regulated power supply that provides stable voltage to the ESP32 controller, camera interface, GSM module, LCD display, and other electronic components. Proper voltage regulation ensures reliable performance of the face recognition process and communication modules. With continuous power availability, the attendance system can function efficiently in real time, providing an accurate, secure, and automated solution for attendance management in educational institutions.

Performance Comparison Table:

Parameter	Specification / Metric	Description
Central Controller	ESP32 Embedded Module	Acts as the main processing and communication unit that coordinates the camera input, recognition system, and alert mechanisms.
Image Acquisition	USB Web Camera	Captures real-time facial images of students present in the classroom for detection and recognition.
Face Recognition	Python Face Recognition Algorithm	Processes the captured images and compares them with the trained dataset to identify registered students.
Dataset Storage	Student Face Image Database	Stores the facial images of authorized students which are used to train the recognition model.
Attendance Recording	Excel Sheet Logging	Automatically records attendance with student name, date, and time when a match is detected.

Status Display	I2C LCD Display	Shows system messages such as face detection results, attendance confirmation, and system status.
Alert System	Buzzer	Produces an audible alert when an unknown or unauthorized person is detected.
Parent Notification	GSM Module	Sends automatic alert messages to parents when a student is marked absent or when unusual activity is detected.

Table 1 Performance Comparison Table

Table 1 The Face Detection Based Attendance System using ESP32 and Python automates student attendance using computer vision technology. The ESP32 module functions as the main controller that manages communication between the hardware components. A USB web camera captures real-time images of students, and a Python-based face recognition algorithm compares the detected faces with a stored dataset of authorized students. When a match is found, the system automatically records the attendance in an Excel sheet with the corresponding date and time. An I2C LCD display shows system status and attendance information. For security, a buzzer generates an alert if an unknown person is detected. Additionally, a GSM module sends notification messages to parents when a student is absent. The system operates using a regulated power supply to ensure stable and reliable performance.

Table 1: Comparative Analysis of Conventional Techniques and the Developed Approach

Parameter	Existing Methods	Proposed Approach (Our System)
Attendance Monitoring	Manual attendance or paper-based registers which are time-consuming and prone to human errors.	Automated attendance using face detection technology with ESP32 and Python for quick and accurate recording.
Identification Method	RFID cards or ID cards that can be misplaced, shared, or used for proxy attendance.	Face recognition algorithm identifies students using their unique facial features, eliminating proxy attendance.
Data Recording	Attendance recorded manually and maintained in physical registers or basic digital files.	Attendance automatically stored in an Excel sheet with student name, date, and time for organized record keeping.
Security Monitoring	No mechanism to detect unknown individuals in the classroom.	System detects unauthorized persons and activates a buzzer alert for security.
Notification System	Parents or authorities are informed manually after checking records.	GSM module automatically sends alert messages to parents if a student is absent.
System Efficiency	Slow process with higher chances of errors and manipulation.	Fast, accurate, and automated system that improves reliability and efficiency in attendance management.

Table 2 Traditional attendance systems rely on manual registers or RFID cards, which are time-consuming and may allow proxy attendance or human errors. In these methods, attendance records must be managed manually and there is no mechanism to detect unauthorized individuals or automatically notify parents. The proposed Face Detection Based Attendance System improves this process by using ESP32 and Python-based face recognition to automatically identify students using their facial features. Attendance is recorded directly in an Excel sheet with date and time for accurate record keeping. The system also enhances security by detecting unknown persons and activating a buzzer alert. In addition, a GSM module sends automatic notifications to parents when a student is absent. This approach increases efficiency, accuracy, and security in attendance management.

VI. RESULTS, CONCLUSION

The Face Detection-Based Attendance System using ESP32 successfully demonstrates an automated and secure approach to attendance management. By integrating real-time face recognition with embedded system control, the proposed prototype eliminates manual attendance procedures and minimizes human error. The use of a USB web camera and Python-based facial recognition ensures accurate identification of registered individuals, while the ESP32 microcontroller efficiently manages system operations and displays attendance information on an I2C LCD.

Security and reliability are further enhanced through the inclusion of a buzzer alert for unregistered detections and a GSM module for remote notification of attendance records to administrators. The system thereby prevents proxy attendance and provides real-time monitoring capabilities. Powered by a stable 12V supply and secure hardware integration, the prototype offers a cost-effective, scalable, and practical solution for modern institutions such as schools, offices, and workplaces.

REFERENCES

[1] S. Sharma and R. Kumar, "Automatic Attendance Management System Using Face Recognition," Int. J. Comput. Appl., vol. 178, no. 7, pp. 15–20, 2019.

[2] M. Prakash, K. Reddy, and S. Verma, "IoT-Based Face Recognition Smart Attendance System using ESP32-CAM," Int. J. Eng. Res. Technol. (IJERT), vol. 9, no. 6, pp. 1023–1027, 2020.

[3] Singh and P. Gupta, "Face Detection Based Attendance System Using ESP32," Int. J. Innov. Technol. Explor. Eng., vol. 8, no. 11, pp. 3540–3544, 2019.

[4] P. Viola and M. Jones, "Rapid Object Detection Using a Boosted Cascade of Simple Features," in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR), 2001, pp. 511–518.

[5] R. Patel and D. Shah, "Facial Recognition Attendance System Using Python and OpenCV," Int. J. Adv. Res. Comput. Sci., vol. 10, no. 4, pp. 65–69, 2019.

[6] K. Suresh and L. Rajesh, "Student Attendance Marking Using Face Recognition in Internet of Things," Int. J. Sci. Res. Comput. Sci. Eng., vol. 7, no. 5, pp. 45–50, 2019.

[7] V. Kumar and A. Mishra, "Attendance Management System Using Face Recognition," Int. J. Comput. Sci. Inf. Technol., vol. 8, no. 3, pp. 345–349, 2018.

[8] S. Gupta and N. Agarwal, "Face Recognition Based Attendance Updation System," Int. J. Eng. Sci. Comput., vol. 8, no. 5, pp. 17654–17658, 2018.

[9] H. Lee and J. Park, "Performance Evaluation of ESP32 Camera Face Recognition for Various Projects," Int. J. Embedded Syst. Appl., vol. 10, no. 2, pp. 21–27, 2020.

[10] Y. Chen and X. Wang, "Design of an IoT System Based on Face Recognition Technology Using ESP32-CAM," in Proc. IEEE Internet Things Conf., 2020, pp. 210–215.

[11] Kumar and P. Singh, "Facial Recognition Attendance System Using Python and OpenCV," Int. J. Comput. Sci. Trends Technol., vol. 7, no. 3, pp. 120–124, 2019.

[12] M. Khan and S. Ali, "Face Recognition Based Attendance System Using ESP32-CAM," Int. J. Adv. Comput. Sci. Appl., vol. 11, no. 5, pp. 458–462, 2020.

[13] D. Arunkumar, K. Ajaykanth, and M. Ajith Kannan, "Student Attendance Marking Using Face Recognition in Internet of Things," Int. J. Innov. Res. Sci. Technol., vol. 6, no. 4, pp. 102–107, 2019.

[14] T. Nguyen and H. Tran, "Student Attendance System Based on Face Recognition of Webcam Classroom Images," Int. J. Comput. Vis. Image Process., vol. 9, no. 2, pp. 33–38, 2019.

[15] R. Kumar and S. Patel, "Smart Attendance System Using RFID in IoT," Int. J. Eng. Res. Appl., vol. 9, no. 4, pp. 56–60, 2019.