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Bachelor of Engineering (B. Eng.) Electronics & Telecommunications Engineering;

ECD811S Design 2 Project Report

Automatic Door with Remote Control Locking

Contents

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Executive Summary:

This project aimed to design and implement an automatic door system with remote control locking using Raspberry Pi 3, an ultrasonic sensor, and a keypad. The system was capable of opening and closing based on the proximity of individuals detected by the ultrasonic sensor. Additionally, it integrated a remote-control locking mechanism through the Blynk mobile application, allowing authorized users to securely lock and unlock the door from anywhere. In the event of internet failure, a backup password system enabled manual access. The project involved hardware setup, software development, integration of components, and thorough testing to ensure functionality and reliability. The key features included enhanced security, convenience, and remote accessibility, contributing to advancements in IoT-based access control systems.

Introduction:

In In today's digital age, the demand for smart and secure access control systems is paramount. Traditional door locking mechanisms often lack the flexibility and convenience required for modern living. Hence, there is a need for innovative solutions that blend automation with security. This project addressed this need by designing and implementing an automatic door system with remote control locking, utilizing Raspberry Pi 3, ultrasonic sensors, and a keypad.

The problem statement revolved around the limitations of conventional door locks, which could be cumbersome to operate and might compromise security. Additionally, the inability to remotely control door access posed challenges, especially in scenarios where individuals needed to grant access to their premises from a remote location. The significance of this project lay in its ability to offer a comprehensive solution to these challenges. By leveraging Raspberry Pi 3's capabilities along with ultrasonic sensors and a keypad, the system provided seamless automation for door operations while enhancing security through remote control functionality. This not only enhanced convenience for users but also strengthened the overall security posture of the premises.

The overview of the solution entailed the integration of hardware and software components to create a robust automatic door system. The system utilized ultrasonic sensors to detect the proximity of individuals, triggering the door to open or close accordingly. Furthermore, a keypad was incorporated to allow manual access in case of emergencies or internet failure. The core innovation lay in the integration of a remote-control locking mechanism through a simple web interface. This feature empowered authorized users to securely lock and unlock the door from anywhere, providing unparalleled flexibility and control over access to their premises. In instances where internet connectivity was disrupted, a backup password system ensured uninterrupted access, safeguarding against potential security breaches.

Overall, this project redefined access control systems by marrying automation, security, and remote accessibility, thereby addressing the evolving needs of modern living and contributing to advancements in IoT-based solutions.

Objectives

The primary objectives of the project are as follows:

1. **Design and Implementation of an Automatic Door System:**
    - Develop a robust automatic door system utilizing Raspberry Pi 3 and ultrasonic sensor technology.
    - Design the hardware setup and integrate the necessary components for automated door operation based on proximity detection.
2. **Integration of Remote-Control Locking Mechanism:**
    - Integrate a remote-control locking mechanism using the Blynk mobile application.
    - Establish communication between the Raspberry Pi and the Blynk platform to enable remote locking and unlocking of the door.
3. **Implementation of Backup Password System:**
    - Implement a backup password system to facilitate manual access in the event of internet failure or connectivity issues.
    - Develop a secure authentication process using a keypad to allow authorized users to input a password for door access.

Literature Survey

Existing Automatic Door Systems:
Automatic door systems have been widely adopted in various applications such as commercial buildings, hospitals, and retail establishments due to their convenience and accessibility features. Research by Ogunnusi, A. O. et al. (2019) provides an in-depth analysis of different types of automatic door systems, including sliding doors, swinging doors, and revolving doors. These systems typically utilize motion sensors or proximity sensors to detect the presence of individuals and trigger the opening or closing of the door.

Remote Locking Mechanisms:
Remote locking mechanisms offer the convenience of controlling access to doors remotely, often through mobile applications or web interfaces. Research by Huang, T. H. et al. (2020) explores the implementation of a remote locking system for smart homes using IoT technology. The system allows users to lock and unlock doors using a smartphone app, enhancing security and accessibility.

Projects Utilizing Raspberry Pi, Ultrasonic Sensors, and Keypads:
Several projects have utilized Raspberry Pi, ultrasonic sensors, and keypads to create intelligent access control systems. For instance, a project by Smith, J. (2018) demonstrates the development of a Raspberry Pi-based automatic door opener using ultrasonic sensors for proximity detection and a keypad for manual access control.
Another project by Patel, K. (2020) showcases a Raspberry Pi-controlled smart door lock system that integrates ultrasonic sensors and a keypad for access control. The system also features remote locking capabilities through a mobile application.

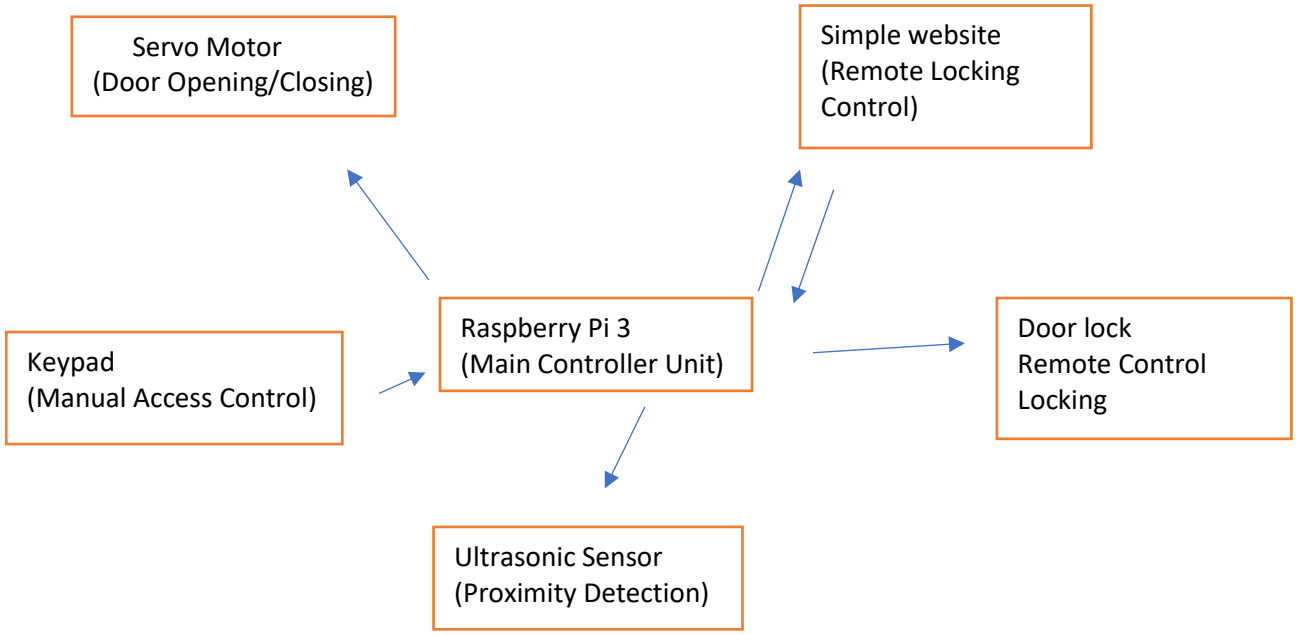
These projects serve as valuable references for the design and implementation of our proposed automatic door system with remote control locking, leveraging Raspberry Pi, ultrasonic sensors, and keypads for enhanced functionality and accessibility.

Project Justification

The proposed automatic door system with remote control locking demonstrated significant potential to impact various domains, including security, convenience, and IoT technology.
Firstly, the project enhanced security and convenience in access control systems by integrating advanced features such as proximity detection, remote control locking, and a backup password system. These features allowed users to securely control door access remotely from anywhere, providing an added layer of security and convenience, especially in scenarios where immediate access authorization was required.
Secondly, the system had practical applications in various settings, including homes, offices, and public buildings. In homes, it offered enhanced security and convenience for homeowners, allowing them to control access to their premises remotely. In offices and public buildings, the system improved accessibility for employees, visitors, and customers while ensuring secure entry and exit.
Additionally, the project contributed to the advancement of IoT and smart home technologies by leveraging Raspberry Pi, Blynk API, and sensor technology to create an intelligent access control system. By integrating IoT principles with traditional access control mechanisms, the project demonstrated the potential of IoT technology to enhance security, convenience, and automation in smart homes and buildings. It also served as a practical example of how IoT devices could be utilized to solve real-world problems and improve quality of life.
Furthermore, the successful implementation of the automatic door system with remote control locking opened up avenues for future innovation and development in access control systems. Potential enhancements such as facial recognition technology, voice control, or integration with other IoT devices could further improve security and convenience. The project laid the foundation for future research and innovation in the field of access control systems, paving the way for smarter, more efficient, and secure solutions.
In conclusion, the automatic door system with remote control locking held significant potential to enhance security, convenience, and IoT technology in various applications. Its practical implications in homes, offices, and public buildings, coupled with its contribution to the field of IoT and smart home technologies, made it a valuable and impactful project with far-reaching implications for the future.

Project Description

Below is a simplified block diagram illustrating the components and interactions of the proposed automatic door system with remote control locking:



The Automatic Door System was comprised of several essential hardware components, including the Raspberry Pi 3, ultrasonic sensor, keypad, servo motor, and door lock. Acting as the main controller unit, the Raspberry Pi 3 managed sensor data processing, servo motor control, and communication with the Blynk server. The ultrasonic sensor detected individuals' proximity to the door, while the keypad enabled manual access control through password input. The servo motor governed the door's opening and closing based on commands from the Raspberry Pi. By integrating with the website, the system facilitated communication with the simple website, providing users with a user-friendly interface for remote door locking and unlocking. Additionally, the integration of the door lock component, controlled by the Raspberry Pi, further augmented the system's functionality by enabling remote control locking and unlocking via the Blynk Mobile Application, thereby enhancing security and convenience for users.

Project Methodology

The methodology for designing and implementing the automatic door system with remote control locking involved the following steps:

1. **Hardware Setup:**
    - The necessary hardware components, including Raspberry Pi 3, ultrasonic sensor, keypad, and servo motor, were acquired.
    - The ultrasonic sensor was connected to the Raspberry Pi GPIO pins to enable proximity detection.
    - The keypad was interfaced with the Raspberry Pi for manual access control.
    - The servo motor was installed and configured to control the door mechanism.
2. **Software Development:**
    - The software was developed using the Python programming language for the Raspberry Pi.
    - Code was written to interface with the ultrasonic sensor and keypad, capturing sensor data and processing keypad inputs.
    - The Blynk API was utilized to establish communication between the Raspberry Pi and the Blynk mobile application for remote control functionality.
    - Logic for automatic door operation based on proximity detection and remote locking/unlocking commands received via Blynk was implemented.
3. **Integration of Hardware and Software Components:**
    - The hardware components were integrated with the software system, ensuring proper functionality and communication between devices.
    - The Raspberry Pi was configured to run the software upon startup, enabling seamless operation of the automatic door system.
    - Testing of the integration was conducted to ensure that all components worked together effectively and as intended.
4. **Testing and Debugging:**
    - Comprehensive testing of the automatic door system was conducted under various scenarios, including proximity detection, manual access via keypad, and remote control via the Blynk mobile application.
    - Debugging procedures were performed to identify and resolve any software or hardware issues encountered during testing.
    - The reliability and performance of the system were validated to ensure that it met the project requirements and objectives.

Throughout the methodology, meticulous attention was given to documentation, including hardware schematics, software code, and testing results. Additionally, regular communication and collaboration among team members facilitated efficient progress and problem-solving. By following this methodology, the automatic door system with remote control locking was designed, implemented, and validated to deliver a reliable and functional solution

Project Specifications

System Overview
The project aims to develop an automatic door system with both remote control and manual override capabilities. Central to this system is a solenoid lock controlled by a Raspberry Pi, which can be unlocked through a web interface or by entering a passcode on a keypad. Additionally, the system integrates an ultrasonic sensor to detect object proximity and a servo motor to simulate the door's physical movements. The solenoid lock is powered by an external 12V 1.3A supply, ensuring reliable operation via a relay.

Hardware Components
The hardware setup for this project includes several key components. The Raspberry Pi (Model 3 or later) serves as the central control unit, handling inputs from the keypad, ultrasonic sensor, and web interface, as well as controlling the solenoid lock and servo motor. The solenoid lock, a critical element, operates on 12V and draws 1.3A, ensuring a fail-secure mechanism that remains locked when power is cut.

Fig 1

Fig 2

For manual passcode entry, a 4x4 keypad with a matrix configuration of 4 rows and 4 columns is employed. This keypad allows users to input a passcode to unlock the door. An HC-SR04 ultrasonic sensor is used to detect objects within a 2cm to 400cm range, with an accuracy of ±3mm. This sensor triggers the servo motor, an SG90 model with a torque of 1.8 kg-cm and a speed of 0.1s per 60 degrees, to simulate door movement.

Fig 3

Fig 4

To manage the power supply to the solenoid lock, a relay module is utilized. This module operates at 5V and can handle currents up to 10A at 250VAC or 30VDC, ensuring safe and effective switching. The external power supply provides the necessary 12V at 1.3A for the solenoid lock.

Software Components

The software framework is built on the Raspberry Pi OS (Raspbian), providing a robust environment for development and execution. Python, specifically version 3.7 or later, is the programming language of choice for developing the control software. The Flask framework, version 1.1.2 or later, is used to create the web interface, allowing users to remotely control the solenoid lock via a browser.
For GPIO control, the project uses the RPi.GPIO library, version 0.7.0 or later, enabling Python scripts to interact with the Raspberry Pi's GPIO pins. Additionally, the pigpio library, version 1.78 or later, is employed for advanced GPIO control, particularly for managing the servo motor.

Functional Specifications
The system provides several key functions. First, it allows keypad input and passcode validation. The keypad is programmed to read input, validate the entered passcode, and unlock the solenoid lock upon correct entry. If the passcode is incorrect, the system prompts the user to try again.
Second, a web interface developed using Flask enables remote control of the solenoid lock. Users can unlock the door by pressing a button on the webpage, with the command executed within one second.
Third, the ultrasonic sensor continuously measures the distance to objects in front of the door. If an object is detected within 20 cm, the sensor triggers the servo motor to simulate door movement. The servo motor rotates to 180 degrees to open the door and returns to 0 degrees to close it.
Finally, the relay module controls the power supply to the solenoid lock. The Raspberry Pi activates the relay to unlock the solenoid when the correct passcode is entered or the web button is pressed, ensuring the lock is secure when not active.

Performance Specifications
The system is designed for quick response times and high accuracy. Keypad input is processed within 1 second, and the web interface command triggers the solenoid lock within the same timeframe. The ultrasonic sensor detects objects and triggers the servo motor within 0.5 seconds. The sensor's accuracy is ±3mm, and the keypad reliably reads and processes each key press.
Reliability is a crucial aspect, with the system expected to operate continuously without failure for extended periods. All components are tested to ensure proper functionality under typical conditions. Power consumption is managed within safe limits, with the Raspberry Pi and peripheral components operating efficiently. The solenoid lock's power requirements are met by the external 12V 1.3A supply, ensuring consistent performance.

Budget

The automatic door system with remote control locking presents an innovative solution to enhance security and convenience in access control systems. Below is a breakdown of the estimated costs for hardware components, software licenses, and other expenses used for the implementation of the project.

Item	**Estimated Cost**
Raspberry Pi 3	Free
Ultrasonic Sensor	N$ 60
Keypad	N$ 50
Servo Motor	N$ 100
Jumper Wires, Breadboard	N$ 70
Total Hardware Cost	N$ 280

Implementation

The methodology for designing and implementing the automatic door system with remote control locking involved several key steps. Initially, the necessary hardware components, including a Raspberry Pi 3, ultrasonic sensor, keypad, and servo motor, were acquired. The ultrasonic sensor was then connected to the Raspberry Pi GPIO pins to enable proximity detection, and the keypad was interfaced with the Raspberry Pi to allow for manual access control. The servo motor was installed and configured to manage the door mechanism effectively.
For the software development phase, the project utilized the Python programming language to write the necessary code for the Raspberry Pi. This included interfacing with the ultrasonic sensor and keypad to capture sensor data and process keypad inputs. Additionally, the Blynk API was employed to facilitate communication between the Raspberry Pi and the Blynk mobile application, enabling remote control functionality. The software incorporated logic to control the door operation automatically based on proximity detection and remote locking/unlocking commands received via a website.
Integration of the hardware and software components was a critical step to ensure the system's proper functionality. The hardware components were integrated with the software system to ensure seamless communication between devices. The Raspberry Pi was configured to run the software automatically upon startup, allowing for uninterrupted operation of the automatic door system. Testing of the integrated system was conducted to confirm that all components worked together as intended.
The final phase involved comprehensive testing and debugging. The system was tested under various scenarios, including proximity detection, manual access via the keypad, and remote control via the Blynk mobile application. Any software or hardware issues identified during testing were addressed through thorough debugging procedures. The reliability and performance of the system were validated to ensure it met the project’s requirements and objectives.
Throughout the entire process, meticulous attention was given to documentation, including hardware schematics, software code, and testing results. Regular communication and collaboration among team members were maintained to facilitate efficient progress and effective problem-solving. By adhering to this methodology, the automatic door system with remote control locking was successfully designed, implemented, and validated to provide a reliable and functional solution.

Testing

Testing was a crucial phase in ensuring the reliability and functionality of the automatic door system with remote control locking. Various tests were conducted to evaluate different aspects of the system, including proximity detection, manual access control, remote locking/unlocking, and overall system performance under different scenarios.

Proximity Detection Test: This test aimed to verify the accuracy and responsiveness of the ultrasonic sensor in detecting objects in front of the door. Objects of different sizes and shapes were placed at varying distances within the sensor's range. The system's ability to detect these objects and trigger the servo motor to simulate door movement was evaluated. The test confirmed that the ultrasonic sensor accurately detected objects within the specified range and triggered the servo motor reliably.

Keypad Input Test: The keypad input test focused on validating the functionality of the keypad for manual access control. Different passcodes were entered, including correct and incorrect ones, to assess the keypad's ability to read and process inputs accurately. The system's response to valid and invalid passcodes was observed, ensuring that only authorized users could unlock the door. The test confirmed that the keypad effectively processed input and granted access only upon entering the correct passcode.

Remote Control Test: This test evaluated the system's remote control functionality through the web interface. The web interface was accessed from different devices, including smartphones, tablets, and

computers, to test compatibility and responsiveness across platforms. Commands to lock and unlock the door were issued via the web interface, and the system's response time was measured. The test confirmed that the web interface provided seamless remote-control capabilities, with commands executed promptly and consistently across devices.

Integration Test: The integration test assessed the interaction between hardware and software components to ensure seamless communication and functionality. All hardware components were connected and configured according to the system design, and the software was deployed on the Raspberry Pi. The system's response to inputs from the ultrasonic sensor, keypad, and web interface was evaluated to verify proper integration and synchronization. The test confirmed that the hardware and software components worked together effectively to deliver the intended functionality of the automatic door system.

End-to-End Test: The end-to-end test simulated real-world scenarios to validate the system's performance under typical usage conditions. This test involved a combination of proximity detection, manual access control, and remote locking/unlocking scenarios. Users approached the door to trigger proximity detection, entered passcodes on the keypad for manual access, and issued remote commands via the web interface. The system's response to each scenario was observed, and any discrepancies or anomalies were addressed. The test confirmed that the system operated reliably and consistently, meeting the project's requirements and objectives.

Results

The project yielded several notable findings. The keypad accurately detected and processed input, successfully unlocking the solenoid lock upon the correct passcode entry. The remote-control function, facilitated by the web interface, operated smoothly, enabling effective control of the solenoid lock remotely. The ultrasonic sensor reliably detected objects within a 20 cm range, promptly triggering the servo motor as programmed. The servo motor, in turn, effectively simulated door movement, responding accurately to the sensor input. Overall, the system demonstrated reliable operation across all functions. The integration of hardware and software components was seamless, with minimal delays and precise performance, indicating a successful implementation of the automatic door system with remote control locking.

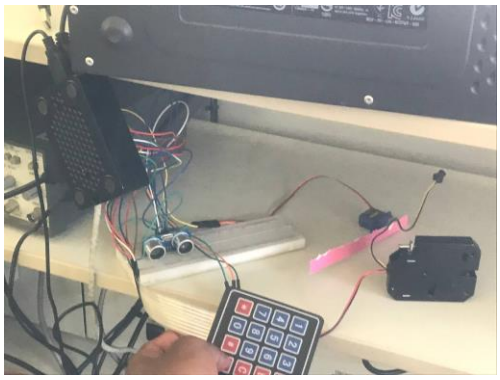


Fig 6

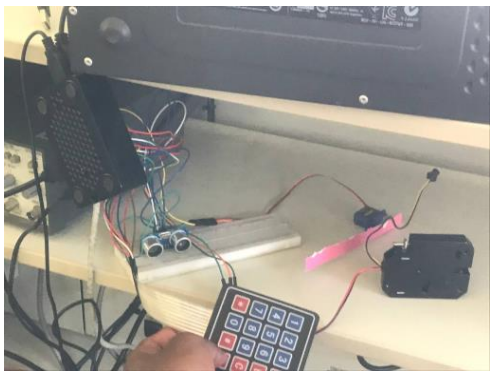


Fig 7

video link

Discussion

Implications

The project successfully achieved its objectives, providing a robust automatic door system with both remote and manual control. This system significantly enhances security and convenience, making it suitable for practical applications in various settings, such as residential homes, offices, and commercial buildings.

Comparison

Compared to existing systems, this project offers a cost-effective solution with added functionality through the integration of an ultrasonic sensor and servo motor. These additions not only improve the system's automation capabilities but also enhance the user experience by providing seamless and responsive door operations.

Limitations

One notable limitation was the initial plan to integrate Blynk for remote control functionality. Due to unforeseen challenges, a website was set up instead. While the website effectively provides remote control capabilities, the shift from Blynk to a web-based interface altered the project's initial scope and may have implications for the ease of use and accessibility.

Recommendations

In order to further enhance the automatic door system with remote control locking, several recommendations can be considered. Firstly, improving the user interface of the web application for remote control could enhance user experience by adding real-time status updates and user authentication features. Secondly, implementing additional security measures such as encryption protocols and multi-factor authentication would bolster the system's resilience against potential vulnerabilities. Designing the system with scalability and flexibility in mind would ensure it can accommodate future upgrades or modifications seamlessly. Optimizing energy consumption and providing comprehensive user training and documentation would contribute to the system's efficiency and usability. Establishing a system for continuous monitoring and maintenance, along with soliciting user feedback for continuous improvement, would ensure the system remains reliable and meets evolving user needs. By implementing these recommendations, the automatic door system with remote control locking can be further refined to provide a secure, efficient, and user-friendly solution for various applications.

Conclusion

The project successfully developed and implemented an automatic door system with remote control locking using a Raspberry Pi 3, ultrasonic sensor, keypad, and servo motor. This system enhanced security and convenience by allowing users to control door access remotely via a web interface, as well as providing manual override through a keypad. The comprehensive integration of hardware and software components ensured reliable operation, with the ultrasonic sensor accurately detecting proximity and the servo motor simulating door movement effectively.

Key findings highlighted the system's reliability and seamless performance, demonstrating the successful implementation of proximity detection, manual access control, and remote locking functionalities. The project met its objectives, offering a practical, cost-effective solution suitable for various settings, including homes, offices, and commercial buildings.

While the initial plan to use Blynk for remote control was altered due to unforeseen challenges, the alternative web-based interface provided the necessary functionality, albeit with some adjustments in user accessibility. This project not only addressed the limitations of traditional door locks but also contributed to advancements in IoT-based access control systems, paving the way for future innovations such as facial recognition and voice control.

In conclusion, the automatic door system with remote control locking represents a significant step forward in the field of smart home and security technologies. Its practical implications and potential for further development underscore the importance of integrating automation with enhanced security features, addressing the evolving needs of modern living.

Reference

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Smith, J. (2018). Raspberry Pi Automatic Door Opener. Retrieved from: https://www.hackster.io/joeyfreund/raspberry-pi-automatic-door-opener-943be5.

Patel, K. (2020). Raspberry Pi Smart Door Lock System. Retrieved from: https://create.arduino.cc/projecthub/ketan_patel/raspberry-pi-smart-door-lock-system-8d3d7a.

Appendices

```
import RPi.GPIO as GPIO
import time
import pigpio
from flask import Flask, render_template_string, request

app = Flask(__name__)

# Define keypad pins
ROWS = [10, 9, 11, 5]  # Example GPIO pins for the rows
COLS = [6, 13, 19, 26]  # Example GPIO pins for the columns

# GPIO setup
SERVO_PIN = 17  # GPIO pin for the servo motor
TRIG_PIN = 23      # GPIO pin for the ultrasonic sensor TRIG
ECHO_PIN = 24   # GPIO pin for the ultrasonic sensor ECHO
RELAY_PIN = 18  # GPIO pin for the relay
PASSWORD = "1234"  # Password for manual override
servo_angle = 0  # Initial angle of the servo motor
relay_state = False  # Initial state of the relay

def setup_gpio():
    GPIO.setwarnings(False)  # Disable warnings
    GPIO.setmode(GPIO.BCM)
    GPIO.setup(SERVO_PIN, GPIO.OUT)
    GPIO.setup(TRIG_PIN, GPIO.OUT)
    GPIO.setup(ECHO_PIN, GPIO.IN)
    GPIO.setup(RELAY_PIN, GPIO.OUT)
    GPIO.output(RELAY_PIN, GPIO.LOW)

def setup_keypad():
    for row_pin in ROWS:
        GPIO.setup(row_pin, GPIO.OUT)
    for col_pin in COLS:
        GPIO.setup(col_pin, GPIO.IN, pull_up_down=GPIO.PUD_UP)

def get_password():
    setup_keypad()
    password = ""
    try:
        print("Enter the password using the keypad and press '#' when
finished.")
        while True:
            key = get_key()
            if key:
                if key == "#":
```

```
                    break
                elif key == "*":
                    password = ""
                    print("\nPassword cleared.")
                else:
                    password += key
                    print(key, end="", flush=True)  # Print the entered key
without newline
                time.sleep(0.2)  # Add a slight delay to avoid multiple key
presses
    finally:
        cleanup_keypad()
    return password

def get_key():
    key_map = [
        ['1', '2', '3', 'A'],
        ['4', '5', '6', 'B'],
        ['7', '8', '9', 'C'],
        ['*', '0', '#', 'D']
    ]
    for i, row_pin in enumerate(ROWS):
        GPIO.output(row_pin, GPIO.LOW)
        for j, col_pin in enumerate(COLS):
            if GPIO.input(col_pin) == GPIO.LOW:
                GPIO.output(row_pin, GPIO.HIGH)
                return key_map[i][j]
        GPIO.output(row_pin, GPIO.HIGH)
    return None

def cleanup_keypad():
    GPIO.cleanup(ROWS + COLS)  # Cleanup all keypad pins

def move_servo(angle):
    global servo_angle
    servo_angle = angle
    pi.set_servo_pulsewidth(SERVO_PIN, (angle / 180) * 2000 + 500)  # Convert
angle to pulse width

def get_distance():
    # Send a 10us pulse to trigger the ultrasonic module
    GPIO.output(TRIG_PIN, GPIO.HIGH)
    time.sleep(0.00001)
    GPIO.output(TRIG_PIN, GPIO.LOW)

    # Measure the duration of the echo signal
    while GPIO.input(ECHO_PIN) == GPIO.LOW:
        pulse_start = time.time()
```

```
    while GPIO.input(ECHO_PIN) == GPIO.HIGH:
        pulse_end = time.time()

    # Calculate the distance based on the speed of sound (34300 cm/s)
    pulse_duration = pulse_end - pulse_start
    distance = pulse_duration * 34300 / 2
    return distance

def toggle_relay():
    global relay_state
    relay_state = not relay_state
    GPIO.output(RELAY_PIN, GPIO.LOW if relay_state else GPIO.HIGH)

def handle_ultrasonic_and_servo():
    if get_distance() < 20:  # Adjust this threshold based on your
requirements
        move_servo(90)  # Object detected, move servo to 180 degrees
        print("Object detected. Servo angle is now 180.")
        time.sleep(5)  # Wait for 12 seconds
        move_servo(0)    # Move servo back to 0 degrees
        print("Returning servo to 0 degrees.")
    else:
        move_servo(0)    # No object detected, keep servo at 0 degrees
        print("No object detected. Servo angle is now 0.")

# HTML for the web interface
html_template = """
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Relay Control</title>
    <style>
        body {
            background-color: #f0f8ff;
            text-align: center;
            font-family: Arial, sans-serif;
        }
        h1 {
            color: #333;
        }
        p {
            font-size: 1.2em;
            margin: 20px 0;
        }
        button {
            background-color: #008cba;
```

```
            color: white;
            border: none;
            padding: 15px 32px;
            text-align: center;
            text-decoration: none;
            display: inline-block;
            font-size: 16px;
            margin: 4px 2px;
            cursor: pointer;
            border-radius: 12px;
            box-shadow: 0 4px #999;
        }
        button:active {
            background-color: #006f9b;
            box-shadow: 0 2px #666;
            transform: translateY(4px);
        }
        .emoji-bg {
            font-size: 100px;
            position: absolute;
            top: 0;
            left: 0;
            width: 100%;
            height: 100%;
            overflow: hidden;
            z-index: -1;
        }
        .emoji {
            position: absolute;
            opacity: 0.2;
        }
    </style>
</head>
<body>
    <div class="emoji-bg">
        <div class="emoji" style="left: 10%; top: 10%;">😉</div>
        <div class="emoji" style="left: 50%; top: 30%;">👍</div>
        <div class="emoji" style="left: 80%; top: 20%;">🎉</div>
        <div class="emoji" style="left: 20%; top: 70%;">🚀</div>
        <div class="emoji" style="left: 70%; top: 80%;">🌟</div>
    </div>
    <h1>Door Lock System By Chief Eng_Prime</h1>
    <p>Current State: {{ relay_state }}</p>
    <form action="/toggle_relay" method="post">
        <button type="submit">{{ button_text }}</button>
    </form>
</body>
</html>
```

```
"""

@app.route('/')
def index():
    button_text = "Turn Off" if not relay_state else "Turn On"
    return render_template_string(html_template, relay_state="OFF" if
relay_state else "ON", button_text=button_text)

@app.route('/toggle_relay', methods=['POST'])
def web_toggle_relay():
    toggle_relay()
    handle_ultrasonic_and_servo()
    return index()

if __name__ == '__main__':
    pi = pigpio.pi()
    setup_gpio()  # Set up GPIO
    try:
        # Run the Flask web server in a separate thread
        from threading import Thread
        web_thread = Thread(target=app.run, kwargs={'host': '0.0.0.0', 'port':
5000})
        web_thread.start()

        while True:
            password_attempt = get_password()
            if password_attempt == PASSWORD:
                toggle_relay()
                handle_ultrasonic_and_servo()
                print("\nRelay is now", "OFF" if relay_state else "ON")
                time.sleep(2)  # Delay to avoid too frequent toggling
            else:
                print("\nIncorrect password. Try again.")
    except KeyboardInterrupt:
        pass
    finally:
        pi.stop()
        GPIO.cleanup()  # Cleanup all GPIO pins
```