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Design & Evaluation of Smart Face Recognition Attendance System Using ESP32 CAM

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ABSTRACT

The aim of attendance management is to establish a convenient and high-quality record keeping system. The idea of "intelligent attendance" is rooted in progress across domains like artificial intelligence and computer vision. In this regard, face recognition technology plays a vital role, acting as a link between human identity and automated system responses. Face recognition users have the ability to mark their attendance regardless of their physical condition. The specific recognition methods may differ from the traditional options. One of the areas where artificial intelligence (AI) is commonly applied is computer vision and image processing. Our project aims to provide users with a contactless attendance system that goes beyond simply marking presence, offering a wide range of functionalities. The user stands before the camera, which captures their face and transmits the appropriate data to the system for verification. The main objective of this project is to create a face-activated system that can operate attendance duties and apps and utilize machine learning algorithms to learn user facial features.

KEYWORDS: ESP32-CAM, Face Recognition, IoT (Internet of Things), AI (Artificial Intelligence), Attendance System.

INTRODUCTION

The method of marking attendance without any physical contact is referred to as automated attendance. This enables individuals to fulfill a requirement that restricts their physical interaction. Many individuals, particularly in educational institutions, have a strong

aversion to depending on manual methods to accomplish their daily attendance activities. In addition to individuals with time constraints, the program also caters to those with other types of impairments. As a result of this technology, these individuals will be able to live more efficiently

Face recognition systems utilize computer vision algorithms, image processing, and pattern recognition technologies to assist users. For Internet of Things (IoT) devices that lack touch functionality, a face interface becomes essential. In addition to traditional methods, face recognition systems are also becoming increasingly popular.

Smart cameras, which are devices equipped with a camera sensor and processor, are becoming more integrated into our daily lives. Due to the limitations of current systems and the advancements in IoT technology, the proposed solution relies on IoT as a bridge between users and attendance equipment. It possesses characteristics similar to those of a digital assistant. The goal of this project is to create a system that combines "Face Recognition" methods with "IoT (Internet of Things)" technology so that consumers can mark their attendance at institutions with face detection.

The technologies currently employed in this industry are significantly less advanced than what we want to propose. The majority of attendance systems on the market today are only capable of basic tasks like manual entry and card swiping. There are several products on the market that use technologies like RFID, Biometric fingerprint, and QR codes to try to make these everyday tasks easier. Nevertheless, whether they are implemented or recommended, these current systems frequently require complex connections with attendance appliances. Some systems depend on sending commands through a mobile device, while others necessitate pressing a button at a designated location.

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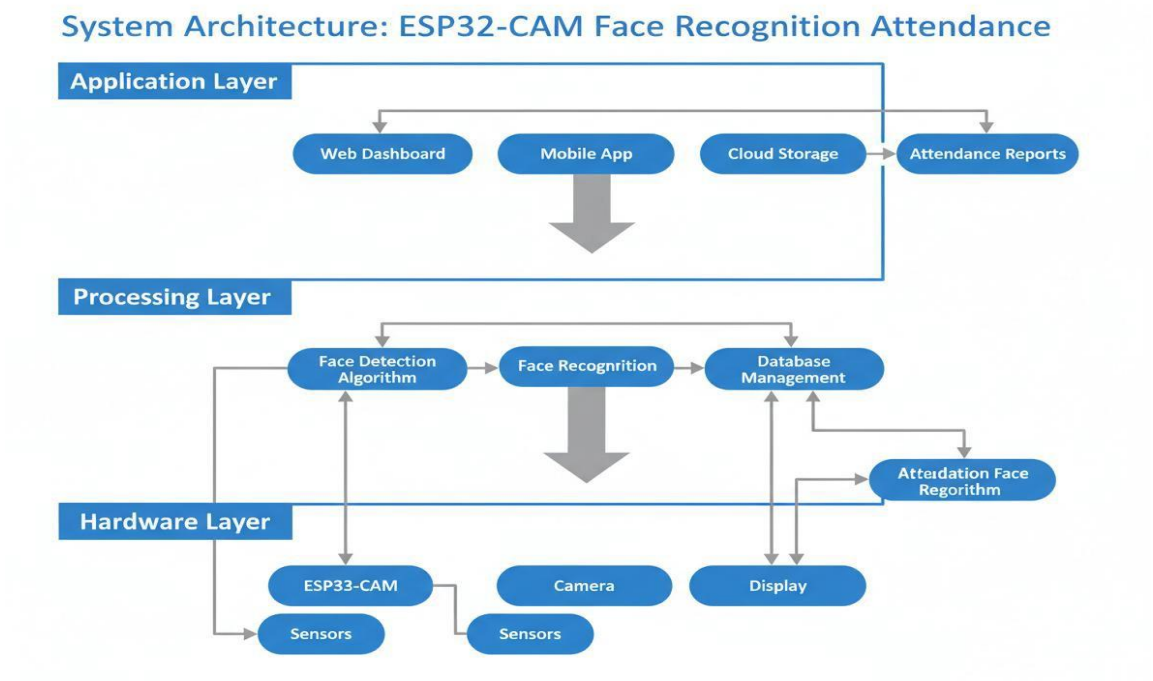
LITERATURE SURVEY

The industry and the academic community have collaborated to achieve success. Their collaboration has resulted in notable advancements in the field of attendance management systems. Consumer products that meet the needs of the general population have been actively developed by a number of well-known tech businesses, including Microsoft, Amazon, and Google. A number of these gadgets, including Microsoft Azure Face API, Amazon Rekognition, and Google Vision API, have been released into the market this year. Nevertheless, none of these systems include artificial intelligence to predict user attendance or aim for omnipresence. Significant success has been made in this field in the last year (2023), which has encouraged businesses and academic institutions to work toward even greater breakthroughs.

Some attendance systems propose relying solely on wireless sensors and disregarding any other option. These systems use simple technologies, such as HTML webpages, to help the Arduino boards communicate with one another. They have also brought up the potential use of a mobile platform, however, this would complicate implementation rather than improve the suggested solution. The heavy reliance on wireless sensors could potentially result in inaccurate outcomes.

Alternative attendance system uses of Arduino boards are the sole solution. Since these systems' functions are the same, they may be readily replaced with a Raspberry Pi, ESP32, or any other programmable board. These systems' primary control interface is largely dependent on mobile devices, which restricts the ability to change the configuration. Since mobile devices are usually carried with the user wherever they go rather than being stationary in the institution, this is a concern for the user. They do not support user face recognition. [1]: A face recognition module, an ESP32-CAM microcontroller, a relay circuit, and a display that can show attendance are all part of the suggested system. To correctly identify and react to faces, the recognition unit needs to be trained beforehand. Regretfully, only basic attendance has access to all of the features mentioned. The proposed concept lacks appropriate design principles and is unduly familiar.
[3] It is typical for several persons in the same vicinity to decipher faces sent to a particular device, resulting in unexpected outcomes. To understand the user's intent, they don't use artificial intelligence or face recognition processing. [5]: RFID technology is the only technology used by the majority of attendance systems. The overhead of using it in a small institutional setting is substantial, despite their amazing remote capabilities. Due to the boards' difficulty meeting RFID technological standards, increased implementation expenses have significantly.

Architecture Diagram



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PROPOSED SYSTEM

Our initiative aim is to offer the most seamless and user-friendly experience possible. An effective method to communicate with attendance devices is by using facial recognition in a manner that is easily understood by humans. We aim to simplify the application process by eliminating the need to navigate through multiple screens using face detection. The face recognition-based initiative strengthens the connection between our system and its users. The main authentication technique is capturing the user's face image on the camera device. The user's face is processed by the ESP32-CAM device, which subsequently sends the relevant data to the designated database.

Reword: The ESP32-CAM device understands the user's facial features via face recognition algorithms. The ESP32-CAM acts as a central hub, determining which person needs to perform attendance marking in order to fulfill the user's request. A desktop, web, or smartphone application can serve as the main control center because the cloud can handle all of the data that is sent. The ESP32-CAM boards, which are set up to react to face inputs, are connected to the attendance system. Our project drastically lowers time consumption caused by excessive or needless use of the equipment's services by simplifying the operation of all attendance marking procedures.

IMPLEMENTATION

The goal is to make marking attendance as simple as possible by using face recognition technology. We plan to eliminate the need for navigating through multiple application screens by enabling control with single face detection by the user. The face recognition system in our system creates a more personal and user-friendly connection for the user. On their camera device, the user first authenticates by showing their face. Following authentication, the system captures a face image, which the device decodes and converts into the operation that the designated attendance needs to perform. The ESP32-CAM device acts as a central hub, identifying the person that must carry out the required task. This central hub can be a desktop application, web application, or smartphone app, with all data being processed in the cloud. However, for user convenience and enhanced mobility, we will be using the ESP32-CAM in this project.

One of the quickly growing sectors that has the potential to transform people's daily lives is attendance to complete specific tasks with face detection alone.Additionally, the system is equipped with a camera device that allows users to mark attendance without having to approach any physical device.

By using face detection to activate the control portion that adjusts their attendance records, this project can improve the quality of life for elderly and physically challenged individuals. Depending on the instruction, it can also control attendance equipment like the display and notification system. The attendance record is stored and synchronized to the correct database using WiFi connectivity.

Face Capture: Describe the process of capturing face images through the ESP32-CAM device, including any pre-processing steps like noise reduction or facedetection.

Face Processing: Provide an overview of how the system interprets the user's facial features, including steps like face detection, feature extraction, and face matching.

Attendance Execution: Detail how the interpreted face is translated into an actionable task and sent to the appropriate attendance database for execution.

Feedback Loop: Explain the process by which the system collects data on user interactions and uses this information to improve its understanding of user facial features and behaviors over time.

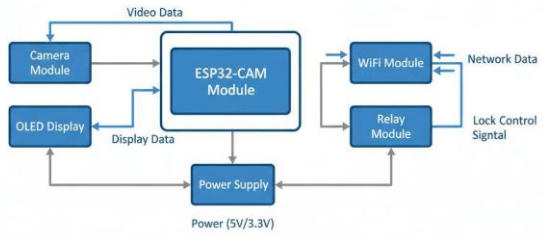

Fig. 1: Block Diagram

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The face recognition for the main attendance is shown in the block diagram. The system's primary function is attendance control, which operates entirely on face detection. Through programming, the system's instructions are put into action. There have been two modes used in total: enrollment and attendance marking. There can only be one active mode at a time. The system's usage of an ESP32-CAM to capture face input or to provide recognition. The ESP32-CAM system's WiFi is linked to a cloud database. Any captured faces are sent to the cloud, which subsequently relays them to the database. This device is located next to the entrance. Simply show your face if attendance is required. The display will show the name and time automatically. In order to activate the relay module circuit pins and enter the desired mode of operation, the face recognition system will provide data to the microcontroller. The display terminal will then receive a signal from the relay circuit directing it to show the recognized person.

HARDWARE IMPLEMENTATION

Figure 2 shows the hardware implementation of a face recognition based attendance system. It connects to display, relay using WiFi, and a camera for input. It can be implemented by using the following steps: Step 1: Start the power supply. Step 2: Initialize system, WiFi module. Step 3: Connect ESP32-CAM to the cloud database. Step 4: In camera mode, when the ESP32-CAM captures the face image from the user, then according to the captured face respective action takes place like face enrollment and attendance marking.

SOFTWARE IMPLEMENTATION

Implementing a face recognition attendance system using AI & IoT and a relay driver is a practical and versatile approach. The relay driver acts as an intermediate between the AI & IoT and the devices you need to control, allowing you to switch them on or off based on face recognition. Here's a step: Connect to cloud services like Firebase, AWS, or Google Cloud for data storage. Implementing attendance control with AI & IoT involves connecting various sensors, cameras, and other components with the AI & IoT to control and monitor different views of the attendance environment. AI & IoT play a key role in managing attendance, and it is connected to mains without the use of any other external systems. Here is the hardware implementation of the activated face recognition for attendance control as shown below:

Slave default Rate of Baud: 115200 Bits of data: 8. Bit of stop: 1. It is not possible to connect the red and blue LEDs independently to pins. Red and blue LEDs blink once every two seconds when the master and slave are connected, but only the blue LED blinks twice per second when they are not. By default, auto-connect to the last powered device. c. Set the default connection for the pairing device. d. By default, auto pairing. e. Auto-reconnect after 30 minutes if unplugged due to connection range issues. The attendance records are controlled simultaneously by embedded C (Arduino IDE Tool) logic in the microcontroller. The enclosure was designed using AutoCAD, Solid Works, and Fusion 360. Proteus is used to model the electronic components. The ESP32-CAM and access port are used to train the face recognition with the WiFi module.

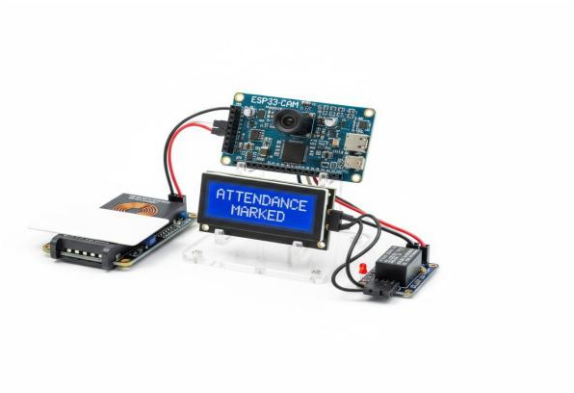

Fig. 2: Hardware Implementation

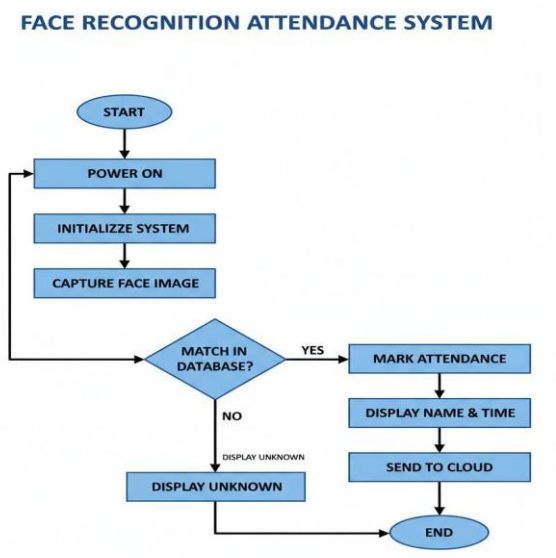

Fig. 3: Flowchart

CONCLUSION

Most modern attendance systems communicate with their equipment using a predetermined set of commands or steps. The users are separated from the technology by these intricate processes. In order to address current issues, our project suggests using face recognition tooperate attendance marking. These face recognition-processed commands inspire customers to utilize the technology more and help them establish a stronger bond with it. Additionally, it eliminates the laborious chore of manually activating attendance equipment.

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