Smart Door Access System with ESP32: Face Recognition & IoT Integration

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The Challenge: Secure & Convenient Home Access

Vulnerable Keys

Traditional keys pose significant security risks, susceptible to loss, theft, and unauthorized duplication, compromising home safety.

Need for Contactless Access

Modern living demands reliable, multi-modal, and hygienic door unlocking solutions that adapt to user needs.

Lack of Monitoring

Homeowners seek real-time status updates and remote monitoring capabilities for enhanced peace of mind and control.

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Our Solution: Multi-Modal Smart Door Lock System

Our innovative system integrates cutting-edge technology to provide a secure and convenient access solution for your home.

Face Recognition Entry

Seamless, keyless access utilizing ESP32-CAM for rapid and accurate facial identification.

IR Sensor Activation

Presence detection initiates the recognition process, ensuring efficiency and responsiveness.

Keypad Alternative

A reliable PIN-based option for entry, providing a versatile backup and alternative access method.

Automated Door Unlock

A servo motor securely opens the door upon successful authentication, combining digital intelligence with physical action.

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How It Works: Step-by-Step User Interaction

01

User Approaches

The IR sensor detects presence, activating the system to prepare for interaction.

02

Image Capture & Recognition

The ESP32-CAM captures a face image, initiating the recognition algorithm for verification.

03

Access Granted / Denied

If recognized, the LCD displays "Access Granted" in green, and the servo unlocks the door. If using the keypad, correct PIN entry triggers the same sequence.

04

Activity Logging

All access events and system status updates are logged, providing a comprehensive record of activity.

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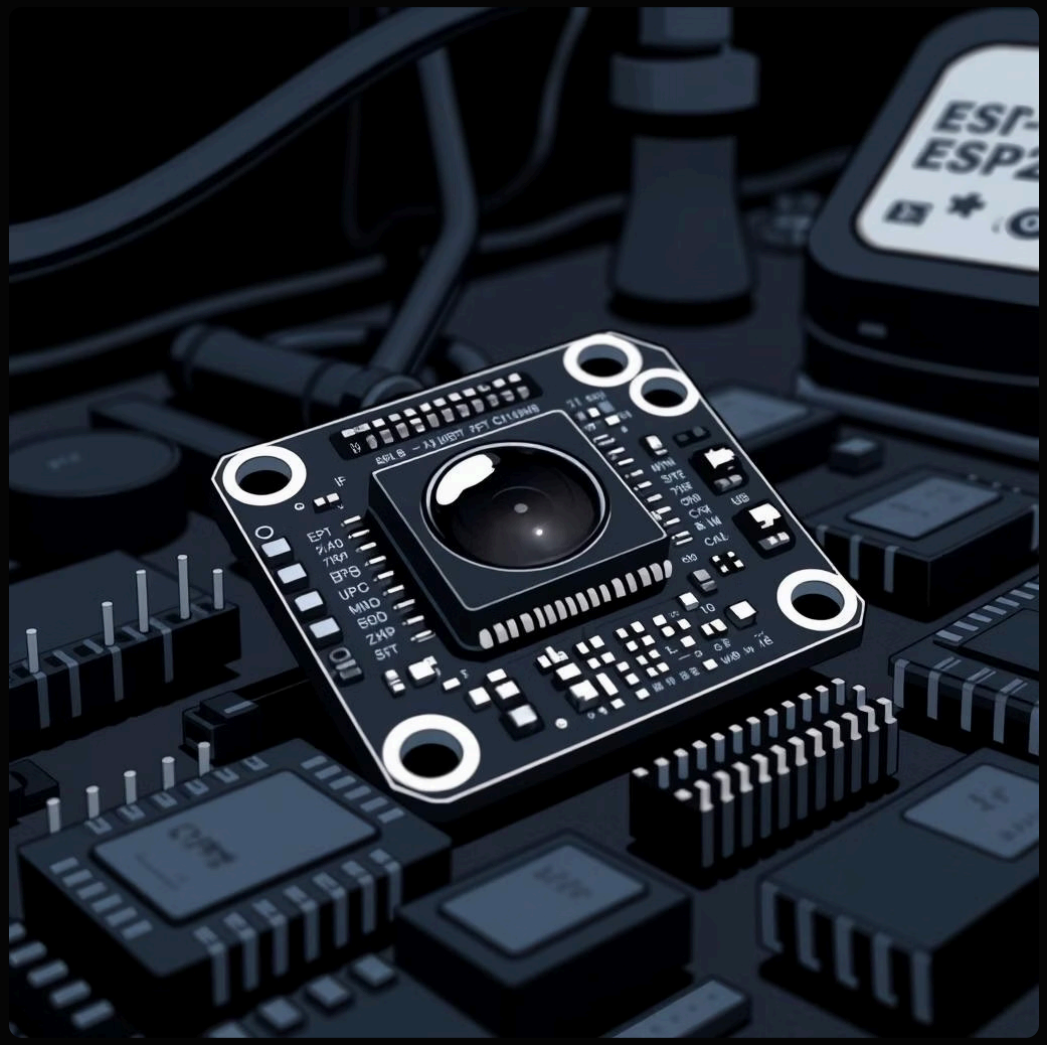
Hardware Components & Circuit Overview



- **ESP32-CAM Module:** Features OV2640 camera for high-resolution face recognition and powerful processing.
- **IR Proximity Sensor:** Detects user presence to efficiently activate the system.
- **16x2 LCD Display:** Provides clear, real-time user feedback with messages like "Access Granted" or "Denied."
- **Servo Motor:** Precisely controls the door latch for reliable physical unlocking.
- **Keypad Matrix:** Enables secure PIN input as an alternative or additional access method.
- **Relay/GPIO Control:** Manages power switching for the servo, optimizing energy usage and system efficiency.

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Software & Connectivity Integration

Our system leverages powerful software and robust connectivity protocols to ensure seamless operation and data management.

Face Recognition Engine

Powered by Espressif's esp-who library, optimized for the ESP32 to deliver fast and accurate facial authentication.

MQTT Protocol

Facilitates real-time, lightweight communication with home automation hubs, enabling instant notifications and control.

Supabase Backend

Securely stores user profiles and access logs in a cloud database, providing robust data management and accessibility.

Arduino IDE

Utilized for efficient firmware development and deployment, streamlining the programming process.

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Security & User Management Features

The system is designed with multiple layers of security and flexible user management to ensure ultimate control and protection.

1

User Enrollment

Easy face enrollment and deletion, either directly via a physical button or remotely through commands.

2

Multi-Factor Access

Option for enhanced security requiring both face recognition and PIN entry for access.

3

Real-time Monitoring

Immediate alerts and comprehensive access logs are viewable through the intuitive Supabase dashboard.

4

Fail-Safe Override

A manual keypad override ensures access even in the rare event of camera malfunction, maintaining reliability.

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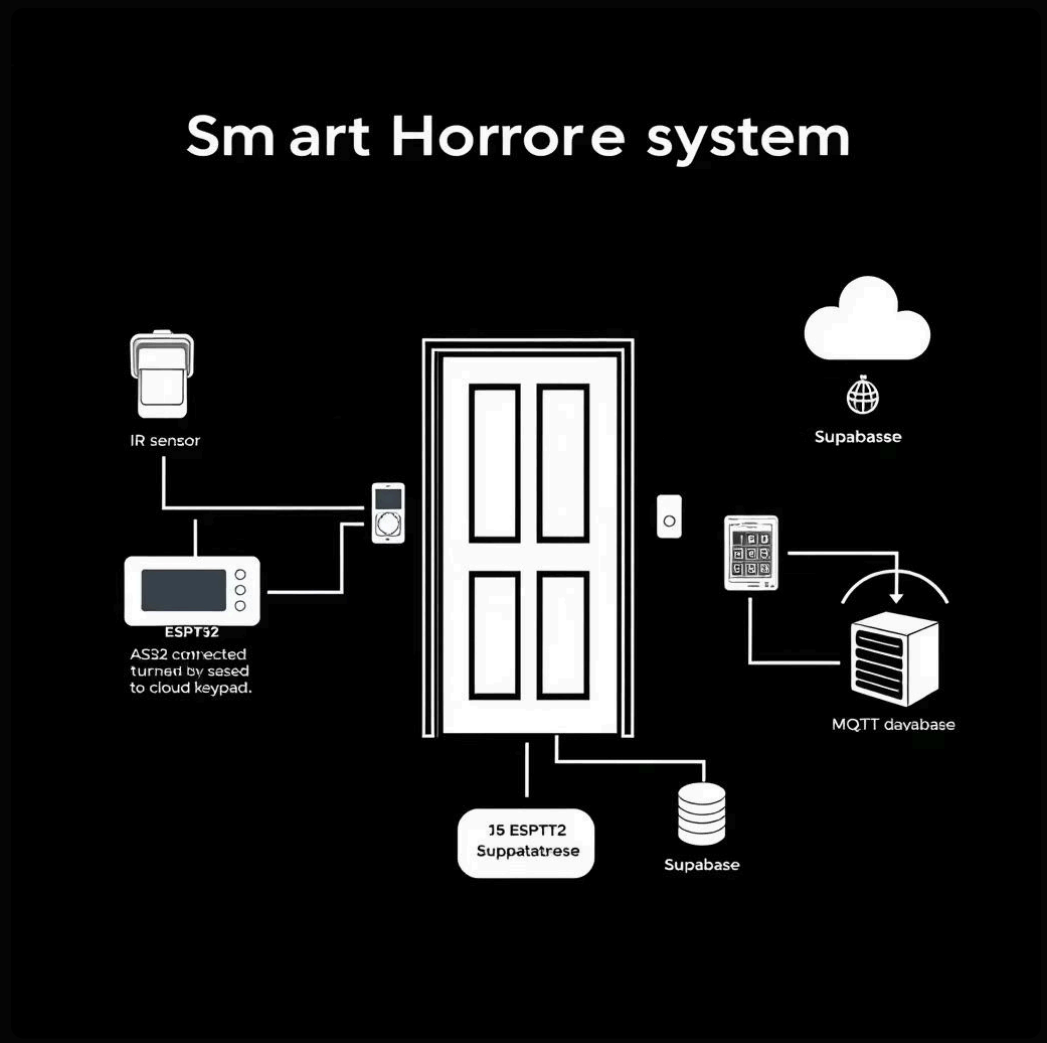
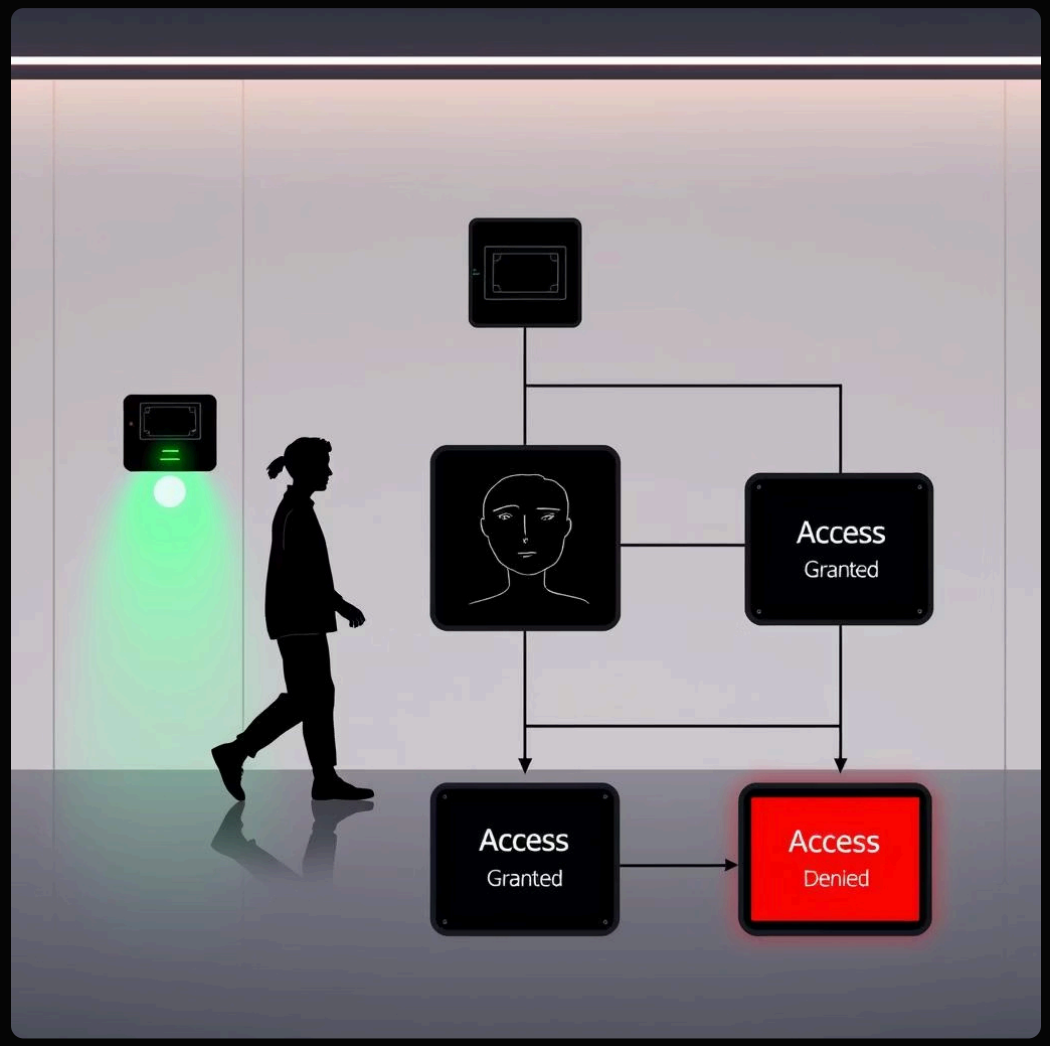
Demonstration & Visual Flow



System Architecture Diagram

This diagram illustrates the interconnected components, from sensors to cloud integration, highlighting the system's comprehensive design.



User Interaction Flowchart

A step-by-step visual representation of how a user interacts with the system, from detection to successful entry.

Visual Demonstration: Imagine a quick video clip showcasing the door unlocking smoothly upon a recognized face and through a keypad entry.

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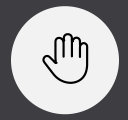
Benefits & Impact



Hygienic, Hands-Free Access

Enjoy effortless and touch-free entry with rapid face recognition, typically within one second.

Enhanced Home Security

Benefit from multi-layer authentication, including biometric and PIN options, for superior protection.

Remote Monitoring & Control

Stay connected to your home with real-time updates and control capabilities via MQTT and cloud integration.

Scalable Future-Proof Platform

The system is ready for future smart home expansions, including voice commands and advanced alert features.

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Conclusion: The Future of Smart Home Security is Here

By combining cutting-edge AI, IoT, and cloud technologies, we are paving the way for smarter, safer, and more convenient homes. The affordability and versatility of ESP32 make this innovation accessible to all.

Next Steps:

Integrate voice commands, mobile app control, and energy optimization for an even more intelligent living experience. Let’s unlock the future—securely and smartly!

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