Project Proposal

IoT Device title: Home Security System
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Project Overview

The proposed project aims to develop a Smart Security System that combines a high-quality security camera and a secure door lock. This system will utilize the ESP32cam module to provide homeowners with an advanced security solution. When motion is detected, the system will send real-time alerts to homeowners, initiate video recording to a web server or local drive, send email notifications with a live feed of the outside, and offer remote pan and tilt control for a comprehensive view of the surroundings. Additionally, the system will implement voice recognition and QR code scanning for secure door access. The Smart Security Lock that is tied to the security camera will also have RFID as an alternative to the QR scanner. This lock will also be equipped with a smoke detector on the inside of the door in case of a fire, it can automatically unlock itself to facilitate evacuation of the building. We are planning to add an IR sensor or magnetic door switch to know when the door is opened or closed. The smart lock can also be activated remotely through an application or through voice command, received by the input from the security camera. The lock will have a real ‘keyless’ entry; There will be no way to pick the lock unless they can manage to hack the system.

Project value proposition

For homeowners who prioritize security and seek an advanced solution to protect their property, the Smart Security System is an IoT product that combines a security camera and a door lock. This system addresses the need for comprehensive home security by offering motion detection, real-time alerts, remote camera control, voice-activated door unlocking, and QR code access. For homeowners who need to protect their homes, our home security project is a type of IoT device that allows convenient control of home access and monitoring.

Objectives

Hardware Integration and Configuration:

Integrate the ESP32cam module, Arduino Nano IOT33, sensors (PIR sensor, IR sensor, magnetic door switch), and the door lock hardware to ensure seamless communication and functionality. Configure the hardware components to work cohesively as part of the IoT system.

Motion Detection Implementation:

Implement a reliable motion detection algorithm using the PIR sensor to trigger security alerts and responses.

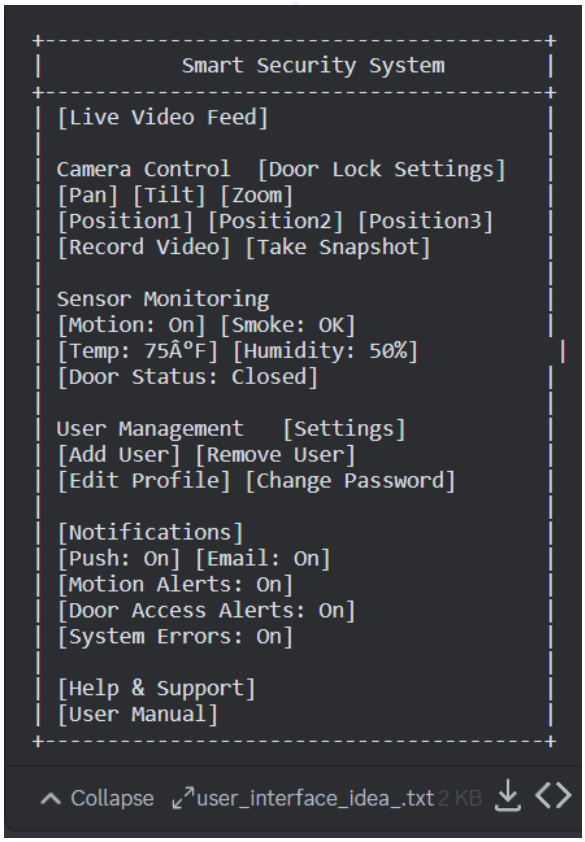
Real-Time Video Streaming:

Create a mechanism for real-time video streaming over Wi-Fi or I2C, enabling homeowners to access live video feeds.

User Interface Development:

Design and develop a user-friendly interface (mobile application and/or web dashboard) that allows homeowners to remotely control the security camera, door lock, and other system functions.

User Interface Design Idea:



Voice Recognition Integration:

Integrate voice recognition software to enable secure door unlocking through voice commands.

QR Code Recognition System:

Implement a QR code recognition system for authorized door access.

Data Storage and Management:

Establish data stutages.

RFID Integration:

Incorporate RFID sensor functionality, allowing the lock to work independently from the security camera.

IR Sensor Implementation:

Utilize the IR sensor to count the number of people entering through the door, providing valuable occupancy data.

Magnetic Door Switch Integration:

Integrate a magnetic door switch to detect the status of the door (open or closed), for monitoring and automation.

Hardware Components

Common Available Sensors/Actuators: See Annex

Specific IoT sensors/actuators for our project:

1. PIR (Passive Infrared) Sensor: This sensor is crucial for motion detection. It detects changes in infrared radiation caused by moving objects, making it ideal for triggering alerts when motion is detected.

2. RFID (Radio-Frequency Identification) Reader: To implement RFID-based door access, an RFID reader can be used to recognize and authenticate authorized RFID cards or tokens.

3. QR Code Scanner: For QR code-based door access, you'll need a dedicated sensor or camera module capable of scanning and interpreting QR codes accurately.

4. IR (Infrared) Sensor: The IR sensor can be used for counting the number of people entering or exiting through the door, providing occupancy data.

5. Magnetic Door Switch: This sensor can detect whether the door is open or closed, providing information about the door's status.

6. Smoke Detector: For safety purposes, a smoke detector is included on the inside of the door to automatically unlock the door in case of a fire, facilitating building evacuation.

7. Pan-and-Tilt Mechanism: To enable remote control of the camera's orientation, you'll need servo motors or stepper motors for pan-and-tilt functionality.

9. Door Lock Actuator: To control the door lock's locking and unlocking mechanisms remotely, you'll need an appropriate actuator or solenoid.

10. Uninterruptible Power Supply (UPS): A UPS module is essential to provide backup power to the door lock in the event of a power outage.

11. Wi-Fi Module: For wireless communication and data transfer, a Wi-Fi module is necessary to connect the system to the internet and enable remote control and monitoring.

12. Temperature and Humidity Sensor: Monitoring environmental conditions can provide additional information for security and comfort. This sensor can be useful in alerting homeowners to potential issues such as fires or water leaks.

13. Light Sensor: To adjust camera settings or trigger actions based on ambient light conditions, a light sensor can be employed.

14. Gas Sensor: If gas leaks are a concern, integrating a gas sensor can provide early detection and alerts.

15. Infrared Distance Sensor: To measure the distance between the camera and objects, particularly for automated pan-and-tilt functions or obstacle avoidance.

16. Keypad or Touchscreen: For local user interaction and configuration, a keypad or touchscreen interface can be integrated into the system.

17. Microcontroller (e.g., Arduino Nano IOT33): To control and manage the sensors and actuators, a microcontroller is the central processing unit of the IoT system.

18:ESP32-CAM Module: To provide Wi-Fi connectivity and enable remote monitoring and control of the camera. This addition allows for real-time video streaming, remote access, and integration with IoT platforms for enhanced functionality and versatility.

Expected Challenges

The development of the Smart Security System may encounter several challenges throughout its implementation. We will have to have user data be secure (encrypted so it can’t be hacked). To make sure of this, we have a contact with a pentester who's willing to help. Hardware integration will be a difficult challenge due to using many sensors, actuators, and 2-3 microcontrollers. Rigorous testing and prototyping will be carried out during the assembly and debugging phase to resolve hardware issues. For example, the ESP32cam will not be able to understand code from the GPIO pins on the Arduino; we will have to use a converter. Moreover, usability can pose challenges as well. We will need to refine the user interface and functionality, to make it easy to understand for our target demographic . We are committed to continuous learning to overcome the previous challengers and any other challenges that may arise during the project.

Communication and Control

The IoT device will be connected to a central hub (mqtt server) using Wi-Fi directly or by proxy using another IoT device via I2C or BLE communication protocol. The central hub will be responsible for data collection and distribution via publish /subscribe mqtt protocol. Exploitation will be performed by an external internet system, including the user's mobile application. Users will be able to control and monitor the facility remotely through a secure and user-friendly mobile app (semester II).

Data Storage and Analytics

During semester II, all sensor data will be securely made available in a cloud-based database for historical analysis and generating insights. Machine learning algorithms will be considered to identify patterns, calibrate sensors, and make recommendations for improving energy efficiency and user comfort.

Timeline

The project will be executed over a period of four months, broken down into the following phases:

1. Planning and Requirements Gathering. 2 weeks
2. Hardware Selection and Procurement. 2 weeks
3. System Development and PCB ordering . 1 month
4. Assembly, Testing , Debugging and documenting. 1 month

Scalability/Future Expansion

- The lock could have integrated data storage to log the RFID.
- Camera could use Physical hard-drive to store all the footage recorded.
- Camera could have Cloud storage.
- A Firewall could be integrated between the system and WIFI connection.
- GUI APK for mobile phones.

Budget

An estimated budget of **450$** will be allocated to purchasing the components, ordering the printed circuit boards and all the miscellaneous and 3d printed parts for casings of the project. A rate of **20$/hour** for the workers of the course of **200** hours for assembly, testing and developing software bringing the total cost to complete the project to **4450$**.

Conclusion

The proposed Smart Security System offers advanced security features to protect homeowners properties autonomously. The homeowner will be able to access a user interface to view a live video feed, move the camera and unlock the door remotely. The security system will also have many quality of life features such as voice activated passwords and QR scanner. The smart lock allows a higher sense of security due to its multiple unlocking methods and protection against lock picking. As stated previously, the security system is the next step toward home automated security, Allowing real keyless entry using QR or RFID as well as being equipped with an emergency feature in case of a fire.

Annex

Common Available Sensors/Actuators:

1. Internal Temperature (nano). Embedded temperature sensor inside the IMU LSM6DS3 that monitor the microprocessor temperature;

2. Internal Temperature (CyberCell). Embedded temperature sensor on the CyberCell that monitor the main board temperature;

3. Unique ID (CyberCell). To capture the unique ID of the CyberCell host located inside the internal CyberCell temperature sensor;

4. Inertial measurement unit (IMU) (nano). To capture relative position and displacement of the IoT device, using 6-axis LSM6DS3 sensor;

5. RTC (nano). To provide an accurate measurement of the time of day;

6. BLE (nano). To provide the capability to sense Bluetooth devices in its surroundings and to provide another unique IoT identifier (MAC);

7. Wifi (nano). To provide the capability to sense Wifi devices in its surroundings and to provide another unique IoT identifier (MAC);

8. ECC608 crypto (nano). To provide another unique identifier, and additionally a pre-saved encryption key;

9. Status LED (nano). To provide minimum visual feedback;

10. 12-bit Analog to Digital Converter (AC) (nano). To sense varying voltage or current or other signals;

11. 10-bit Digital to Analog Converter (DAC) (nano). To generate varying signal voltage amplitude;

12. DHT11 Digital Humidity sensor (shield). To monitor humidity levels outside of the IoT device;

13. InfraRed receiver (shield). To monitor modulated infrared signals outside the IoT device;

14. InfraRed transmitter (shield). To actuate external infrared controlled devices or to be used as local data transmitter;

15. OLED (shield). To provide readable text/graphic based feedback to users;

16. PSPT switch(shield). To provide user triggered OLED power;

17. Wheel Horizontal Micro Seesaw and Lever Leave Thumbwheel Switch With Center Push (shield). To allow user input / up/down menu navigation on the OLED;