IN1901

Microcontroller Based Application Development Project

Final Report

GATE SENTINAL

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1. Introduction

The Advanced Smart Doorbell System is an innovative home security solution designed to combine convenience, safety, and advanced technology in integrated units. This system utilizes a blend of modern hardware and software to provide homeowners with real-time control and monitoring of their front gate, ensuring enhanced security and seamless communication.

Equipped with a camera, PIR motion detection, and a biometric fingerprint scanner, the doorbell ensures precise monitoring and secure access. The fingerprint scanner is integrated to allow authorized family members to unlock the gate easily by verifying their fingerprints. This added feature eliminates the need for traditional keys, ensuring that only authorized individuals can gain access to the home, even from a distance.

The system is powered by a Wi-Fi module for data sharing and includes a mobile application that allows homeowners to receive alerts, view live camera feeds, communicate with visitors, and unlock the gate remotely, from anywhere. An interactive display on the doorbell unit shows the status of household members, while an indoor control panel provides additional management options for in-home convenience.

Backup battery support ensures uninterrupted operation during power outages, while the integration of a microphone and speaker facilitates two-way communication. This project redefines home security by merging advanced hardware with intuitive software, providing a robust, secure, and user-friendly system for modern homes, combining video surveillance, biometric security, and smart lock capabilities into one comprehensive solution.

2.Literature Survey

Smart door locks and doorbells have emerged as critical components of modern home security systems, offering a blend of convenience, remote accessibility, and advanced security features. Unlike traditional locks, smart door locks incorporate mechanical locking mechanisms with digital technologies such as fingerprint recognition, WiFi/Bluetooth connectivity, touchscreen keypads, and mobile app integration. Similarly, smart doorbells enhance security by providing video surveillance, two-way audio communication, motion detection, and local/cloud video storage. This review explores the current state of these technologies, their integration into smart home ecosystems, and the challenges associated with their adoption.

Current Technologies in Smart Door Locks

Smart door locks currently available on the market range in price from $77 to $300, depending on their features and brand. Key features include:

- Biometric Authentication: Fingerprint recognition offers quick and secure access.
- Remote Access: WiFi/Bluetooth-enabled locks allow users to control and monitor access via mobile apps.
- Touchscreen Keypads: These provide an alternative to traditional keys or keycards.
- Integration with Smart Home Platforms: Many smart locks are compatible with systems like Apple HomeKey, Google Assistant, and Amazon Alexa, enabling seamless automation.

Despite these advantages, challenges such as potential hacking risks, reliance on stable internet connections, and higher upfront costs remain.

Features of Smart Doorbells

Smart doorbells complement smart locks by enhancing monitoring and interaction capabilities. Their key features include:

- Video Surveillance: Real-time video feeds and recorded footage provide an added layer of security.
- Two-Way Audio: Integrated microphones and speakers enable communication with visitors.
- Motion Detection: Alerts users to activity near their doors, even without a doorbell ring.
- Storage Options: Recorded footage can be saved locally or on the cloud, depending on user preferences.

Gate Sentinel: Integration of Smart Lock and Doorbell

The Gate Sentinel represents an innovative integration of smart locks and doorbells with an indoor panel system. This device allows homeowners to:

- Communicate with visitors through a panel equipped with video and audio capabilities.
- Unlock the gate remotely via a mobile app for added convenience.
- Combine some of the security features of both smart door locks and doorbells into a single, unified system.

This integration addresses common issues in standalone devices by offering a centralized control system, improving user experience and functionality.

The convergence of smart locks and doorbells, as exemplified by the Gate Sentinel, marks a significant advancement in smart home technology. While these innovations offer numerous benefits, challenges such as cybersecurity risks and cost barriers must be addressed to ensure widespread adoption. Future research could explore the development of more affordable, energy- efficient, and secure systems to further enhance the smart home experience.

3.Features of the Proposed Solution

1. Smart Fingerprint Locking System:
   Allows remote or local unlocking of the gate lock through biometric authentication, web or the mobile applications and an automatic locking mechanism using a limit switch.
2. Biometric Fingerprint Scanner:
   Ensures secure and keyless access for authorized family members.
3. Video Surveillance:
   Real-time video feeds and recorded footage provide an added layer of security.
4. Two-Way Audio Communication:
   Enables real-time interaction between the homeowner and visitors using a built-in microphone and speaker.
5. Real-Time Alerts:
   Sends notifications about motion detection, visitor arrivals, or access attempts to the homeowner.
6. Indoor Control Panel:
   Provides additional control options like viewing live feeds, managing doorbell functions through a web application , and communicating with visitors from inside the home.
7. Interactive Display:
   A touchscreen is used to display the web application in the indoor panel for a more modest look.
8. Backup Battery Support:
   Ensures uninterrupted operation during power outages.
9. Mobile Application Integration:
   Facilitates remote monitoring, alert notifications, and access control through a smartphone app.

4. Problem and proposed solution

4.1. Problem in brief

In highly populated urban areas, home security has become a growing concern due to the increasing risk of unauthorized access, theft, and other security threats. Traditional security measures, such as conventional locks and basic doorbell systems, often fail to provide the comprehensive protection and convenience required in modern urban living.

The Advanced Smart Doorbell System addresses these challenges by integrating cutting-edge technology, such as biometric fingerprint authentication, motion detection, and real-time monitoring, to offer a robust and secure solution. This system not only enhances the safety of urban homes but also ensures seamless communication and remote control, allowing homeowners to manage access and monitor their property efficiently, even from a distance. By combining innovative hardware and intuitive software, the project redefines home security for densely populated areas, addressing the pressing need for advanced and user-friendly security systems.

4.2. Proposed solution

The proposed solution is the Advanced Smart Doorbell System, a cutting-edge home security system designed to tackle the challenges of securing homes in highly populated urban areas. This system provides a comprehensive, reliable, and user-friendly security solution by integrating advanced hardware and software features.

Key elements of the proposed solution include:

1. Biometric Fingerprint Scanner
    - Provides secure and convenient access by verifying the identity of authorized individuals through fingerprint recognition, eliminating the need for traditional keys and ensuring restricted entry.
2. ESP32-S Camera
    - Ensures continuous video surveillance, even in low-light conditions, enabling homeowners to monitor their surroundings at any time of the day.
2. PIR Motion Detection
    - Detects movement near the entrance and triggers alerts, providing real-time updates on any suspicious activity.

2. Interactive Display and Indoor Control Panel
    - Displays household member status and provides in-home management options for added convenience.
2. Backup Battery Support
    - Ensures uninterrupted operation during power outages, maintaining security at all times.
2. Mobile Application Integration
    - Allows homeowners to receive notifications, view live camera feeds, communicate with visitors via two-way audio, and unlock the gate remotely from anywhere, ensuring flexibility and control.

By combining video surveillance, biometric access, and smart locking capabilities into a single system, this solution redefines home security, providing an effective response to the growing concerns in densely populated urban areas. It enhances safety, ensures convenience, and brings peace of mind to homeowners.

5. Aim and Objective

5.1. Aim

To develop an advanced smart doorbell-lock system that integrates modern security features, biometric authentication, and real-time monitoring to enhance home safety, convenience, and user experience.

5.2. Objectives

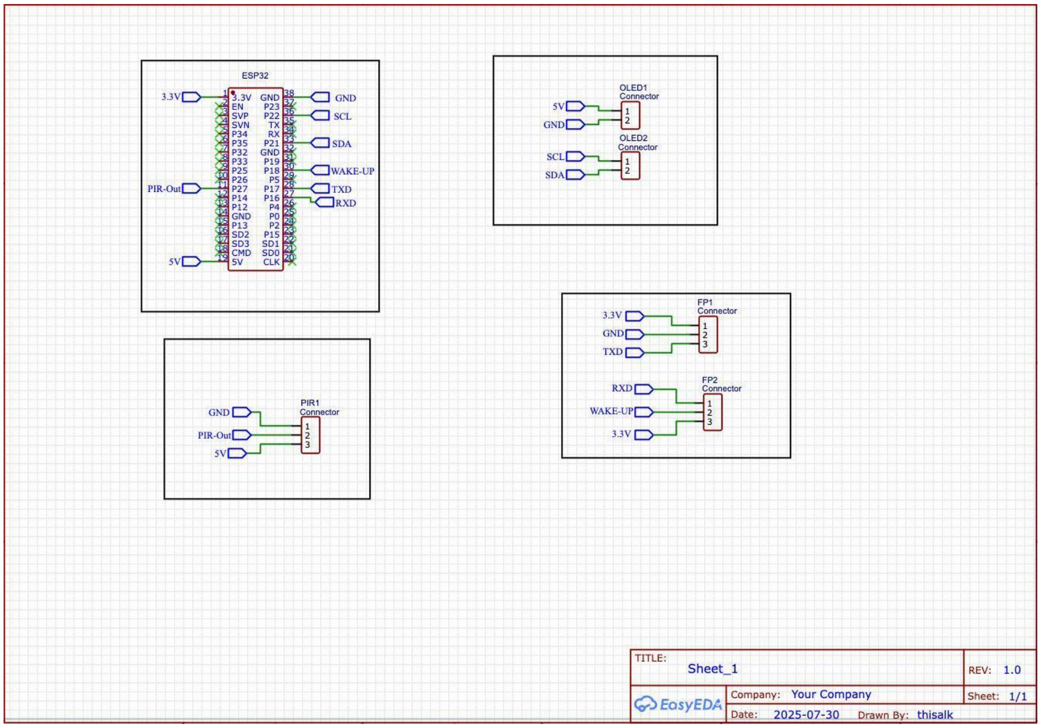
1. Enhance home security with advanced features like a vision camera and motion detection.
2. Streamline entry management using a biometric fingerprint unlocking system.
3. Ensure reliability with a backup battery for uninterrupted operation.
4. Facilitate two-way communication between homeowners and visitors.
5. Enable remote access and monitoring via the indoor panel and mobile app.
6. Provide in-house control through an indoor panel with live feed display.
7. Combine video surveillance, smart locking, and biometric access into a single system

6. Analysis & Design

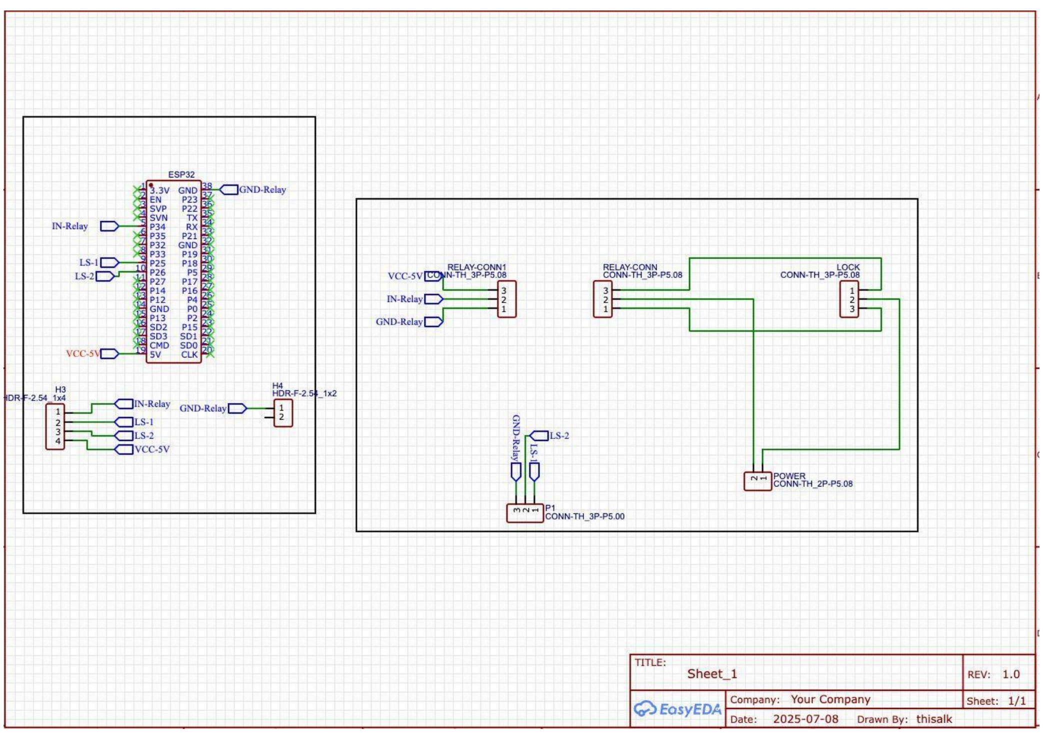
6.1. Schematic Diagram

- Outdoor panel

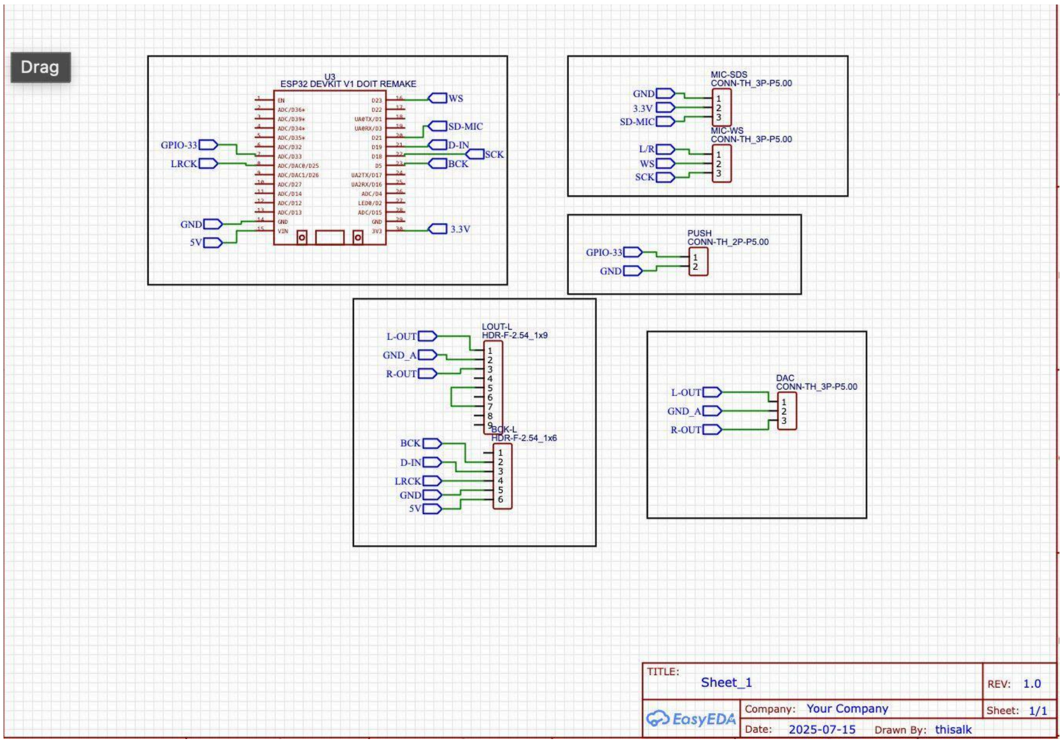
sni



- Microphone and speaker

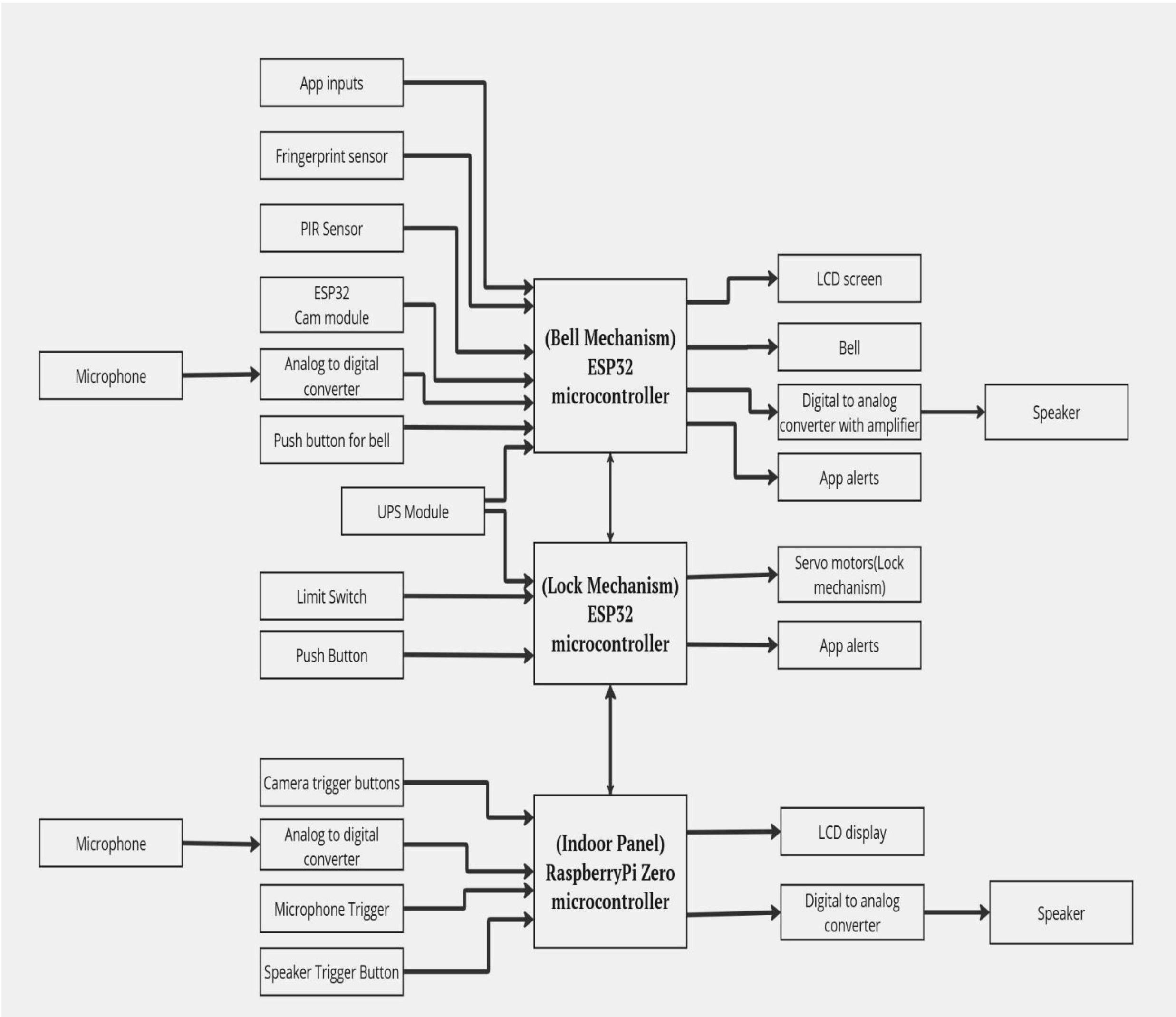


- Gate Lock



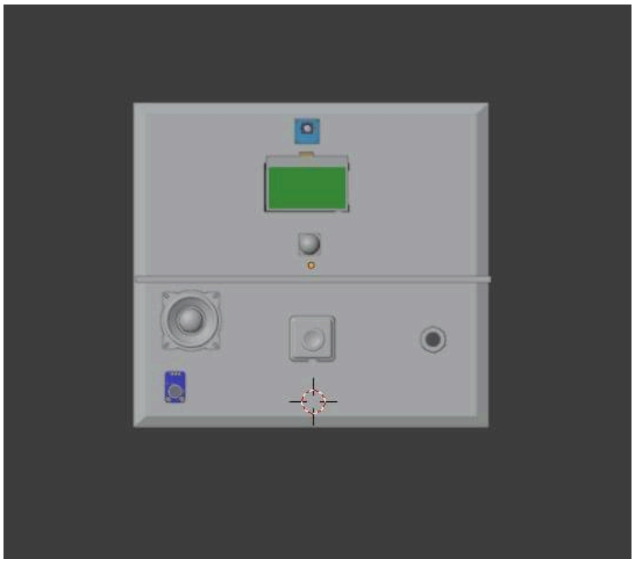
Drag
U3
ESP32 DEVKIT V1 DOIT REMAKE
GPIO-33
LRCK
GND
5V
WS
SD-MIC
D-IN
SCK
BCK
3.3V
MIC-SDS
CONN-TH_3P-P5.00
GND
3.3V
SD-MIC
MIC-WS
CONN-TH_3P-P5.00
L/R
WS
SCK
PUSH
CONN-TH_2P-P5.00
GPIO-33
GND
LOUT-L
HDR-F-2.54_1x9
L-OUT
GND_A
R-OUT
BCK-L
HDR-F-2.54_1x6
BCK
D-IN
LRCK
GND
5V
DAC
CONN-TH_3P-P5.00
L-OUT
GND_A
R-OUT
TITLE:
Sheet_1
REV: 1.0
Company: Your Company
Sheet: 1/1
EasyEDA
Date: 2025-07-15
Drawn By: thisalk

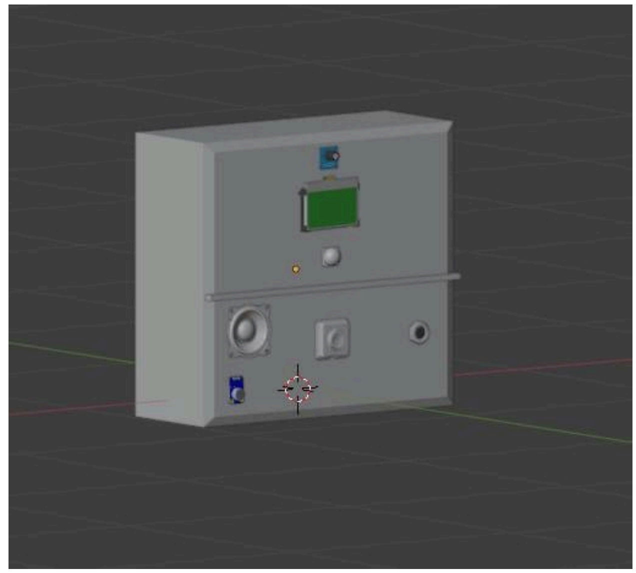
6.2. Block Diagram



6.3. 3D Design

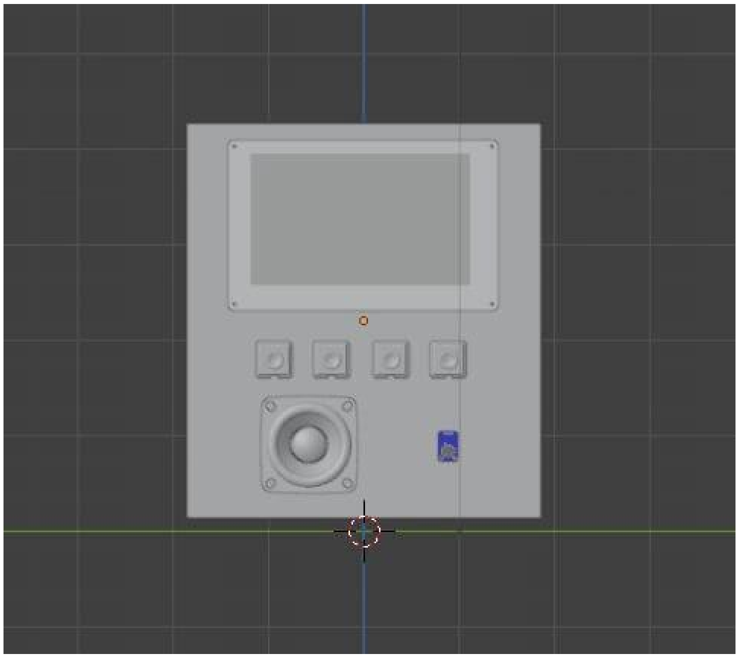
- Outdoor Panel

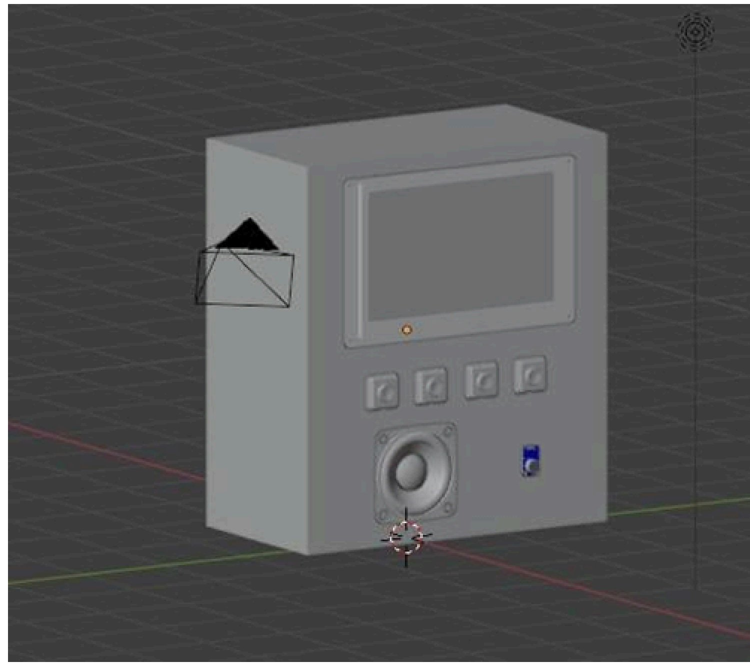




- Outdoor Panel Placement

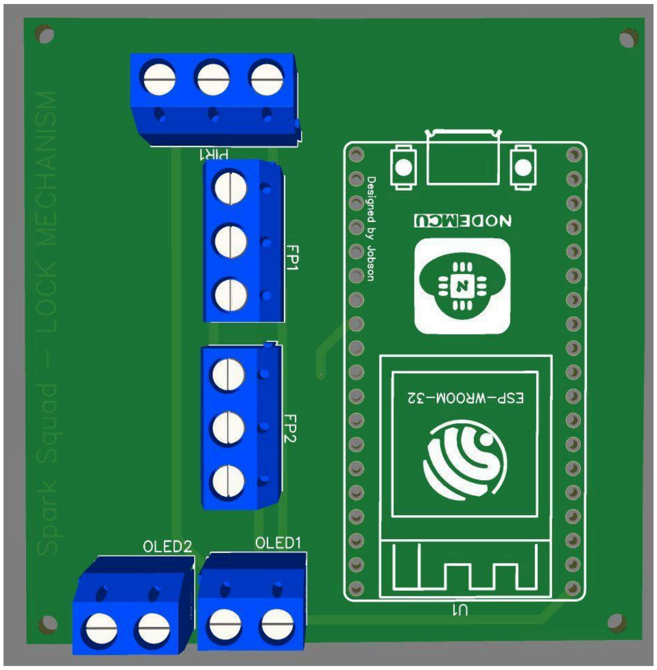
- Indoor Panel

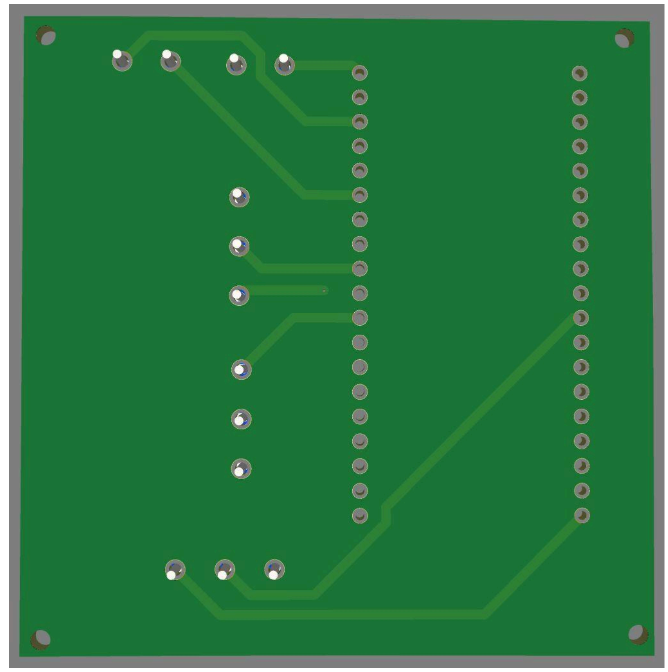




6.4. PCB Design

- Outdoor Panel

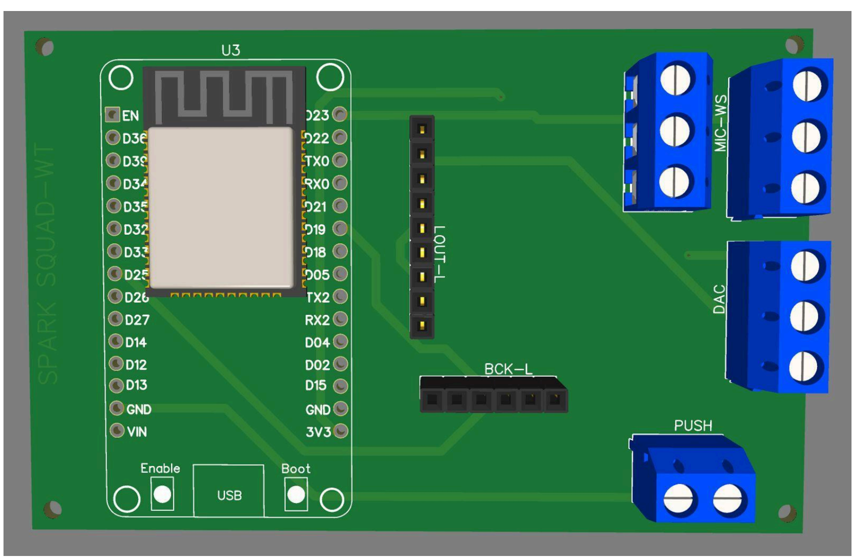




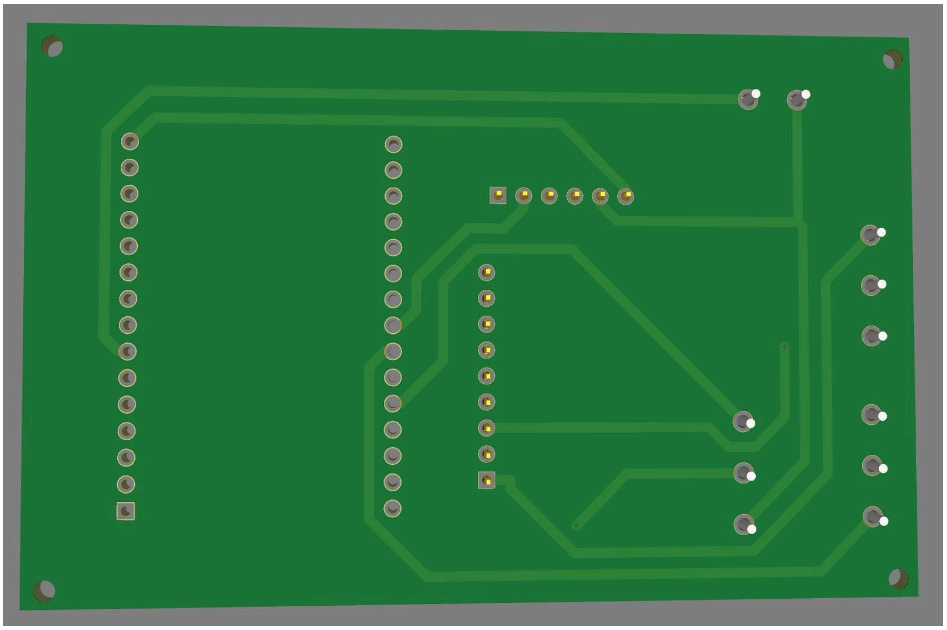
Front view

Back view

- Microphone and Speaker

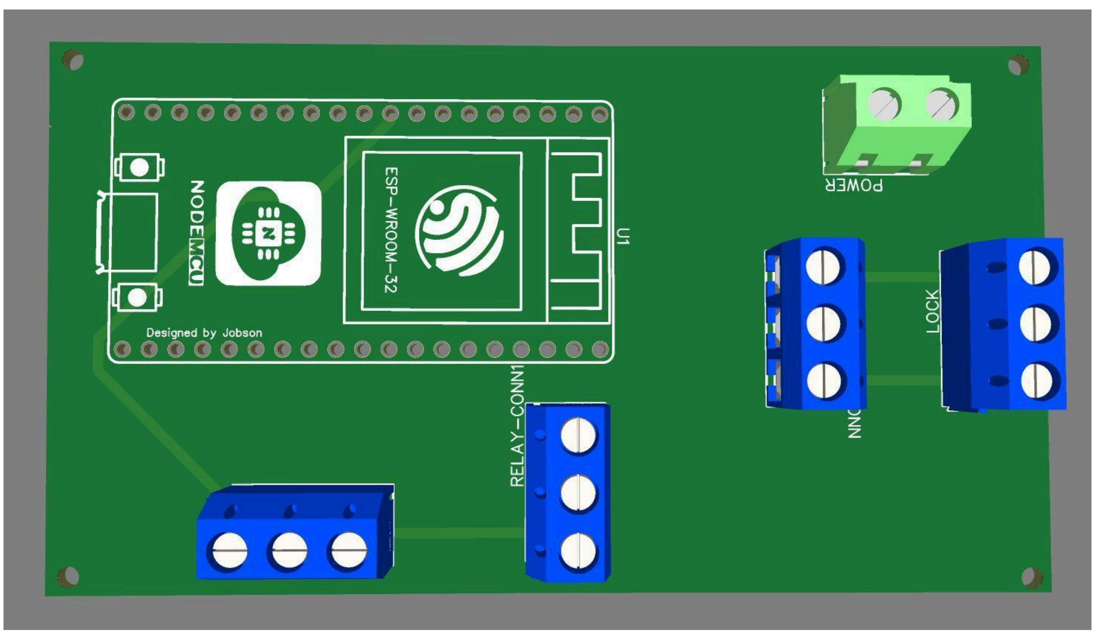


Front view

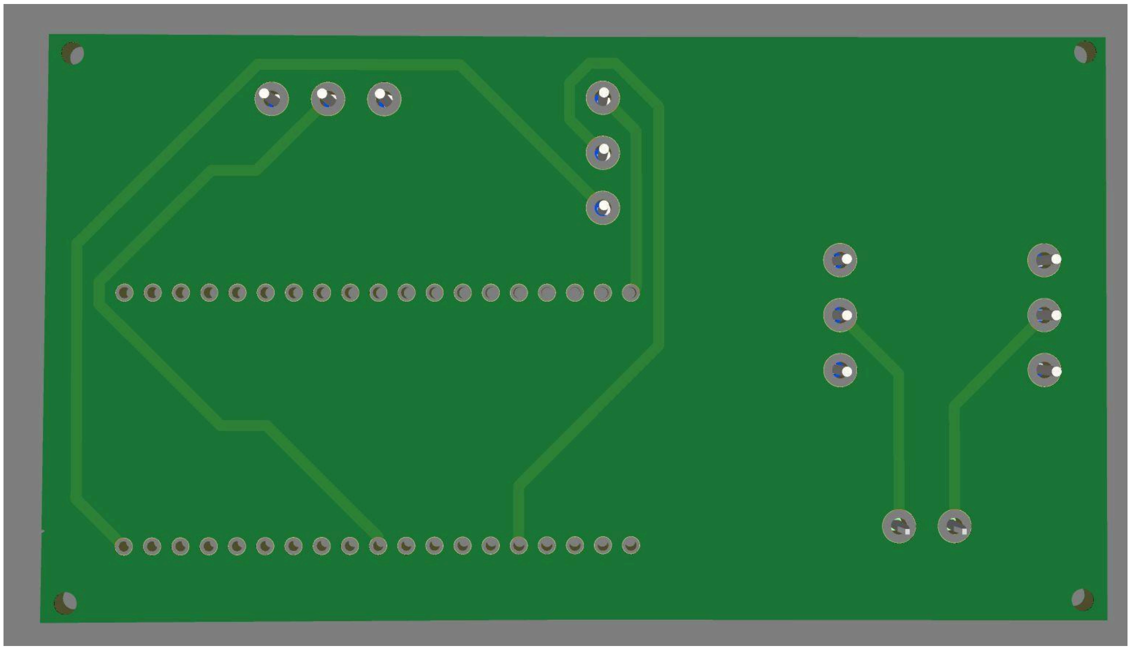


Back view

- Gate Lock



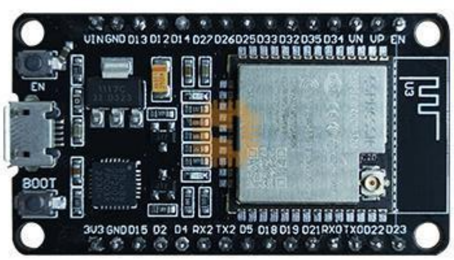
Front View



Back View

7. System Components & Resources Requirements

7.1. NodeMCU ESP32-WROOM-32U



NodeMCU ESP32-WROOM-32U comes without an antenna, but it works a reasonable distance without an external antenna. An IPEX socket is available to connect an external antenna. Similar to the D and S versions, WiFi+Bluetooth connectivity, onboard CP2102 and keys are included in this version. Similarly all the I/O pins of ESP32 module are accessible via the extension headers.

Acts as the main microcontroller of the system. It controls all peripherals, processes sensor data, handles fingerprint recognition, and communicates with the mobile app using Wi-Fi (MQTT protocol).This is the central unit that controls and processes all the inputs and outputs of the system, including camera, sensors, fingerprint scanner, and communication.

Specifications:

- WIFI module: ESP32
- Processor: ESP32
- Built-in Flash: 32Mbit
- Bluetooth: Bluetooth 4.2
- Frequency range: 2.4G ~ 2.5G (2400M ~ 2483.5M)
- Power supply: 5V
- Logic level: 3.3V
- Dimensions: 51.4mm x 25.4mm

7.2. 1.5 inch 128*128 OLED Display Module

- Size: 1.5
- Resolution: 128X128
- Viewing angle: greater than 160 degrees
- Supported platforms: for Arduino, 51 series, MSP430 series, STIM32 / 2, SCR chips
- Low power consumption: 0.04W during normal operation
- Support wide voltage: 3.3V-5V DC
- Working temperature: -30-80 degrees
- Driver IC: SH1107
- Communication: IIC, only two I/O pins

Used to display system status messages. Provides visual feedback to users at the gate.

7.4. HC-SR501 PIR Sensor Module for Arduino

HC-SR501 is based on infrared technology, automatic control module, using Germany imported LHI778 probe design, high sensitivity, high reliability, ultra-low-voltage operating mode, widely used in various auto-sensing electrical equipment, especially for battery-powered automatic controlled products.

Detects motion near the gate, triggering the system to activate the camera, send alerts, and prepare for user interaction. Acts as a passive security trigger.

Specification:

- Voltage: 5V – 20V
- Power Consumption: 65mA
- TTL output: 3.3V, 0V
- Lock time: 0.2 sec
- Trigger methods: L – disable repeat trigger, H enable repeat trigger
- Sensing range: less than 120 degree, within 7 meters
- Temperature: – 15 ~ +70
- Dimension: 32*24 mm, distance between screw 28mm, M2, Lens dimension in diameter: 23mm

7.5. TZT Type-C 15W 3A Fast Charge ups power supply

The TZT Type-C 15W 3A UPS Power Supply Module is a compact, efficient, and reliable uninterruptible (UPS) solution designed to provide continuous power to small electronics, such as Raspberry Pi, ESP32 boards, Arduino systems, and smart home modules.

This module ensures that your device stays powered without interruption, even during external power outages, by automatically switching to a connected lithium battery.

Provides stable power to the system and supports charging the backup battery. Ensures smooth operation even during power transitions.

UPS Functionality: Supports uninterruptible power switching between USB input and battery power.

Type-C Fast Charging: 5V 3A input for rapid charging of lithium batteries.

Output Voltage: Regulated 5V output to power devices.

7.6. R503 Fingerprint Identification Circular Capacitive Fingerprint Module

R503 Fingerprint Sensor is a device that allows you to read and save up to 200 fingerprints through a touch panel, it also contains a configurable LED light indicator. This sensor is small and easy to use, it has a wide detection range, a nut so you can install it easily and it has 6 pins, 2 for power, 1 for the finger detection signal, another for the touch power and 2 for communication via serial protocol (Tx, Rx) so you can use it with Arduino, ESP32, PIC and other microcontroller development boards.

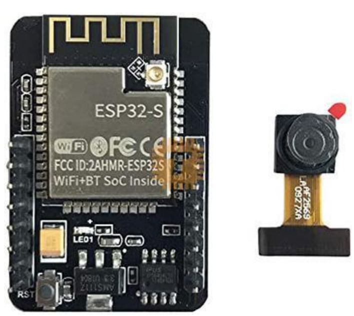
R503 Fingerprint Sensor can be used in security, access control and attendance applications, you can use the LED colours to indicate errors in the census, fingerprints found in the records, fingerprints not registered, among other things.

Enables biometric authentication for gate access. Allows authorized users to unlock the gate using their fingerprint, enhancing security.

- Model: R503
- Resolution: 508 DPI

- Voltage: 3.3VDC
- Capacity: 200 fingerprints
- Sensing array: 192x192 pixels
- Working current: 20mA
- Standby current: Typical touch standby voltage: 3.3V, Average current: 2uA
- Module size: 28mm (external diameter) / 23.5mm (inner diameter)
- Module height: 15.5mm
- Sensor area: 15.5mm
- LED Colors: Blue and Red

7.7. ESP32-S Camera



Captures images and video footage of visitors.

- Low power 32-bit CPU, can also serve the application processor.
- Up to 160MHz clock speed, summary computing power up to 600 DMIPS.
- Built-in 520 KB SRAM, external 4MPSRAM

7.8. INMP441 Omnidirectional Microphone Module

The INMP441 is a high-performance, low-power digital MEMS microphone module with an I2S interface, perfect for audio capture projects requiring digital sound input. With its omnidirectional sensitivity, compact form factor, and compatibility with ESP32, Raspberry Pi, and other microcontrollers, it's ideal for applications like voice recognition, smart assistants, and IoT audio.

Facilitates voice input for two-way communication. Works with the speaker to allow conversations between the visitor and homeowner via the mobile app.

- Omnidirectional Microphone – Captures sound from all directions equally
- Digital I2S Output – Direct digital audio output; no need for analog-to-digital conversion
- I2S Interface – Compatible with ESP32, STM32, Raspberry Pi, and other I2S-enabled boards
- MEMS Technology – Compact and reliable with low power consumption
- Low Noise & High Signal-to-Noise Ratio (SNR) – Ideal for clear voice/audio applications

Specifications:

- Microphone Type: MEMS (Digital)
- Directionality: Omnidirectional
- Interface: I2S (Serial Audio Interface)

- Supply Voltage: 3.3V DC
- Output Format: I2S, 24-bit PCM
- Frequency Response: 60 Hz – 15 kHz
- Signal-to-Noise Ratio: 61 dBA (typical)
- Sensitivity: -26 dBFS (±1 dB)
- Current Consumption: ~1.4 mA
-

7.9. 5VDC 1 Way 1 Channel Relay Module

There are isolation slots in the control zone and load zone.With power and relay action indication, it lights up when connected, and disconnects when disconnected.When the signal input has a signal, the common and common terminals will jump.

It can be used not only as a microcontroller development board module, but also as a home appliance control.It can control not only DC or AC signals, but also 220V AC loads.Has permanent opening and closing vent contact.It is convenient to connect the blue KF301 terminal access control cable.

Controls high-voltage components like the solenoid lock using signals from the ESP32. Safely switches the gate lock mechanism on/off.

Module interface:

- VCC: Connect 5V power supply positive
- GND: Connect 5v negative power supply
- IN: Relay module signal trigger terminal (active low level trigger), drive current at least 4mA

- COM: Control circuit is grounded and connected to GND

7.10. Waveshare7 inch 1024x600 HDMI IPS LCD Touch Screen for Raspberry

Used as the indoor control panel display. This touchscreen provides a visual interface for in-home users to view the live camera feed, monitor system status, receive motion alerts, and manually control gate functions. It enables interactive system management through a user-friendly GUI, offering convenience for household members without using the mobile app.

- Size: 7.0 inch
- Physical Resolution: 1024x600
- View Angles: 178 degrees IPS Screen
- Used as a Raspberry Pi display, support Raspbian, win10 IOT, free drive
- Capacitive touch screen, support for five touch.

7.11. Solenoid Door Lock 12VDC 27x15x17mm

The electromechanical gate lock that secures the entrance. Controlled remotely via fingerprint verification or mobile app commands.

- Powered form: Interrupted
- Unlock time: 1 second
- Input Current: 0.4A;DC12V
- Approximate Dimension: 27x15x17mm; Tongue Length - 7mm; Tongue Height - 10mm
- Cable Length: 120mm

7.12. BU0031-Micro Limit Switch with 10mm Roller Lever 15A 250VAC

3 terminals, applicable to AC DC control circuits. High precision mechanism design offering acute operation. Durable in use. Designed to control the movement of a mechanical part. Used in industrial control applications to automatically monitor and indicate whether the travel limits of a particular device have been exceeded.

Detects the position of the gate lock or mechanical components. Helps ensure that actions like locking or unlocking are completed successfully.

Specification:

- Material: plastic & metal

- Lever Type: 10mm Roller Lever
- Colour: black, red
- Rating: 15A, 1/2HP, 125/250VAC 0.6A, 125VDC; 0.3A, 250VDC

7.13. 3.7V 3200mA 18650 Rechargeable Battery

Serves as a backup power source, ensuring that critical modules (like the microcontroller, lock, and sensors) continue to operate during power outages. This enhances the reliability and uninterrupted functionality of the smart gate lock system.

Battery Type:18650

Battery Capacity: 3200mAh

Battery Chemistry: Li-Ion

Battery Voltage: 3.7V

Battery Terminal Type: Flat Top

Product Dimensions:18x65mm (DxH)

7.14. 8Ohm 5W Speaker 2.5 inch

This compact yet powerful speaker converts the amplified audio signal into audible sound, enabling the system to produce alerts, notifications, and voice communication effectively within the environment.

7.15. TPA3110 Digital Stereo Power Amplifier Module 2x15W HW-644 (MD0597)

This amplifier module boosts the audio signal from the DAC to a higher power level, driving the speakers with sufficient volume and clarity, which is crucial for alarms, alerts, and two-way communication.

Features:

- With this module the sound quality is very good.
- Bluetooth wireless audio input and the max receive distance is 10m.
- Applicable speaker impedance are 4/6/8/10 ohm, great for turning normal speaker into bluetooth speaker.
- Digital amplifier has a higher overload capacity than analog amplifier, and it won't cause crossover distortion, transient inter modulation distortion and you don't have to worry about the loudspeaker internal resistance.
- HW-644 TPA3110 Digital Amplifier Board only, other accessories demo in the picture is not included.

Specification:

- Amplifier Chip: TPA3110
- Working Voltage: 8-26VDC (power input with polarity protection)
- Recommended Power Supply: 12V DC 2A current
- Output Power: 2x15W
- Recommended Speaker Impedance: 4 ~ 10 Ohms
- With Mute Interface: MUTE (generally vacant)

7.16. Tactile Push Button 12*12*7.3mm

These buttons provide manual control inputs for functions such as fingerprint enrollment, system reset, or mode switching. Integrated into the control panel, they allow local user interaction with the system, especially during setup or maintenance.

- Type: Vertical
- Contact Type: Momentary Contact
- Switch Size (Approx.): 12x12x7.3mm (LxWxH)
- Button Size (Approx.): 3.8x3.8mm (LxW)
- Number of pins: 4

7.17. Raspberry Pi 5 8GB Original UK (DB0127)

The Raspberry Pi 5 8GB Original UK (DB0127) serves as the central processing unit of the smart security system, managing all control, processing, and communication tasks. Powered by a Broadcom BCM2712 quad-core 64-bit CPU running at 2.4GHz and equipped with 8GB of LPDDR4X RAM, it provides high performance for multitasking, such as handling sensor inputs, camera streaming, and mobile application backend operations. Its GPIO pins enable seamless integration with components like the PIR sensor, gate lock, fingerprint scanner, and speaker, while its USB, HDMI, CSI, and network interfaces support device connections, live monitoring, and high-speed communication. With dual-band Wi-Fi, Bluetooth 5.0, and Gigabit Ethernet, the Raspberry Pi 5 ensures reliable connectivity, making it the perfect hub for real-time control and automation in the project.

7.18. PCM5102 DAC Decoder I2S Player Module GY-PCM5102 (MD0831)

This high-performance digital-to-analog converter module processes I2S digital audio signals from the main controller and converts them into high-quality analog audio for the speaker system, ensuring clear sound output for notifications and voice communication.

This DAC Module provides a super affordable high-quality DAC for the Raspberry Pi. Since it's digital audio, it sounds really good and is much better than the onboard analog audio. The stereo jack comes soldered onto the board already.

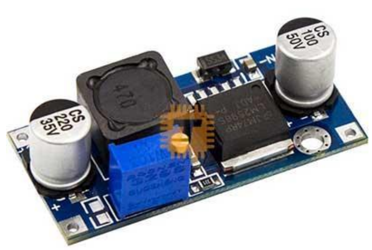
Features:

- Line out stereo jack
- pHAT format board
- Uses the PCM5102A DAC to work with the Raspberry Pi I2S interface

Specifications:

- Type:I2S DAC Decoder
- Model: PCM5102

7.19. LM2596S 3-40V to 1.5-35V 4A DC to DC Adjustable Step-Down Buck Module (MD0042)



This power regulation module efficiently steps down higher input voltages to a stable, lower voltage required by various components in the system, ensuring safe and reliable operation without overheating or damaging sensitive electronics.

- Input voltage: 4-35V
- Output Voltage: 1.5-35V (adjustable)
- Output current: rated current 2A, maximum 3A (heat sink required)

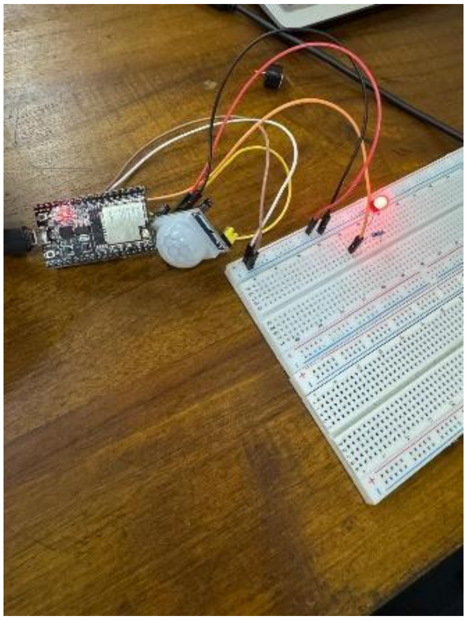
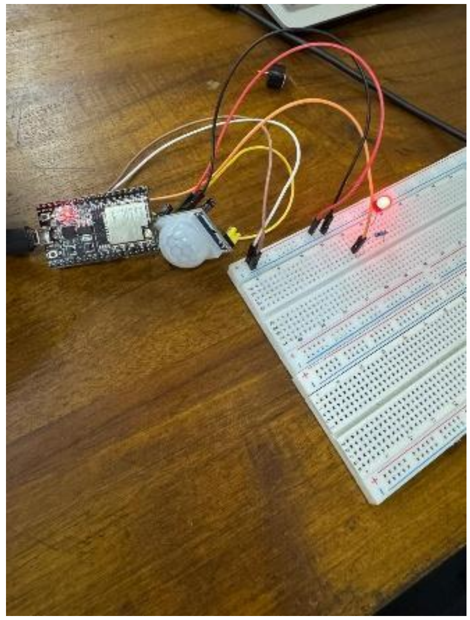
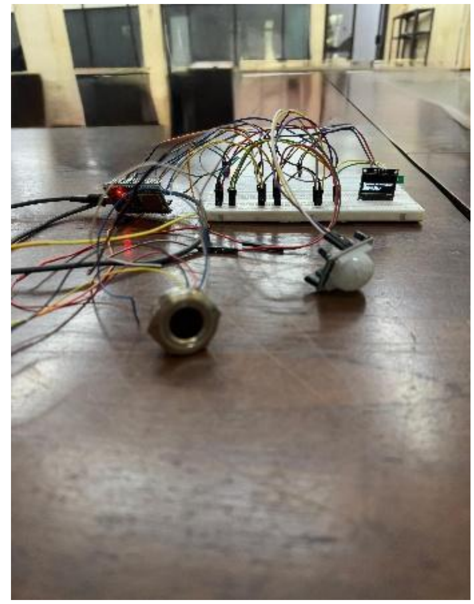
- Conversion efficiency: Up to 92% (the higher the voltage, the higher the efficiency)
- Switching Frequency: 150KHz
- Rectifier: Non-Synchronous Rectification
- Module Properties: Non-isolated step-down module (buck)
- Short circuit protection: current limiting
- Operating temperature: Industrial grade (-40 ℃ to +85 ℃) (output power 10W or less)
- Full load temperature rise: 40 ℃
- Load regulation: ± 0.5%
- Voltage regulation: ± 0.5%
- Dynamic response speed: 5 0uS

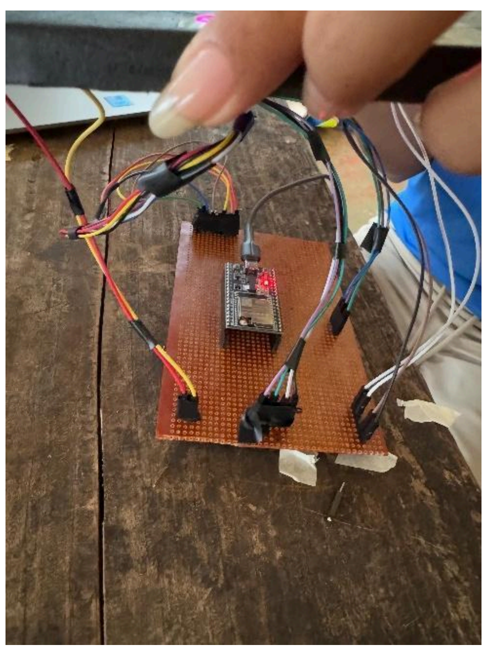
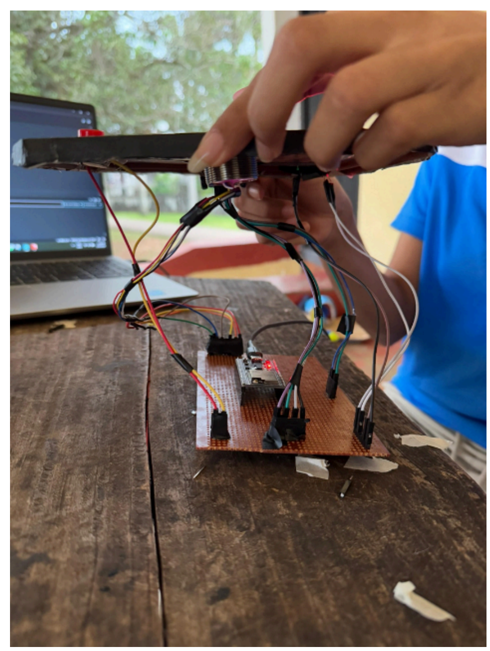
7.20.12V 5A SMPS Power Supply Metal Casing (PS0052)

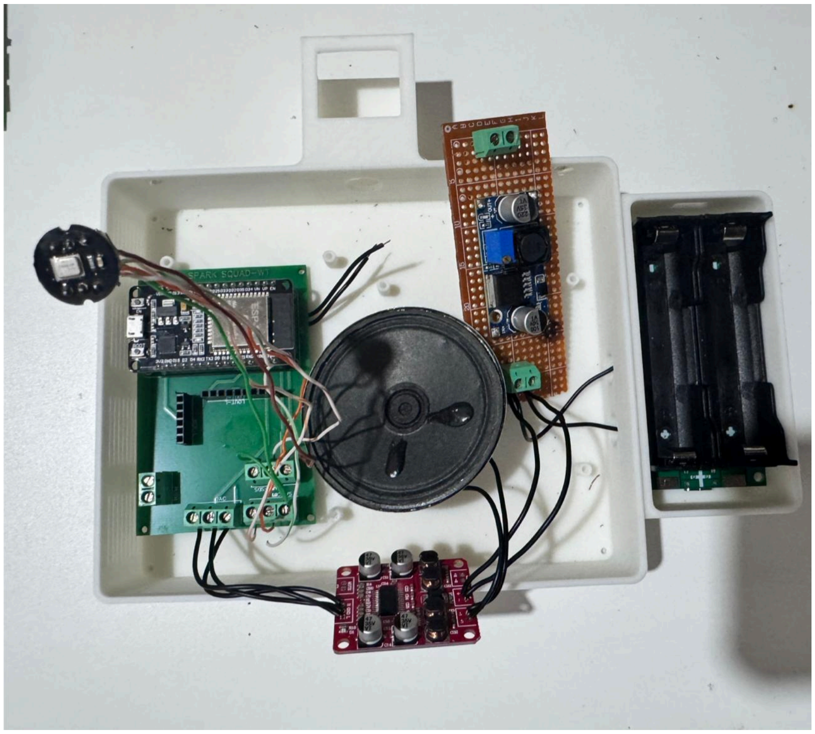
This switch-mode power supply provides a stable 12V DC output with up to 5A of current, serving as the primary power source for the system. Its efficient design and metal casing ensure durability, heat dissipation, and consistent performance, reliably powering the Raspberry Pi, sensors, and other electronic modules throughout the project.

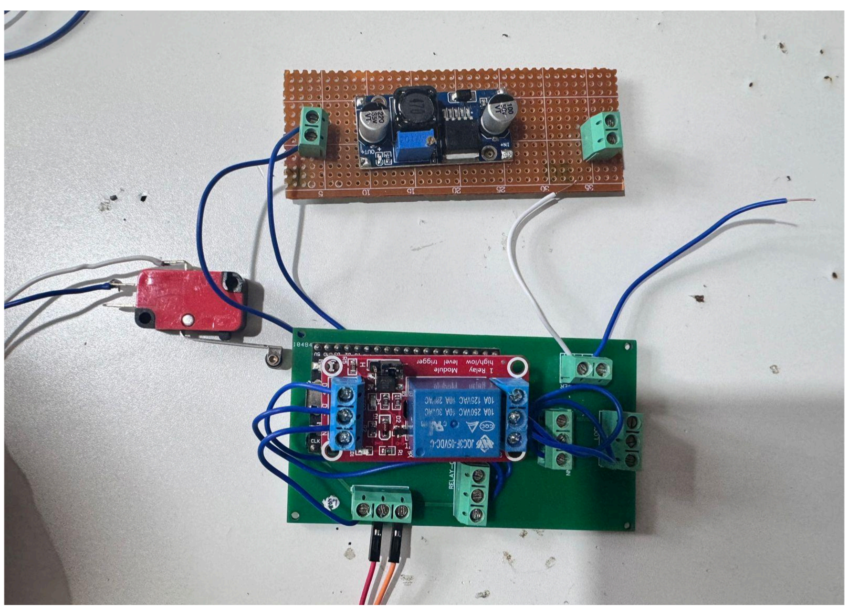
- Type: Metal Case
- Input Voltage: 230VAC
- Output Voltage: 12VDC
- Output Current: 5A (max)

8.Testing and Implementation

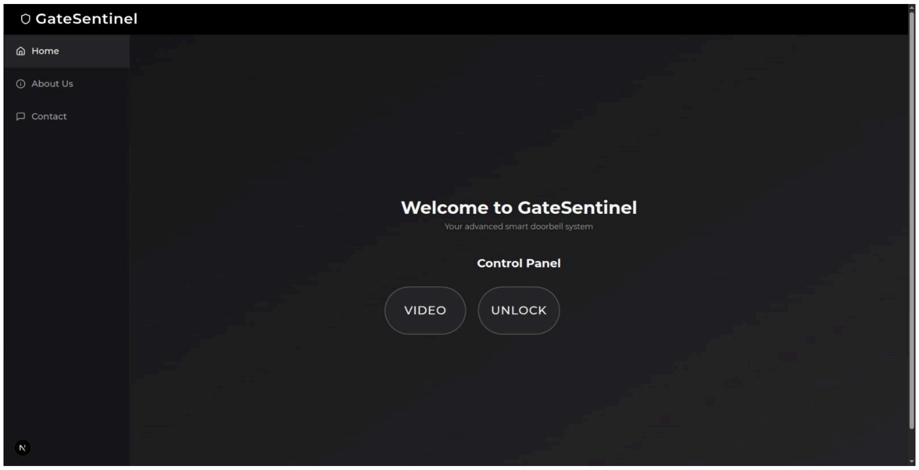




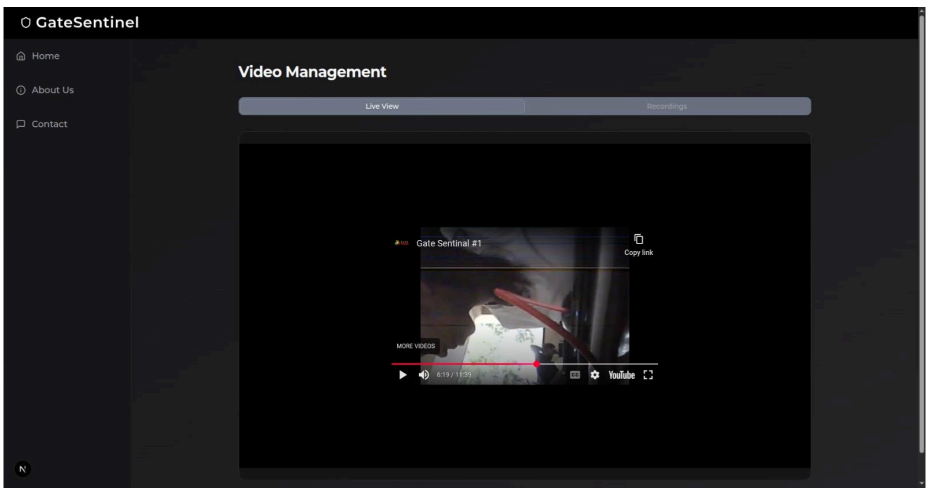


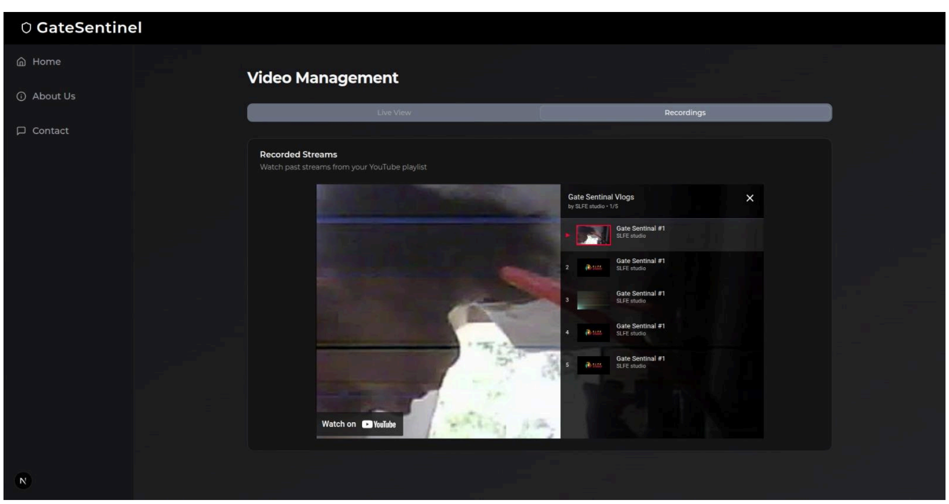


Lock System

Web App

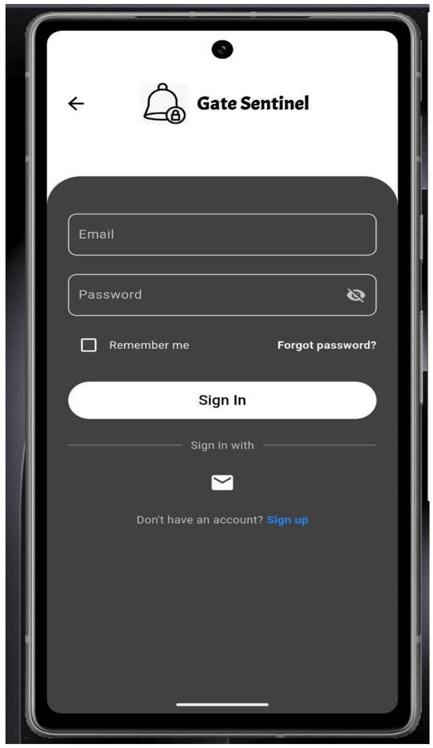

GateSentinel
Home
About Us
Contact
Welcome to GateSentinel
Your advanced smart doorbell system
Control Panel
VIDEO
UNLOCK

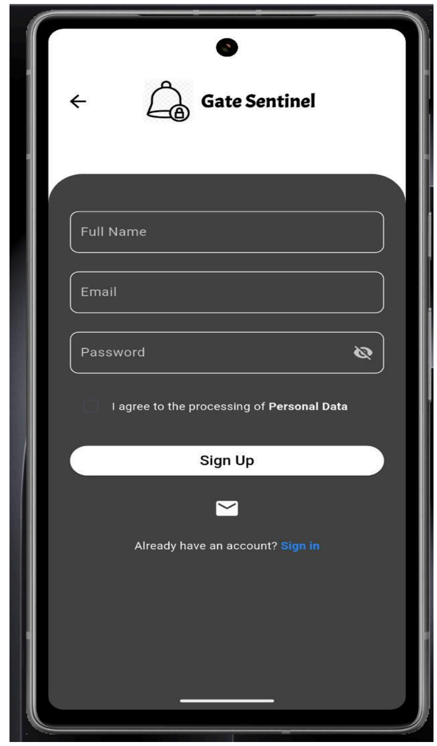

GateSentinel
Home
About Us
Contact
Video Management
Live View
Recordings
Gate Sentinal #1
Copy link
MORE VIDEOS

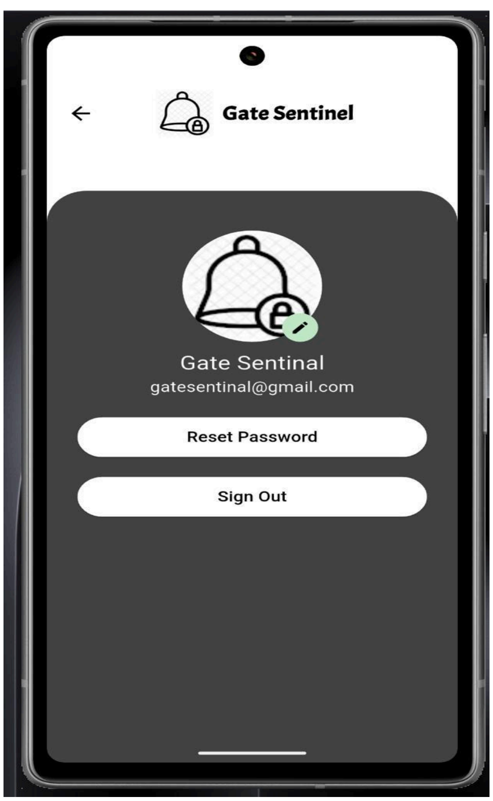

GateSentinel
Home
About Us
Contact
Video Management
Live View
Recordings
Recorded Streams
Watch past streams from your YouTube playlist
Gate Sentinal Vlogs
Gate Sentinal #1
Gate Sentinal #1
Gate Sentinal #1
Gate Sentinal #1
Gate Sentinal #1
Watch on YouTube

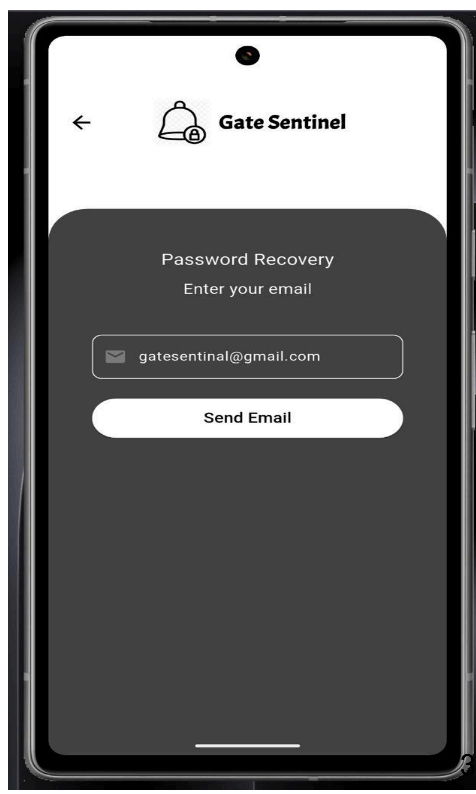
Mobile App

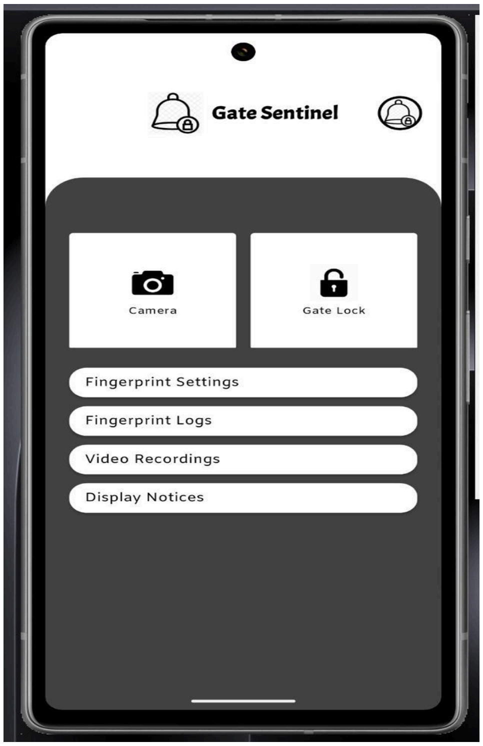

Gate Sentinel
Get Started

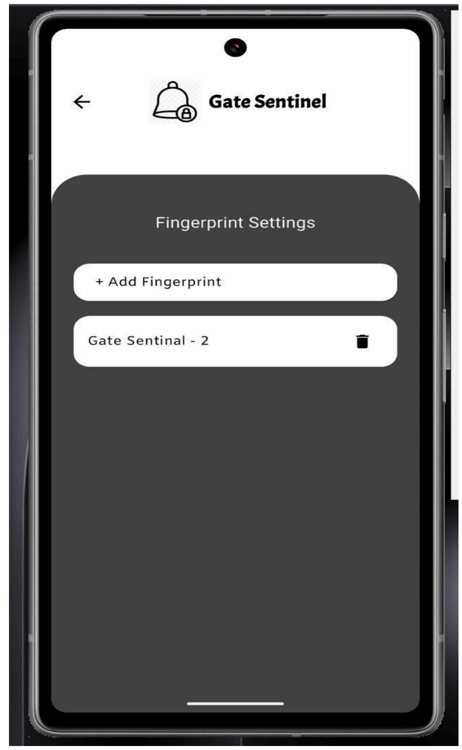

Gate Sentinel
Email
Password
Remember me
Forgot password?
Sign In
Sign in with
Don't have an account? Sign up

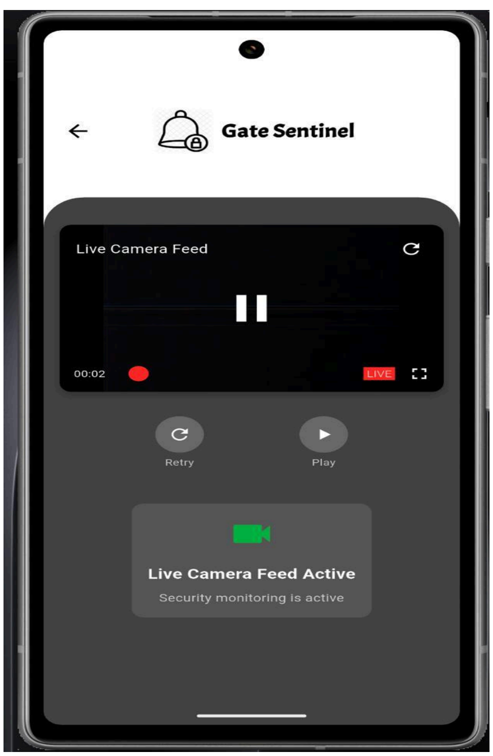

Gate Sentinel
Full Name
Email
Password
I agree to the processing of Personal Data
Sign Up
Already have an account? Sign in

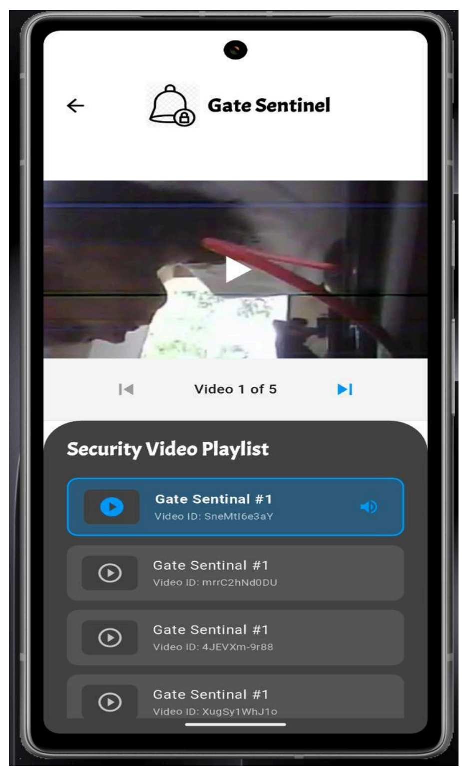

Gate Sentinel
Gate Sentinal
gatesentinal@gmail.com
Reset Password
Sign Out


Gate Sentinel
Password Recovery
Enter your email
gatesentinal@gmail.com
Send Email


Gate Sentinel
Camera
Gate Lock
Fingerprint Settings
Fingerprint Logs
Video Recordings
Display Notices


Gate Sentinel
Fingerprint Settings
+ Add Fingerprint
Gate Sentinal - 2


Gate Sentinel
Live Camera Feed
00:02
LIVE
Retry
Play
Live Camera Feed Active
Security monitoring is active


Gate Sentinel
Video 1 of 5
Security Video Playlist
Gate Sentinal #1
Video ID: SneMtI6e3aY
Gate Sentinal #1
Video ID: mrrC2hNd0DU
Gate Sentinal #1
Video ID: 4JEVXm-9r88
Gate Sentinal #1
Video ID: XugSy1WhJ1o

9.Cost Estimation

Component	Unit Price(LKR)	Units	Total Price(LKR)
NodeMCU ESP32-WROOM-32 Wi-Fi Bluetooth	1250.00	4	5000.00
1.5 inch 128*128 OLED Display Module	1528.00	1	1528.00
HC-SR501 PIR Sensor Module for Arduino	560.00	1	560.00
TZT Type-C 15W 3A Fast Charge ups power supply	929.90	3	2789.70
R503 Fingerprint Identification Circular Capacitive Fingerprint Module	6650.00	1	6650.00
ESP32-S Camera	2200.00	1	2200.00
INMP441 Omnidirectional Microphone Module I2S Interface MEMS	840.00	2	1680.00s
MD0486-5VDC 1 Way Channel Relay Module (Transistor version)	130.00	1	130.00
BU0031-Micro Limit Switch with 10mm Roller Lever 15A 250VAC	100.00	1	100.00
RL0018-Solenoid Door Lock 12VDC 53*26*23mm	1270.00	1	1270.00
Adjustable Door Closer	1780.00	1	1780.00
12V/5A Power Supply	1250.00	1	1250.00
3.7V 3200mA 18650 Rechargeable Battery	530.00	6	318 0.00
Micro HDMI to HDMI cable	800.00	1	800.00
Waveshare7 inch 1024x600 HDMI IPS LCD Touch Screen for Raspberry	15 850.00	1	15 850.00
8 Ohm 5W speaker 2.5 inch for portable amplifiers	180.00	2	360.00

Tactile button cap red colour 12*12*7.3mm	10.00	2	20.00
Tactile Push Button 12*12*7.3mm	20.00	2	40.00
LM2596S 3-40V to 1.5-35V 4A DC to DC Adjustable Step-Down Buck Module (MD0042)	180.00	2	360.00
NodeMCU ESP32 Wi-Fi Bluetooth Dual Mode IoT Dev Board	1100.00	2	2200.00
Solder Wire Lead Roll 60/40 0.8mm per meter (TA0159)	60.00	1	60.00
BA033T 3.3V Voltage Regulator THT (IC0008)	150.00	2	300.00
PCM5102 DAC Decoder I2S Player Module GY-PCM5102 (MD0831)	850.00	1	850.00
TPA3110 Digital Stereo Power Amplifier Module 2x15W HW-644 (MD0597)	390.00	2	780.00
5.08mm Pitch 2-Pin 2-way Screw Terminal Block PCB Mount (TB0009)	20.00	4	80.00
5.08mm Pitch 3-Pin 3-way Screw Terminal Block PCB Mount	30.00	3	90.00
MIC29302WU Low Drop-out Regulators (IC0058)	120.00	2	240.00
PCB			12500.00
3D Printing			21700.00
Total			84 347.70

10.Individual Distribution

234097M - Jayathilaka G. D. T. U.

- Integrating the camera.
- Set up Raspberry Pi and touch screen.
- Develop the web.

As a key contributor to the Advanced Smart Gate Lock System, my work spanned both hardware integration and software development, ensuring seamless functionality and a user-friendly experience. My main responsibilities revolved around integrating the camera module, configuring the Raspberry Pi, and setting up the touchscreen interface, alongside leading the development of the system's web application.

A major aspect of my role was the integration of the ESP32-CAM into the gate security system, which acts as a crucial visual monitoring component. I worked on streaming the camera feed to the Raspberry Pi 5, where it was further processed and relayed to platforms such as YouTube Live for remote access. This required configuring FFmpeg for video encoding (H.264), optimizing frame rates and resolution, and ensuring minimal latency for real-time monitoring.

In addition to the camera, I set up the Raspberry Pi as the system's central controller for the visual and web-based features. This included installing and configuring the operating system, enabling necessary interfaces, and integrating the Pi with the touchscreen module. The touchscreen interface was designed for local control, providing users with an intuitive way to view the camera feed, access gate control features without needing a mobile device.

On the software side, I contributed significantly to web application development. My focus was on creating a responsive and secure interface that allows users to view live video, manage access control remotely. I worked on integrating fireball real-time database to the web app to control the gate lock system.

Throughout the project, I participated in system integration testing, making sure the camera, Raspberry Pi, touchscreen, and web platform functioned as a cohesive unit. My contributions directly enhanced the system's usability, visual monitoring capabilities, and overall accessibility for users.

234040J - Chandupa K. T.

- Worked on the fingerprint sensor.
- Set up the camera to ensure smooth functionality.
- Set up the OLED display.
- Design the PCB layout.

As a member of the Advanced Smart Gate Lock System team, I was responsible for several core components that enabled secure access, visual feedback, and reliable hardware design. My main contributions involved configuring the fingerprint sensor, setting up the OLED display, optimizing camera performance, and designing the PCB layout that tied the entire hardware system together.

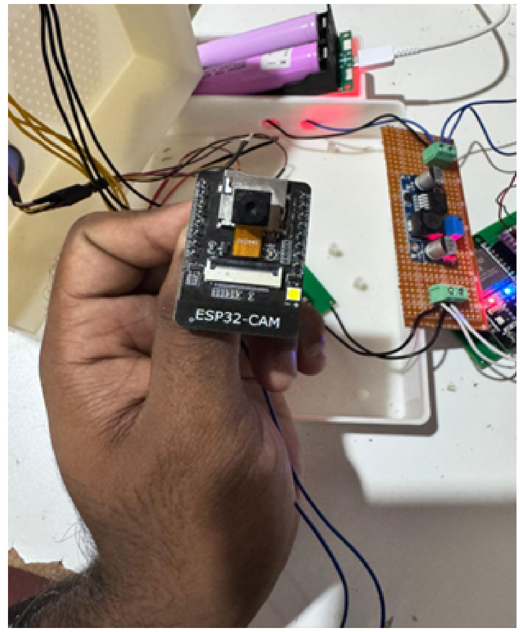
A critical task I undertook was integrating the fingerprint sensor, one of the system's primary authentication methods. I worked on connecting it to the main controller, calibrating it for accurate biometric matching, and configuring both the enrolment and verification processes. I also tested the sensor extensively to ensure it could handle varying finger placements and environmental conditions without reducing accuracy.Also I worked on the appearance aspect of the fingerprint sensor by adding different colors to different modes.

I played a key role in setting up the OLED display, which serves as a local interface for providing status updates and feedback to the user. I configured the display to show important system messages such as access granted/denied notifications, device status, and operational prompts. This required coding display logic that was both efficient and visually clear.

In addition, I contributed to the camera setup by fine-tuning its placement, focus, and resolution to ensure clear visual capture for security monitoring. This optimization was important to ensure that the live feed remained stable and high-quality in various lighting conditions.

One of my most technical tasks was designing the PCB layout for the smart gate lock system. Using PCB design software EasyEDA , I arranged components to minimize noise, improve signal integrity, and ensure stable power delivery. The design had to be space-efficient yet robust, allowing for easy assembly and future maintenance. I supported the fabrication process and validated the assembled board against the original schematic to confirm reliability.

My contributions were instrumental in creating a secure, efficient, and well-designed hardware foundation for the project.



234175C - Ranathunga I. V. S.

- Worked on the communication system between the outdoor and indoor panels.
- Contributed by handling microphone and speaker.
- Worked with voltage regulator and low drop-out regulator.
- Setup digital stereo power amplifier.
- Develop the mobile application.

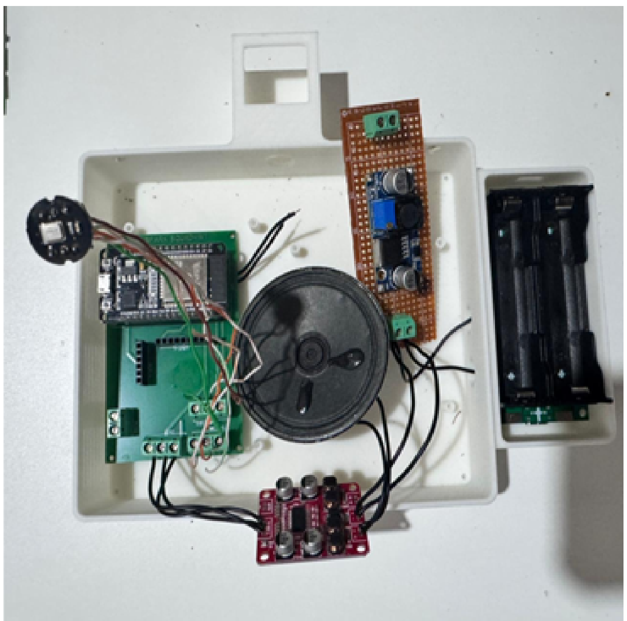
As a committed member of the Advanced Smart Gate Lock System team, I contributed to both the audio communication features and the system's power management. My work primarily focused on integrating the microphone and speaker modules, configuring voltage regulation components, setting up the digital stereo power amplifier, and contributing to the development of the mobile application.

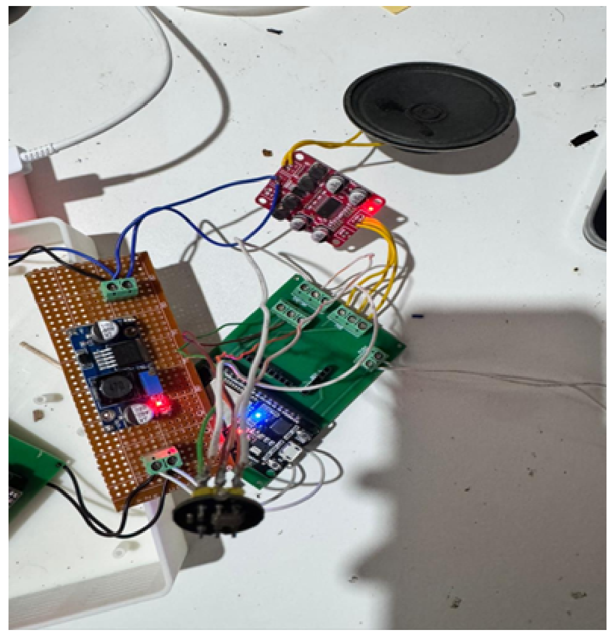
One of my main tasks was handling the microphone and speaker setup to enable two-way voice communication between the visitor and the homeowner through the mobile app. I worked with the INMP441 I2S microphone and ensured its seamless integration with the ESP32 microcontroller, while fine-tuning it for clear audio capture with minimal noise. I paired it with the speaker module, configuring the system for balanced audio input and output to provide smooth, real-time communication.

I also worked extensively with power management components, specifically the voltage regulator and low drop-out (LDO) regulator, to ensure stable and noise-free power delivery to sensitive modules such as the audio system. Proper voltage control was crucial for preventing malfunctions and preserving sound clarity, so I conducted multiple load tests to verify consistent performance.

To enhance audio output quality, I set up the digital stereo power amplifier, calibrating gain levels to deliver clear and distortion-free sound. This was particularly important for making voices easily audible on the homeowner’s side, even in noisy outdoor environments.

In addition to hardware work, I played an active role in developing the mobile application. I worked on integrating audio streaming capabilities, real-time status updates, and gate control functions into the app. This ensured that users could monitor, communicate, and operate the gate remotely with ease.





234218M – Warnasinghe M.N.O.

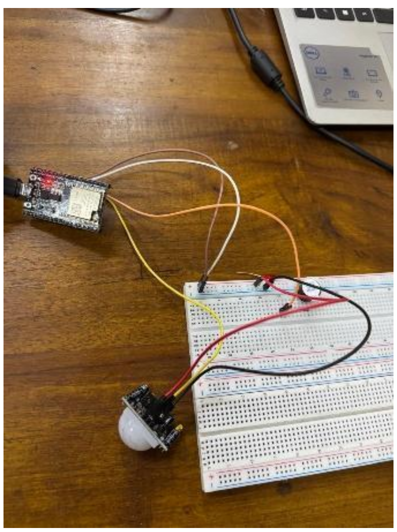
- Focused on setting up the PIR sensor.
- Integrating the UPS power supply into the system
- Use buck converters to reduce the UPS voltage.

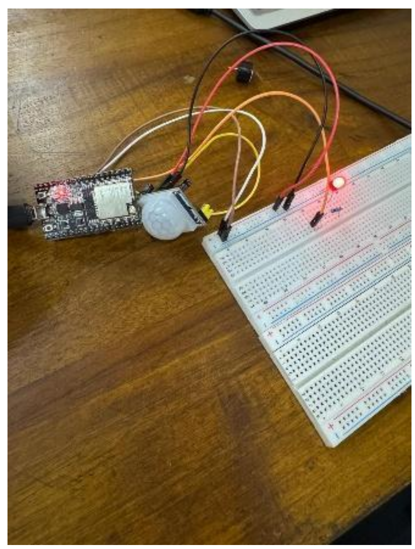
I was responsible for integrating the HC-SR501 Passive Infrared (PIR) sensor into our smart security system to enable reliable motion detection. The PIR sensor works by detecting changes in infrared radiation emitted by moving objects, primarily humans, using a pyroelectric element and a Fresnel lens. This allows the sensor to act as a passive trigger, providing low-power and continuous monitoring suitable for battery-operated systems.

For integration, I physically mounted the sensor near the gate area to cover the main entry path and connected it to the microcontroller via the GPIO pins. I implemented software logic to continuously read the sensor output, distinguish between motion and no-motion states, and record motion events. To prevent false or repeated triggers, I added a software-based 11-second reset timer, ensuring that each motion was counted only once within the reset period.

Additionally, I developed the monitoring logic to track the number of motion events within a one-minute window. If motion occurred a specified number of times, the system would generate an alert, providing the basis for further automated actions. I also handled the logging of real-time motion and no-motion messages to the serial monitor, which helped in debugging and verifying sensor performance during testing.

The PIR sensor was selected over other motion detection alternatives such as ultrasonic or microwave sensors due to its cost-effectiveness, low power consumption, simplicity, and reliability. Through this integration, I ensured that the system could passively and accurately detect human presence, forming a crucial component of the overall security and automation functionality.





One of my major responsibilities in this project was to design and integrate the power supply and voltage regulation system, which serves as the backbone of the entire setup. Since our system requires different DC voltages for components such as the Raspberry Pi, sensors, relays, and display modules, I implemented a reliable two-stage power system.

The process begins with the TZT Type-C 15W 3A Fast Charge UPS Power Supply Module, which I connected directly to the 230V AC mains. This UPS module converts the high-voltage AC into a regulated 12V DC output while simultaneously charging two 3.7V 3200mAh 18650 lithium-ion batteries. These batteries provide backup power during mains failure, ensuring uninterrupted operation of the system. The UPS also features integrated charging management, overcharge/discharge protection, and automatic switching between AC and battery power, which eliminates the need for manual intervention.

Once the 12V DC was supplied from the UPS, I integrated the LM2596S DC–DC Buck Converter as the second stage of regulation. This converter steps down the 12V DC to the specific voltages required by each module, such as 5V for the Raspberry Pi and sensors and 3.3V for low-voltage components. During integration, I carefully calibrated the output voltage using the onboard potentiometer to match the voltage requirements of our devices. I also tested the stability of the output under different load conditions to make sure sensitive components were not exposed to voltage fluctuations.

The integration process required proper wiring and isolation. I routed the UPS output into the buck converter input, then distributed the buck outputs to the respective components in the system. To ensure safety and efficiency, I added appropriate connectors and checked polarity before finalizing the wiring. Furthermore, I monitored current draw from the modules to confirm that both the UPS and buck converter could handle the load without overheating.

Through this power design, the system is able to operate reliably, even during power interruptions, while ensuring each component receives the correct voltage and current. This integration of the UPS and buck converter not only stabilized the power supply but also enhanced the overall safety, efficiency, and continuity of the project.

234028F - Bandara D. M. P. M.

- Worked on the gate lock.
- Setup the relay module and limit switch.
- Develop the web.

As a member of the Advanced Smart Gate Lock System team, my focus was on the physical gate locking mechanism and its seamless integration with the system's web-based control platform. My main responsibilities included setting up the gate lock, configuring the relay module and limit switch, and contributing to the development of the web interface.

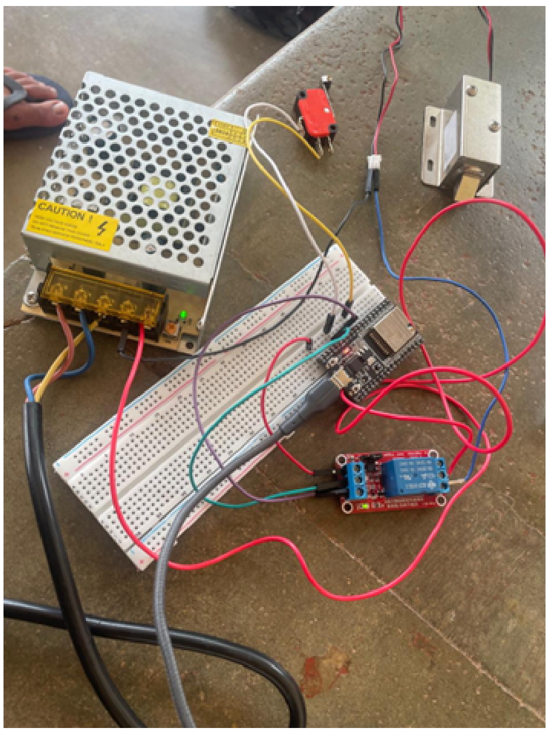
I began with the installation and configuration of the electronic gate lock, ensuring that it was mounted securely and aligned for smooth locking and unlocking operations. To control it electronically, I set up the relay module as the main switching mechanism. This allowed the microcontroller to trigger the lock based on commands from both the web interface and mobile application.

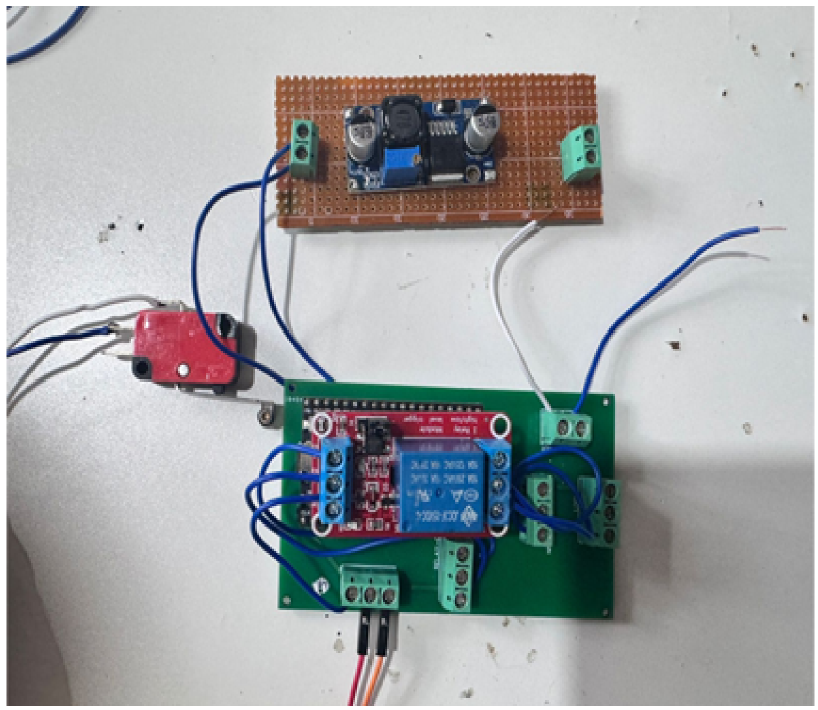
Also I focused on the communication between the ESP32 that operates the lock and the main system, first we used wifi communication and then we shifted it to firebase for communication.

For real-time gate status monitoring, I integrated a limit switch to detect whether the gate was open or closed. I tested it extensively to ensure accurate readings under various conditions, helping prevent incorrect status updates or malfunctioning control commands.

On the software side, I contributed to the development of the web platform, creating a user-friendly interface for remote gate operation. This interface allowed users to unlock the gate, view its status, and manage access logs from any device with an internet connection.

My contributions helped ensure that the system's physical access control was secure, reliable, and easily manageable through a responsive online platform.





10.Codes

https://github.com/Vineth-R/GateSentinal_Arduino.git

11.References

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