

IOT-Based Touchless Door Lock System Using Facial Recognition through ESP32 CAM

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Abstract

A Nowadays, many technologies are based on the Internet of Things (IoT). IoT is an emerging technology that impacts internet and communication systems, enabling individuals and objects to connect anytime, anywhere, and in various forms. Over the past few decades, mechanical systems have gained popularity and contributed to improved living conditions, which has led to the development of many innovative systems.

One such system is the Touchless Door Lock System, which is implemented using facial recognition technology in conjunction with the ESP32 CAM to achieve more accurate face detection. The ESP32 CAM controls the door locking system, relying on facial detection and recognition. An entryway is one of the key features that ensures the physical security of a home. If a door can be easily opened, an intruder may easily enter and steal belongings from the house.

Initially, doors only required a physical key to lock or unlock them. However, with advancements in technology, more modern doors have been developed, particularly digital doors that can lock or unlock without the need for a physical key. These types of systems use IoT technology, enabling the door to lock or unlock automatically without physical contact, through the ESP32 CAM.

Keywords: IOT, ESP-32 CAM, RELAY MODULE, SOLENOID LOCK, TTL - PROGRAMMERS, CNN

1. Introduction

Face detection technology has indeed become increasingly prevalent, especially in the realm of smartphone security and various IoT applications. Leveraging ESP32 CAM, a development board with a built-in camera, opens up wealth of possibilities for creating innovative projects. One such project is the Face Detection Door Lock System, which utilizes face recognition to grant access.[01]

In this research project, the ESP32 board, equipped with a camera, runs a code example that enables video streaming and face detection. When an enrolled face is detected, the smart lock mechanism is triggered, allowing access. This functionality can be immensely beneficial for home automation and enhancing security measures. The significance of this research for face detection and recognition extends beyond just convenience and security. In fields like biometrics, face recognition technology

is experiencing rapid growth due to its reliability and efficiency. Identifying individuals through facial features enables precise authentication, making it a valuable tool in various industries.

The increasing demand for face recognition in security systems is driven by both economic interests and advancements in technology. As the technology becomes more accessible and reliable, its applications continue to expand, ranging from smartphone unlocking to access control in smart homes and offices. Overall, the integration of face detection and recognition technology into IoT projects like the ESP32 CAM-based Face Detection Door Lock System showcases the potential for innovation and enhanced security in home automation and beyond.[06]

The ESP32 CAM combined with face detection technology can be used in developing innovative projects, such as the Face Detection Door Lock System, to enhance home automation security and convenience contains the introduction of Face recognition technology, using algorithms like CNNs, enables efficient detection and authentication in ESP32 CAM-based door locks.[06] IOT integration ensures remote control and enhanced security with advanced techniques like SVM for accurate identification contain the related work.

Traditional door locking systems lack security and are door lock systems present a touchless, hygienic, and advanced solution to home security. A touchless door lock system that uses ESP-32 CAM technology enables unlocking doors through face detection, removing the need for physical keys. This system consists of an ESP-32 CAM, a relay module, a solenoid lock, and a battery. When the camera detects a face, it verifies the person's identity. If the person is recognized as authorized, the door opens; if not, the system alerts the homeowner about the attempted access. By effectively integrating these components, a secure and efficient touchless door access solution is created. The smart door-lock system built on the ESP32-CAM provides a touchless and secure solution, making it perfect for reducing contact during COVID-19. It allows for face-based access, which boosts security beyond traditional CCTV systems while also cutting down on manpower and costs. Future improvements are expected to enhance its accuracy and reliability.

2. Literature Review

Provide an overview of face recognition technology and its applications in door lock system. Introduce the ESP32 CAM module and its capabilities. In face recognition many algorithms are used such as Eigenfaces, Fisher faces and deep learning – based method like Convolutional Neural Networks. Using this algorithms camera detect and recognize face and perform operation. In camera we can insert SD card to store data like images, videos etc. Also, camera have some additional storage but in that we can't store images or video so we can add SD card. ESP32 CAM have 2 mega pixel camera for capture the face. It is better than CCTV camera because it can detect or recognize face and also store data. Camera passes the signal to the relay module.[01]

In recent years, the popularity of earth devices has increased due to efficiency and influence due to the integration and cost of smart phones. Text up and implement relevant IOT information by introducing IOT concepts and foundations in a conscious state.[03]

Now anyone can connect anywhere, anytime, and build relationships that create good dynamic networks. In this section, they solve the problem if there is a problem with the device connected to the system and the concept of data; use the solution so that the best solution can be found.

Data communication is a small field of computer science that is used to track systems in big data, such as statistics, machine learning, deep learning and database systems. This includes analysing data and specific words and translating them into important information or knowledge.

Administrators can access and control all devices that are not connected to each user, but only one user can connect devices to the user. With the help of the Internet of Things (IOT) system, mobile devices and computers can remotely control all the work and activities on earth devices over the Internet. It can also be used with voice commands such as Google Voice & Apple Home Kit to easily monitor your earth for security reasons.[02]

Support vector machines (SVM) have been as of late proposed as a modern strategy for design acknowledgment. SVM with a twofold tree acknowledgment methodology are utilized to handle the confront acknowledgment issue. We illustrate the potential of SVM on the Cambridge ORL face database, which consists of 400 images of 40 individuals, containing quite a high degree of variability in expression, pose, and facial details. We too display the acknowledgment test on a bigger confront database of 1079 pictures of 137 people. We compare the SVM-based recognition with the standard eigenface approach using the nearest center classification (NCC) criterion.[07]

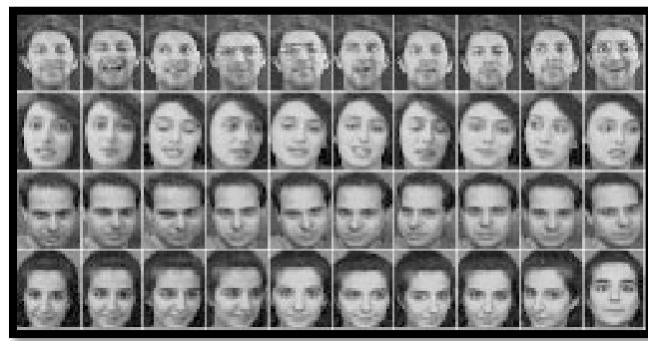


Figure 1: SVM Based Recognition[07]

As a baseline comparison, we first used an eigenface matching technique for recognition [06]. The normalized images from the gallery and the probe set were projected onto eigenfaces similar to those shown in the figure. A nearest-neighbour rule based on a Euclidean distance was then used to match each probe image to gallery image. We note that this compares to a generalized template-matching

strategy which employs a Euclidean standard limited to the central subspace of the data. We ought to moreover include that these eigenfaces represent the principal components of an totally different set of pictures i.e., none of the people in the gallery.[07]

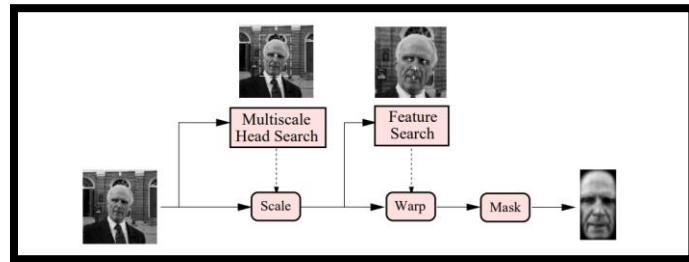


Figure 2: Bayesian Face Recognition[09]

In recent years, Great advantages in object classification have been shown by CNN. In the context of smart transportation, an essential task is to correctly detect vehicles from videos and classify them into different types (e.g., car, truck, bus, etc.). The classified vehicles can be further analysed for surveillance, monitoring, and counting purposes. However, at least, two main challenges remain; excluding the uninteresting region (e.g., swaying motion, noise, etc.) and designing an efficient and accurate system.[08]

In face detection, a convolutional neural network (CNN) matrix is a collection of filters or kernels, that identifies specific features of a face. CNN is made of many layers, with each layer containing different filters. Early layers can focus on broad features of the face. Later layers can focus on more specific features of the face. This layers of CNN can be used for face recognition in security cameras.[08]

3. Problem Statement

In the past, many problems were faced in traditional door locking systems. The primary problem with the traditional system is its lack of security. The traditional system relies on a physical key that can be easily lost, stolen or copied, making it difficult to control access to your home. With this system, the monitoring capabilities are also compromised. There is no way to track unauthorized access. In situations like COVID-19, when distance is mandatory and hygiene concern are more important, the physical key becomes a major problem. Without touch, you cannot open the door.

As technology grows, many advanced technologies have also been invented in the field of home security. Home security is a big concern at this point in time, as technology is advancing day by day. For home security, an IOT technology can be used. Nowadays, many technologies are used for smart home security. One of the best technologies used for smart home security is the ESP-32 CAM based door lock system. This technology enables touchless access to the door. Your hygiene concern related to touch can also be maintained.

4. Methodology

For touchless door locks system, many technologies are used. One of the best technologies for touchless door lock system should be ESP-32 cam face detection. Using this technology, you can unlock your door without touch or a physical key. This technology is based on face detection using the ESP-32 cam. In this technology camera will detect face. The door will open only when the face is authorized. When an unauthorized person tries to unlock door, the camera detect face and sends an alert to house owner. For developing this technology many components can be used. ESP-32 cam, relay module, solenoid lock, battery etc. By connecting all these components in the right manner, a touchless door lock system can be created.

In the system design, the ESP32 cam is connected with the solenoid lock, relay module and battery. When any face comes in front of door, the camera detects it and checks whether it is authorized or not. The result from camera is sent to the relay module and at the end when the face is detected as authorized, the lock will open. This whole system can work based on battery. When an unauthorized face tries to unlock door, the camera detects it and sends an update to the owner regarding the unauthorized access.

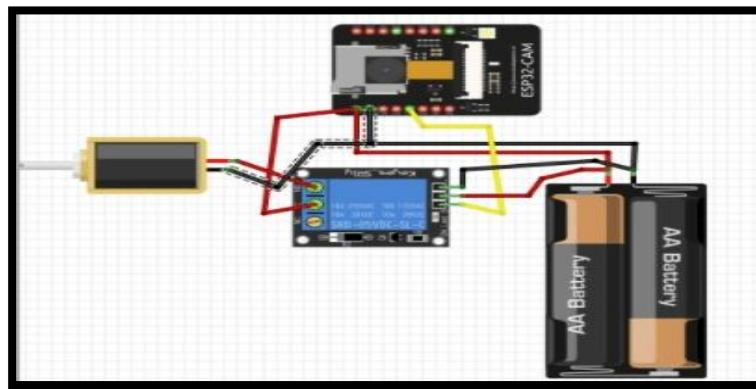


Figure 3: Overall Circuit Diagram

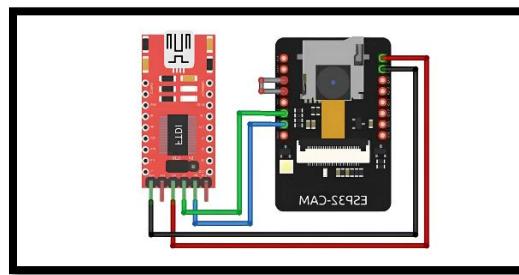


Figure 4: Programming ESP-32 CAM with TTL Programmer

5. Results and Discussion

Indeed, this smart-locking door system with camera surveillance based on an ESP32-CAM is a security technology, especially relevant during COVID-19. To minimize physical contact and lessen risks of virus transmission, touchless solutions such as this are becoming an important element in measures taken to support social distancing.

It allows the door to open the door when a face is detected by the camera. This process is a smooth and touchless method that makes life easier while ensuring the touchless benefits of this system, whether at home, in offices, or in other commercial places.

There are many possibilities for advances and improvements in this field that one can think about. These technologies and the algorithms will improve more in the future to yield much higher accuracy and reliability in face detection and recognition.

This combined smart lock system is not like conventional CCTV cameras that only record movement outside premises. This generates a more forward-looking approach for security as it enables face detection so that access can be acquired to the door, providing a higher level of protection against unauthorized entry and/or break-ins. Such systems use less manpower on the site and lower costs by efficient security. Automated systems can keep the premises safe and protected even if the homeowner is not physically present. Integration of ESP32-CAM Technology in smart door-lock system is the future of home security, especially under present public health safety conditions.

The **accuracy** of face recognition using the **ESP32-CAM** depends on several factors, including **lighting conditions, camera positioning, image quality, and algorithm efficiency**.

Estimated Accuracy of ESP32-CAM Face Recognition:

Daylight / Good Lighting: 70% – 85% accuracy

Low-Light Conditions: 50% – 65% accuracy

Different Angles & Partial Face Visibility: 40% – 60% accuracy

Blurry Images / Fast Motion: 30% – 50% accuracy

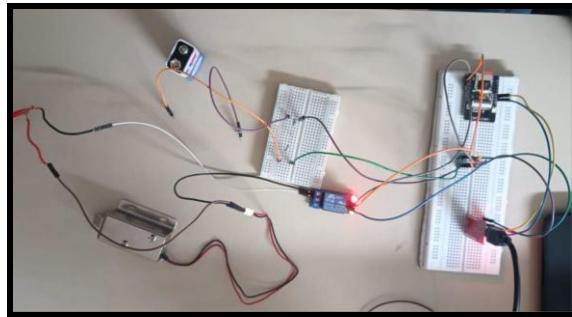


Figure 5: Result of Circuit Diagram

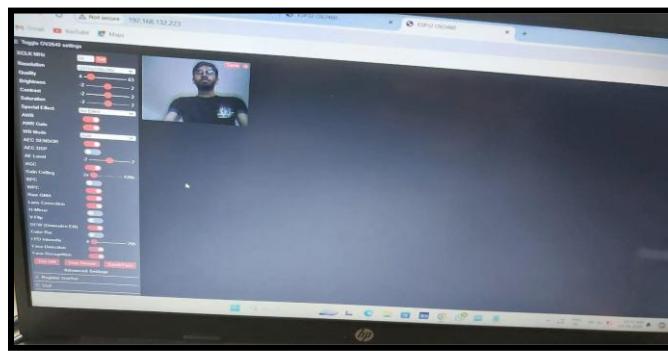


Figure 6: Face Enrollment

6. Conclusion and Future Scope

Developing the ESP32 CAM-based face recognition door lock is not just to observe the door status but to secure the home environment with comprehensive peace of mind; on the other hand, integrating surveillance and security features could provide the most powerful barrier against unauthorized intrusions and thefts.

The ESP32 CAM's ability to capture images of individuals for face recognition adds a layer of authentication to the door locking mechanism. This means that only recognized faces are granted access, significantly reducing the risk of unauthorized entry. Though traditional CCTV systems do provide surveillance, the present system goes one step ahead by actively preventing break-ins through its intelligent face recognition technology. It thus transforms the system from mere surveillance to a robust security platform.

Moreover, considering the current scenario where minimizing physical contact is crucial due to COVID-19, this system becomes even more relevant. By relying on face recognition for access control, it eliminates the need for physical keys or touch-based entry systems, thereby reducing the risk of virus transmission.

From a cost and resource perspective, this system proves favorable. It automatically reduces person to person intervention, hence saving more time and resources needed for monitoring and addressing problems. An upfront investment at the beginning is not a prerequisite for gaining the long-term benefits of secured convenience. The ESP32 CAM face detection door lock system is not just about securing physical spaces; it's about embracing innovative technology to create safer environments, adapt to evolving challenges like COVID-19, and streamline security operations efficiently.

The ESP-32 CAM-based door locking system has a large scope of future, which is likely to integrate into advanced IoT projects using Ethernet Arduino and Wi-Fi module for global remote access and energy management. For registered users, increased security can be achieved through double authentication setups and AI operated face detection. Further features such as LED screens for visitors' communication and smart home functions, such as dealing with many doors, curtain control and visual temperature monitoring, can expand the purpose. In order to ensure continuous operation under power failure, a reliable battery safety system can be included.

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