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Smart Attendance System Using Esp32-Cam

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Abstract*: The Smart attendance system using ESP32-CAM provides a modern, contactless solution to the problem of attendance tracking. It is well known that a fingerprint-based attendance system will become contaminated over time with the number of people that it will take an imprint from. Facial recognition-based attendance will capture the attendance of people based on recognizing their face, which does not require the person to touch anything. The ESP32-CAM camera streams footage from the camera to a computer and captures the face of each person in real time, while the attendance records provided by the ESP32 flash memory matches the time when you pressed the push button. The attendance data can be stored securely and it can easily interface with cloud-based or locally based databases to efficiently manage data. The face smart attendance system using ESP32-CAM is a clean accurate, and scalable alternative to attendance tracking and monitoring for any context including schools, offices and the industry.*

Key words: *Smart Attendance system, ESP32-CAM, Contactless, Real time face capture, Secured data storage, Hygienic, Accurate attendance tracking, scalable.*

I.INTRODUCTION

In today's digital era, automation plays a significant role in helping to improve our efficiency and accuracy in performing such routine tasks as attendance management, which is mostly performed manually in many colleges and industries. Manual attendance is not only time-consuming, but it is also susceptible to human errors. To help solve problems like this, the goal of the project is to develop a Smart Attendance System employing the ESP32-CAM module. The ESP32-CAM is a small microcontroller with its own camera and Wi-Fi capability, making it excellent for real-time face detection and recognition. The smart attendance system will take an image of the individual, run the image through a face detection and recognition algorithm, and automatically mark attendance. After the face has been identified, the algorithm will display the name of the individual on an OLED screen for confirmation. In the background, attendance and the current timestamp are recorded in an Excel table, either locally or through the cloud. We can avoid records register and all the hassle of manually updating attendance on a computer. The Smart Attendance System makes attendance faster, more accurate, limits a proxy presence, and most importantly it provides a contactless way of delivering attendance in our current health-conscious world. This project will address attendance management in an entertaining way, while at the same time integrating knowledge from embedded systems and IoT practices.

II. METHODOLOGY

The methodology for designing the Smart Attendance System using ESP32-CAM involves combining methodologies for hardware and software in structured steps. To begin, the ESP32-CAM needs to be powered and connected to an FTDI programmer in order to upload the code. An OLED display needs to also be connected in order to monitor appropriate output. The overall programming of the ESP32-CAM will happen in the Arduino IDE. The code will involve functions to initialize the Camera module, detect faces, and write an output to the OLED. The Smart Attendance System is able to stream live video in the camera feed (video frames) along with detecting faces and matching those faces with data that was previously stored in a data base. Once a face is recognized, the user's name will be displayed on the OLED screen as feedback, and the attendance of that user will be stored with the name, current date and current time of the recognition process. The attendance data can be either retrieved from a local CSV file, or accessed from an Excel sheet uploaded onto the internet via Wi-Fi. The face recognition functionality must be trained with images in order for the smart system to recognize faces accurately. After the system has been programmed, a multi-user test is conducted to evaluate performance. After successful evaluation of the Smart Attendance System, the design will be encased for real life implementation. Following this methodology, the system clearly exemplifies a contactless and automated attendance system comprised of embedded systems and IoT principles to achieve efficient communication.

III. WORKING

The Smart Attendance System described operates with an array of hardware module and uses the processing power of the cloud by way of machine learning. First, the ESP32-CAM module, supplied externally manages live images of the person in front

of the device. The live images sent to a cloud server via an IoT URL, and later on the server side the ML model developed in Python, when the server receives the image, an analysis of the imagery is done, including face detection and face recognition from a database of previously enrolled students' faces. When a face is recognised, a response is sent to the ESP32-CAM module, which interacts with the ESP8266 module.

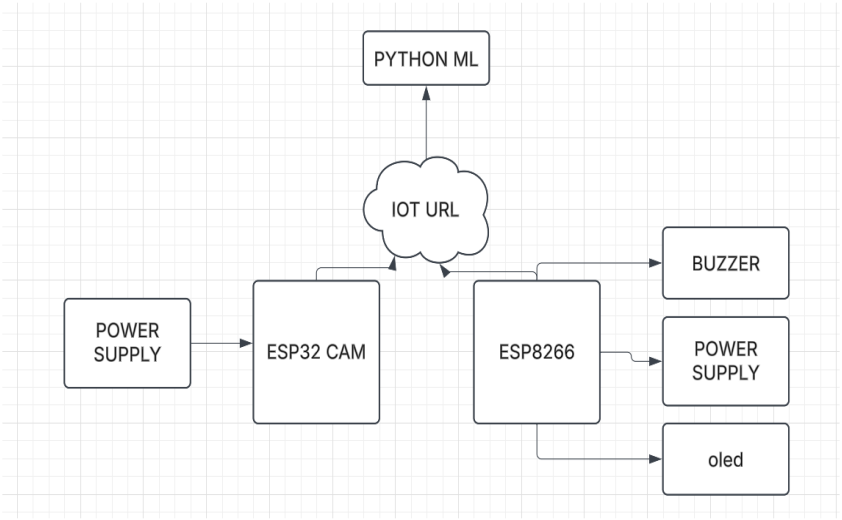


Figure 1: Block Diagram

The ESP8266 module is externally powered, then it interfaces to the output devices. The ESP8266 can be hooked up to a buzzer, which when instructed from the ESP32-CAM module to buzzer, the system can notify the successful marking of attendance. Perhaps an OLED display could indicate the attendance marker and other identifying traits about the marker, like the student's name. This division of the workload works well because not only do you provide immediate feedback through the local ESP8266, but you leverage the traditional and time-honored intelligence interpretation abilities of the cloud server for fast facial recognition. Example: Real-time attendance that is accurate and automated with little human input.

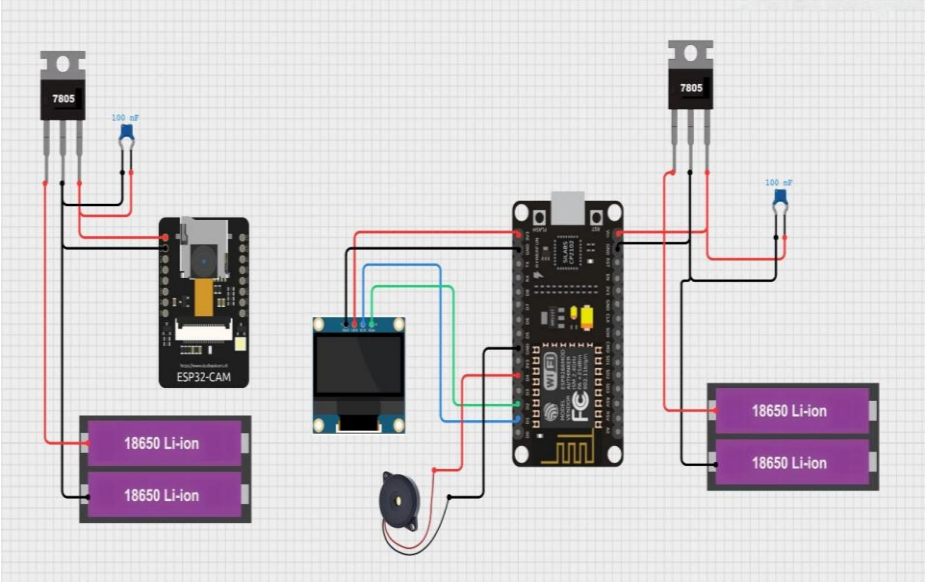


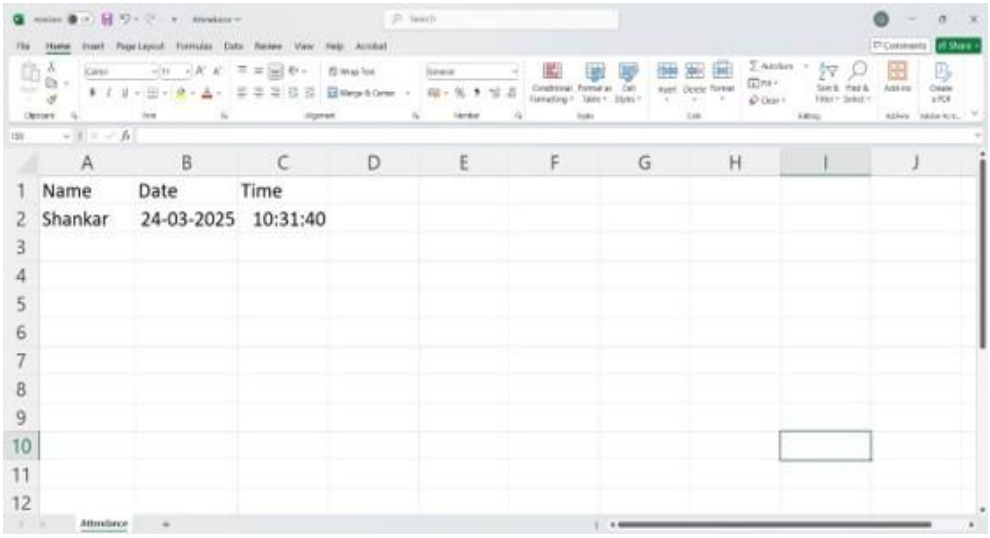
Figure 2: Circuit Design

IV. RESULTS AND DISCUSSION

The Smart Attendance System was successful in achieving real-time face recognition using Python and OpenCV. After a student image is captured by the ESP32-CAM module and sent to the server, the image is then processed by the Python program with OpenCV's Haar Cascade for face detection and LBPH (Local Binary Patterns Histograms) for face recognition. The program is able to identify all registered faces with an approximate recognition accuracy of 90–95% and only under optimal lighting conditions. The time it takes to detect a face, recognize it, and mark attendance for an individual is approximately 2 to 4 seconds. After a positive identification has been made, the system will save the attendance to the database with a successful outcome and also send feedback through the ESP8266 module to activate the buzzer and update the OLED display to the name of the identified person. OpenCV has improved the identification speed and efficiency process, to the point where the system can truly be a reliable, portable, and a quick to deploy solution for real classroom implementation.

Figure 3: ESP32-CAM Footage

Figure 4: OLED Screen Display



	A	B	C
1	Name	Date	Time
2	Shankar	24-03-2025	10:31:40

Figure 5: Excel Sheet Output

V. CONCLUSION

In this paper, we describe a Smart Attendance System using ESP32-CAM that represents an efficient and automated way to take students' attendance. Using face recognition functionality provides a dependable solution with accuracy while removing the process of manually taking attendance. The ESP32-CAM offers a promising low-cost, compact, and energy-efficient hardware implementation for budget-constrained schools. Our system has multiple advantages to take attendance, by eliminating a lot of time spent on taking attendance, removing human error, capturing attendance data in real-time, and availability of data storage in the cloud. With cloud storage, attendance data is easily retrieved and data can be plugged into existing school management software or kept in the cloud. While the system works well in controlled conditions, we encountered issues with lighting conditions and faces being partially covered. Further work can be done to improve on this system surrounding the issues we encountered. Improvements could include using multiple cameras for the ability to provide wider coverage of faces being recognized, add mask detection features, or build an offline version to help provide a reliable system in locations with inconsistent internet connectivity.

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