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FACIAL DETECTION BASED DOOR LOCKING SYSTEM USING ESP-32 CAM

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ABSTRACT

People want security in everyplace possible when they are into their homes or away from their homes. An anti-theft system is a device or method used to prevent or deter the unauthorized intrusion or trespassing activity in its coverage area. The implemented system was developed in combination of hardware and software. It's a unique security system made with low-cost wireless camera and sensors which ensured remote monitoring and control of doorways. The system empowered the user to monitor the doorway by capturing images using a high-performance wireless camera i.e. ESP32-CAM connecting other devices and sensors in an IoT network. A major challenge was to develop this dynamic system with zero error, Realtime response and smooth performance, viable, smart and feasible.

INTRODUCTION

The increasing concern for home security in today's society has prompted the need for innovative solutions to safeguard residential properties. With the rise in time spent away from home due to various commitments, such as work and school, homes are left vulnerable to potential threats, including burglaries. Additionally, the responsibility of caring for older adults or children further emphasizes the importance of efficient supervision even in the homeowner's absence.

To address these challenges, the implementation of a reliable home security system has become essential. Leveraging advanced technology, these systems aim to create safer and more secure living environments by enabling remote monitoring and surveillance capabilities.

The project focuses on developing a Facial Detection-Based Door Locking System using ESP32-CAM to enhance security and automation. It utilizes real-time facial recognition to grant or deny access, ensuring that only authorized individuals can unlock the door. The ESP32-CAM captures images, processes them using AI-based facial detection, and communicates with a locking mechanism through IoT integration. This system provides a cost-effective, efficient, and smart security solution, suitable for homes, offices, and restricted areas.

With advancements in IoT and AI, traditional security systems are evolving into intelligent and automated solutions. This project eliminates the need for physical keys or access cards, reducing security risks associated with theft or unauthorized duplication. By leveraging cloud-based or edge computing for image processing and decision-making, the system enhances security, efficiency, and user convenience.

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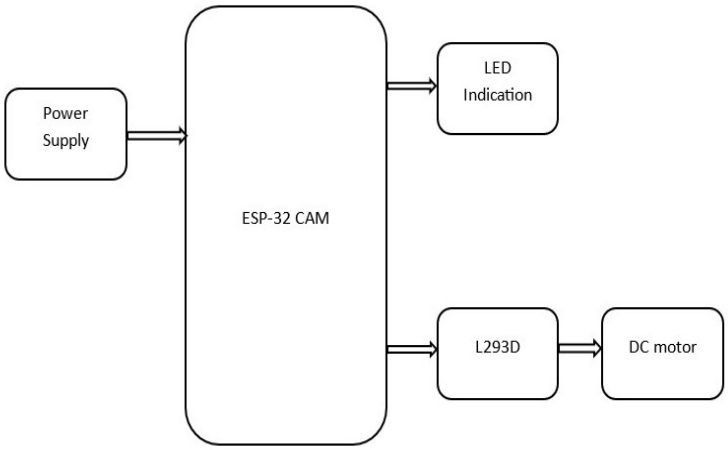

Figure.1 Block Diagram

LITERATURE SURVEY

Traditional Security Systems

Conventional door-locking mechanisms rely on physical keys, RFID cards, PIN-based authentication, or fingerprint recognition. While these methods are widely used, they come with challenges such as key duplication, card misplacement, and PIN breaches. Biometric methods like fingerprint scanners improve security but require physical contact, leading to hygiene concerns.

Facial Recognition in Access Control

Recent advancements in artificial intelligence (AI) and computer vision have enabled facial recognition to become a key player in security systems. Studies have shown that AI-based facial detection offers high accuracy and efficiency in identifying individuals. Researchers have integrated facial recognition with IoT platforms for real-time monitoring, enhancing security measures. However, challenges like lighting conditions and face variations still affect performance.

PROPOSED SYSTEM

The proposed Facial Detection-Based Door Locking System utilizes the ESP32-CAM for secure and automated access control. This system integrates facial recognition with a motorized locking mechanism to enhance security and convenience.The ESP32-CAM captures images and processes facial recognition to determine access. If an authorized person is detected, it sends a signal to the L293D motor driver, which controls a DC motor to unlock the door. An LED indicator module provides visual feedback: a green LED signals successful authentication and unlocking, while a red LED indicates denied access.

A regulated power supply ensures stable operation, providing 5V or 3.3V to all components for reliable image processing and motor control. The L293D motor driver is essential as the ESP32-CAM cannot drive the motor directly, ensuring smooth door locking and unlocking.

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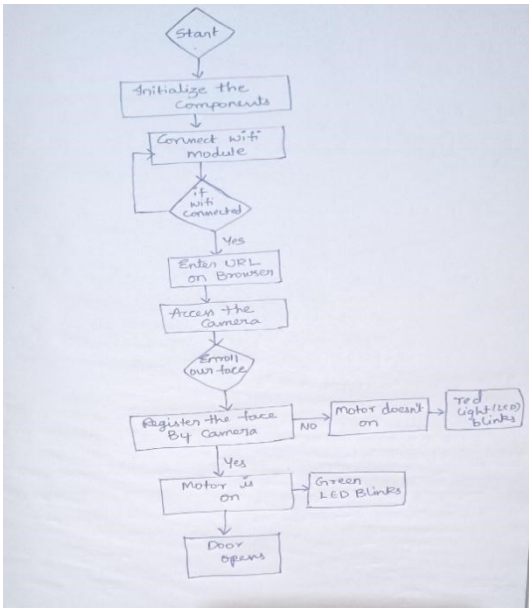

Figure.2 Flow Chart

The Facial Detection-Based Door Locking System utilizes AI-driven facial recognition to authenticate users and control door access. When a person approaches the ESP32-CAM, it continuously scans the field of view to detect and capture facial images. The system processes these images using AI-based facial recognition algorithms, extracting unique facial features such as eye distance, nose shape, and jawline. These features are then converted into numerical data and matched against a database of authorized users. If authentication is successful, the ESP32-CAM sends a control signal to the L293D motor driver, which amplifies the signal to operate the DC motor and unlock the door. A green LED indicates successful access, while a red LED signal denied entry if no match is found. The ESP32-CAM's Wi-Fi connectivity allows real-time remote monitoring by storing access logs in a cloud database or sending alerts to a mobile application. This enables remote access control, allowing authorized users to grant or deny entry through a web interface. The system ensures secure, automated, and contactless access, reducing risks associated with keys, passwords, and unauthorized access. The integration of AI-driven image processing, ESP32-CAM, and IoT-based monitoring provides a scalable and cost-effective security solution for homes, offices, and high-security environments.

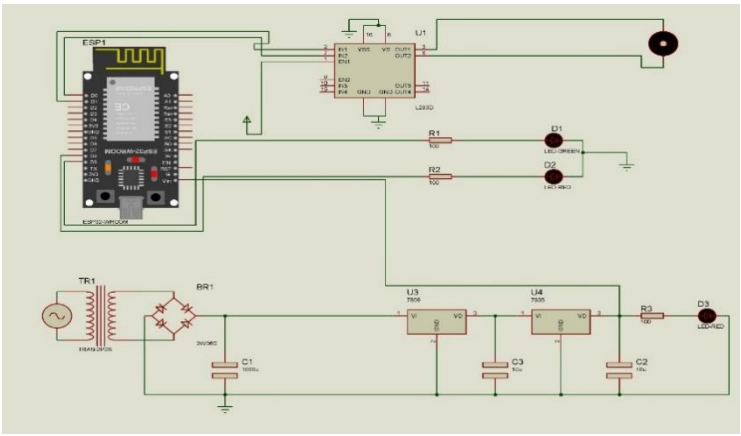

Figure.3 Schematic Diagram

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RESULTS

When a person approaches the door, the ESP32-CAM captures a real-time image and processes it using the AI Tinker Board's facial recognition algorithm. The system compares the detected face with pre-registered images stored in the database. If the face matches an authorized user, the system sends a signal to the L293D motor driver, which then activates the DC motor to unlock the door. Simultaneously, the LED indicator turns on, providing visual confirmation that access has been granted. This contactless authentication ensures high security and ease of use, eliminating the need for physical keys or passwords.

Firstly we need to enroll the face in the given ip address and it takes the 5 samples

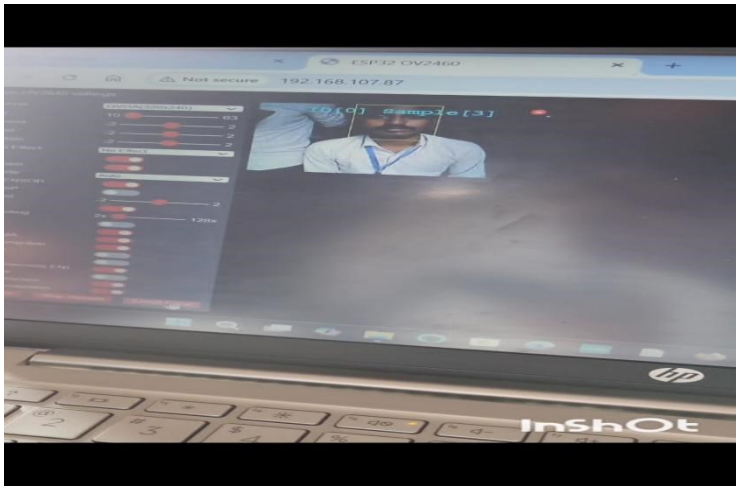

Figure.4 Collecting the samples

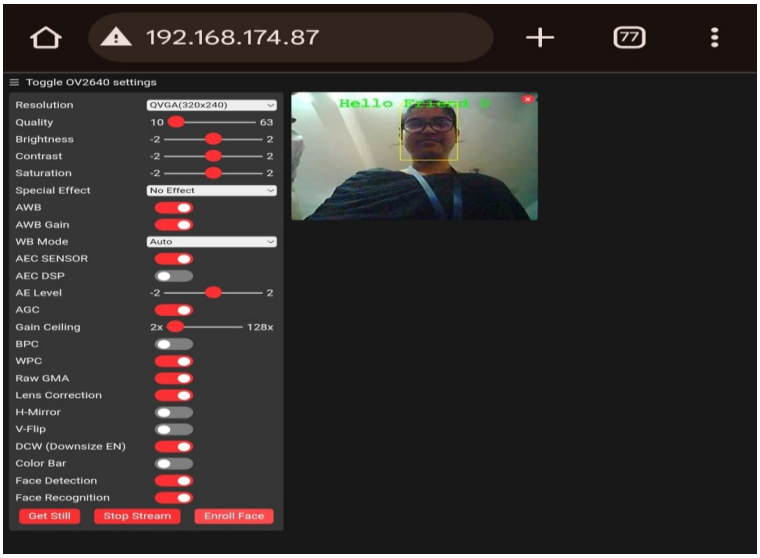

Figure.5 Enrolling the Face

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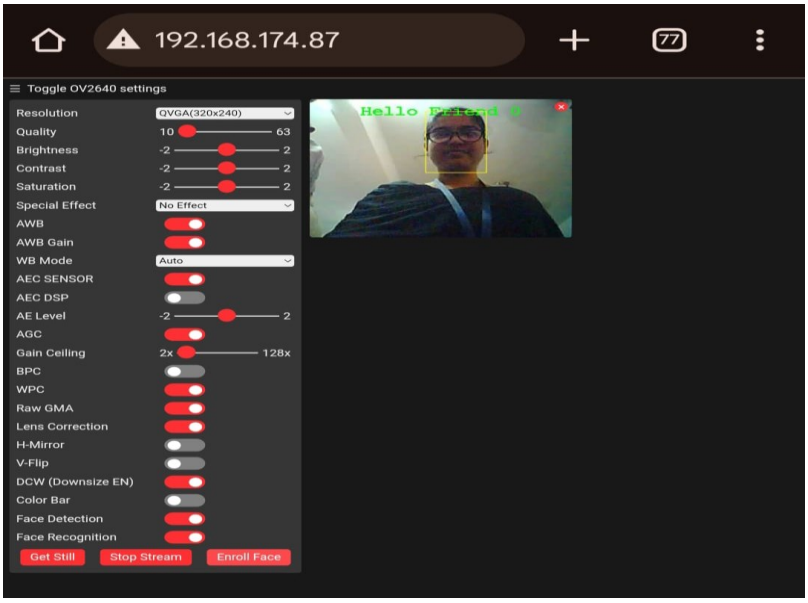

Figure.6 Authenticated person

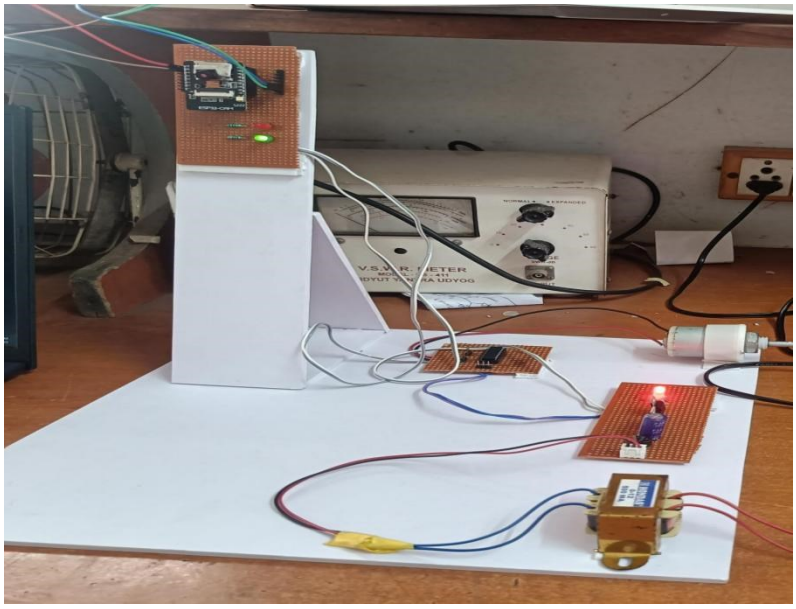

Figure.7 Successful authentication of door unlocking

If an unrecognized face is detected, the system denies access, and the door remains locked. The LED indicator remains off, signalling that authentication has failed. The system prevents unauthorized users from manipulating access by ensuring that only pre-registered individuals can unlock the door. If repeated failed attempts occur, the system can be programmed to restrict further authentication attempts for a certain duration, preventing brute-force access attempts and It shows intruder alert in the given ip address.

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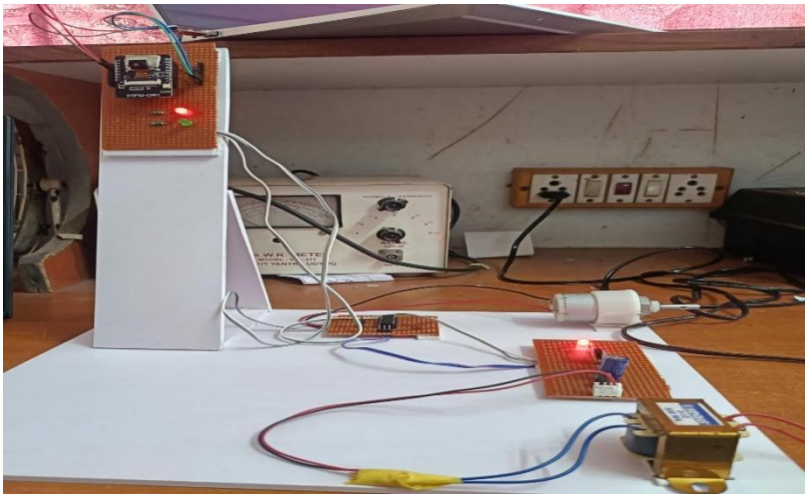

Figure.8 Unauthorized Access Attempt

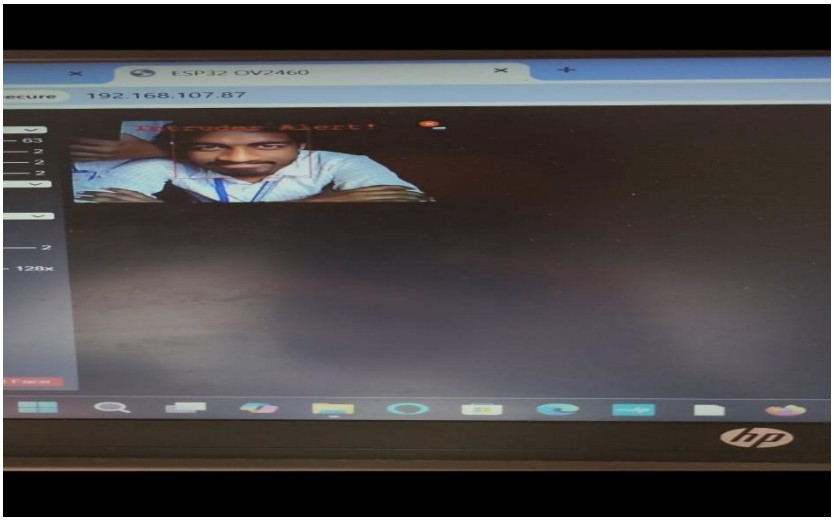

Figure.9 Intruder alert

APPLICATIONS

- **Home Security –** Enhances residential security by allowing only authorized individuals to access the house.
- **Corporate Offices –** Used in offices for employee authentication, reducing unauthorized access.
- **Bank Vaults & ATMs –** Increases security for banking and financial institutions by enabling biometric access control.
- **Educational Institutions –** Ensures secure access to restricted areas like staff rooms and labs.
- **Hospitals & Healthcare Centers –** Prevents unauthorized entry into sensitive areas such as ICU and pharmacy storage.
- **Hotels & Hospitality –** Replaces traditional key cards with secure, personalized facial recognition access.

ADVANTAGES

- **Contactless & Hygienic –** Eliminates the need for physical keys, reducing the spread of germs.
- **Enhanced Security –** Prevents unauthorized access and duplication of keys or passwords.
- **Real-Time Monitoring –** IoT integration enables remote access control and log tracking.
- **Fast & Efficient –** Provides instant authentication without the need for PINs or RFID cards.
- **Reduced Human Intervention –** Automated system eliminates manual authentication requirements.
- **Scalable & Customizable –** Can be integrated with smart home and office automation systems.
- **Tamper-Proof System –** Difficult to bypass compared to traditional locks.
- **Energy Efficient –** Uses minimal power, making it ideal for long-term use.

CONCLUSION

The Facial Detection-Based Door Locking System using ESP32-CAM successfully demonstrates a modern and secure access control mechanism by leveraging facial recognition technology. The system eliminates the need for traditional keys or passwords, reducing security vulnerabilities such as key duplication or password breaches. With the integration of a WiFi module, users can remotely access and manage the system, enhancing convenience and flexibility.

This project showcases the practical implementation of AI-driven authentication, ensuring real-time face detection and verification for robust security. The automation of the door locking mechanism through motor control provides a seamless experience, while LED indicators offer immediate visual feedback regarding access status. Additionally, the system's ability to recognize and differentiate between authorized and unauthorized individuals significantly improves safety measures.

In conclusion, this smart door lock system represents a step toward intelligent security solutions by combining automation, AI, and IoT technologies. Its ability to enhance security, streamline access control, and offer a user-friendly experience makes it a promising alternative to traditional door locking mechanisms. With continuous development, it can evolve into an even more sophisticated and widely adopted security solution.

FUTURE SCOPE

Future versions of the system can integrate with cloud storage for real-time data access and remote monitoring. IoT connectivity can enable smart home and industrial automation, allowing users to manage access from anywhere. Implementing advanced AI models, such as deep learning-based facial recognition, can improve accuracy and speed, reducing errors due to poor lighting or angle variations.Combining facial recognition with other authentication methods, such as fingerprint scanning or OTP verification, can strengthen security and prevent unauthorized access.

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