IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 12, Issue 4, April 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 | Monthly Peer Reviewed & Referred Journal |

|| Volume 12, Issue 4, April 2024 ||

| DOI: 10.15680/IJIRCCE.2024.1204314 |

IoT Based Facial Access Door Security System Using ESP32 Cam

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ABSTRACT: In this paper, the creation of a door lock system is accomplished using facial recognition in conjunction with the ESP32 CAM for more accurate face detection. The ESP32 CAM is powered by a 12v/2A adaptor that acts because it is the system's backbone and controls the door locks and unlocks systems. This door lock system works with facial recognition. Here, the door lock system is controlled by the face recognition of a private. A door is one of the defenses features to take care of the physical security of the house. If the door of the home is often opened easily, a thief can easily enter and steal the contents of the house. At first, a door only requires a physical key to lock or unlock it, but on the other hand, with the advancement of technology, a more modern door has been innovated, namely the digital door, which will lock or unlock doors without requiring any physical key. We propose an application called Face Detection. Door lock, which is predicated on Arduino using Internet of Things (IoT) technology to watch the status of the door, control the door, and increase security. By using the ESP32 cam, the door will lock or unlock automatically.

KEYWORDS: E— Authentication, ESP32-CAM, face recognition, Camera, Security.

I. INTRODUCTION

Face detection has been utilized in smartphones in the past few years. It's a cool technology where we can unlock mobile phones or access any application that needs high security. With ESP-32 CAM, we will try to develop an easy project that uses our face as an ID. The ESP32 board comes with a camera web server example code that is used for video streaming and face detection. During this ESP-32 cam project, we've made a face detection door lock system using ESP32-CAM. When Smart Lock detects any enrolled face, it automatically works. So, this is often an easy but very useful home automation project using the ESP-32 CAM module.

Information gathered from the face helps people understand others identities. During this face detection approach, a given face is necessarily compared with the authorized faces to spot the right person. Within the field of bioscience, face recognition technology is one of the fastest-growing fields. The necessity of face recognition in security systems is attributed to the increase in economic interest and, thus, the development of feasible technologies to support face recognition.

Most doors could previously be opened with conventional methods like keys, security cards, passwords, or patterns. But events like a critical loss have resulted in a lot of alarming incidents, like identity fraud and robbery. This is now a serious problem. The Internet of Things (IoT) is being used to bring face recognition, utilizing a deep learning technique, in order to solve this issue.

The most natural method for performing biometric verification between people is probably face recognition. The face recognition system's initial stage is face detection. An ESP-32 camera can be used to take face photos from a distance. Without making physical contact, the person can be identified using any specific hardware to perceive their identity.

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II. BACKGROUND STUDY

A. *Introduction to IoT and Facial Recognition:*

The Internet of Things, or IoT, is a breakthrough paradigm that allows common objects to be networked and interact over the internet, opening up a plethora of applications across multiple disciplines. IoT technologies have brought in a new era of monitoring, access control, and surveillance capabilities in the field of security systems. IoT-enabled security systems may collect and analyses real-time data in real time, as well as react autonomously to security incidents or threats, by integrating sensors, actuators, and intelligent devices into physical locations.

Modern security systems rely heavily on facial recognition technology since it offers a highly sophisticated method of identification and authentication. Facial recognition systems use cutting-edge algorithms and machine learning approaches to identify people individually by analysing facial traits from photos or video streams. In security applications, this technology has multiple benefits, such as increased automation, convenience, and accuracy.

Facial recognition technology replaces conventional access control techniques like keycards and PIN codes in security systems to provide smooth access management. Access to restricted locations can be obtained by authorized individuals only by scanning their faces, which lowers the possibility of identity theft or illegal access. Furthermore, by integrating facial recognition technology with security cameras, congested areas and high-security zones may be monitored in real-time, alerting security staff to the presence of known individuals or questionable activity.

B. ESP32 Cam:

The ESP32 Cam module is a multipurpose and potent microcontroller board made especially for Internet of Things applications, especially ones that need camera features. The ESP32 Cam's central component, the ESP32-S chip, has dual-core processing capability and can handle complicated computations and activities with ease. Because of its processing power, the ESP32 Cam can process and analyse images in real time, which is essential for applications like object detection, facial recognition, and surveillance.

The ESP32 Cam's extensive connectivity choices, which include integrated Wi-Fi and Bluetooth capabilities, are among its most notable features. With the help of these connectivity characteristics, devices and networks can communicate with each other and with one another more easily, facilitating data transmission, remote monitoring, and cloud service integration. In particular, the Wi-Fi connectivity makes it easier to implement IoT solutions because it allows the ESP32 Cam to connect to networks that are already in place for data exchange and internet access.

C. Existing Facial Recognition System

Facial recognition systems currently in use range from for-profit goods to scholarly investigations, and each has its own advantages, disadvantages, and restrictions. Commercial systems, such as Amazon's Recognition and Apple's Face ID, have shown impressive accuracy and dependability in a variety of applications, ranging from smartphone unlocking to person identification in dense crowds. These systems achieve excellent recognition rates through training on large datasets and sophisticated deep learning algorithms. However, issues with mass monitoring and unapproved data collection have sparked worries about privacy, bias, and even abuse.

Academic research initiatives have investigated novel ways to identify faces, including multi-modal biometric systems, facial expression analysis, and 3D face modelling. Even while these projects frequently push the envelope of technology and provide new insights into methodology, they may encounter difficulties with scalability, practical implementation issues, and the availability of adequate training data. Furthermore, the practical usefulness of many academic facial recognition algorithms in different circumstances is limited because they are specifically designed for particular use cases or experimental settings.

III. METHODOLOGY

The system can be represented using algorithms, and the algorithms are designed using flowcharts.

Below flowchart illustrates the operational steps of an IoT-based facial recognition door access system. Initially, the system initializes its components, including the camera module. It then attempts to establish an internet connection using the provided Wi-Fi credentials. If successful, users can stand before the camera to register their facial features by clicking on the "Detect Face" button and entering their username for enrollment. The system ensures that a sufficient number of face samples are collected before proceeding.

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Upon user request to access the secured area, indicated by clicking on "Access," the system verifies captured faces against stored data. If a match is found, the door is unlocked, as indicated by turning on the green LED and turning off the red LED. After a predefined duration, typically 10 seconds, the system automatically relocks the door. Additionally, users can monitor the system remotely via a web browser by entering the device's IP address, where they can view real-time video streams and facial detection results. The flowchart also includes a conditional check for a push button press, which could trigger alternative actions within the system. This sequential process ensures secure access control while leveraging IoT technology for remote monitoring and management.

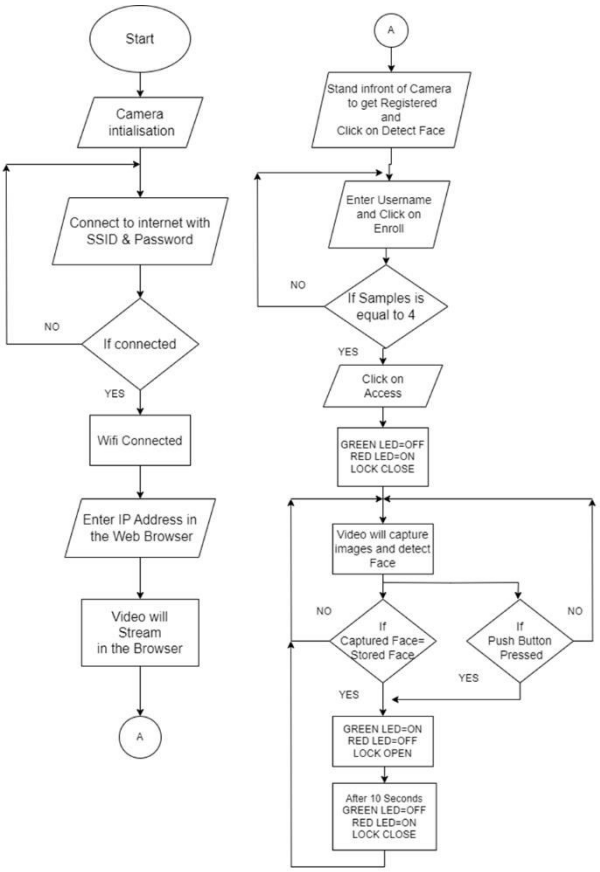

Figure 1: Flow chart for training and testing phase.

IV. SIMULATION RESULTS

In this section, we'll discuss how a local network is used to access the ESP32-CAM board. The ESP32-CAM board is set up as a station, while the router serves as an access point. The ESP32-CAM web server is controlled and accessed by connecting to a local network. The ESP32-Cam module's network access protocol incorporates Wi-Fi connectivity, enabling it to transmit videos in real time. The module is primarily composed of a microcontroller that functions similarly to an Arduino; thus, we can program it using the Arduino software.

The module must initially be connected to a PC using a programmer in order for the computer to upload the program to the ESP32-Cam. The ESP32-Cam module, which is hosted by a web server, has the ability to establish its own wireless network, giving it the independence to establish a connection and transmit footage to any location.

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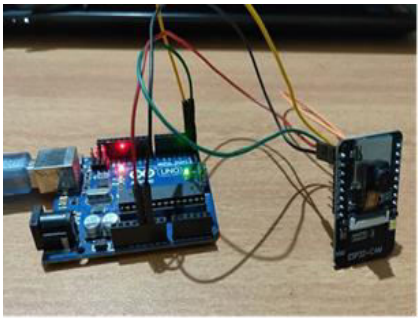

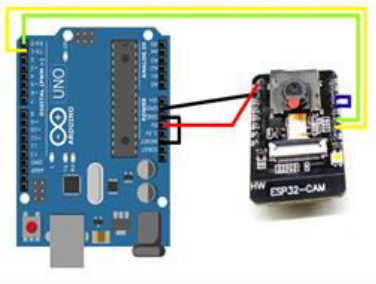

Fig.2: Connection between the ESP32CAM board and the Arduino board. Fig.3: Face recognition program upload.

The serial monitor displays the IP address that will allow the opening of the camera according to the URL reserved in a web browser. This step opens the camera. To ensure the proper functioning of our application. We need to update the URL variable in the code with the URL copied from the Arduino serial monitor to run our code, Fig. 4.

```
WiFi connected
Starting web server on port: '80'
Starting stream server on port: '81'
Camera Ready! Use 'http://192.168.43.192' to connect
```

Fig. 4. Camera is connected to web browser.

After a real-time comparison between the detected face and those registered in our database, an identification is made each time the camera detects a face. After the comparison, the program can return two results: either the person's name if the face was correctly chosen from the database, or an unknown person if the face is not present. Using a variety of grimaces and positional indications of the required person's percentage of confirmation, Fig.5 demonstrates how the phenomenon of facial recognition works properly.

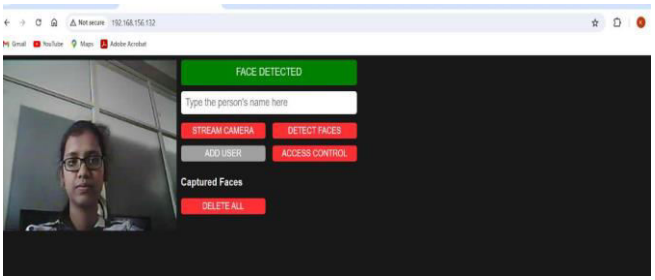

Fig.5. Example of recognized phase.

V. CONCLUSION AND FUTURE WORK

In this project, we successfully developed an ESP32 Cam Face Detection Door Lock System that monitors the status of the door and boosts home security. The system that we are working on is very easily managed and completed, so we come to the conclusion part. Here we developed a surveillance and security-based system; through this, we can avoid unauthorized break-ins and prevent theft. It can be done by its ESP32 CAM face, which is used for capturing the images of an individual to open the door lock. CCTV is so popular lately; it only provides surveillance facilities, but here we will control the break-ins and provide a far better security platform (i.e., door lock after face recognition), and looking at today's scenario where people avoid physical contacts due to COVID-19, it's also very helpful and needed at this point for the precaution of an individual. By using this technique, we'll reduce the physical contact, cost, and manpower required for safety purposes. Little or no coding is required, and one can get a system up and running in very little time.

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INTERNATIONAL STANDARD SERIAL NUMBER INDIA

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