Senior Design: Home Security II

December 14, 2022

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1 Introduction

The objective of our project is to provide a system that allows the user greater security for their home or building that they wish to install the system into. The security provided will provide protection against a variety of threats. The main threat the system defends against are intruders and will utilize cameras to detect when movement occurs as well as capturing an image of the intrusion from a camera which will then be sent to the user. In addition, the system will provide additional security against fire and smoke with sensors that will notify the user should it detect such. All of this information will be available for the user to access through a website and view in an easy to understand format.

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2 Problem Statement and Proposed Solution

Homeowners rarely know when their home is at risk. They find out about fires after firefighters have broken into their homes. Break-ins are noticed after valuables are gone if no home security system is implemented. Homeowners should have the ability to immediately know when their property is facing any of these threats without breaking the bank. Specifically, homeowners should be able to decide whether a fire hazard can be prevented before their smoke detector warns the fire department.

Everyone deserves a cheap product to secure their homes and a way to customize it in accordance to their needs and budget.

Our project aims to notify users if their home is at risk. Rather than a neighbor calling you about a break in or the fire department having to come put out the fire, we aim to facilitate a quicker response from the user in order to better prevent catastrophes at one's home before it is too late.

The center of the product is a website where homeowners can monitor their home through live video feed as they please. Additionally, the user interface allows the user to activate a siren whenever they want to notify the intruder that their unwanted presence has been detected. Smoke detection is also incorporated into the system. All data acquired by the system is logged into a solid-state drive.

Even though the most basic system includes video surveillance, movement detection, and smoke detection, the beauty of the system lies in its scalability. If a user wants to strategically place a smoke sensor by their stove, it can be incorporated into this monitoring system as long as it's Wi-Fi compatible with the main system.

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3 System Requirements

The product should be able to monitor the current state of the home through its basic sensors and make them accessible through the internet. In particular, video data should be visible at all times. When light starts dimming, the camera should switch feeds to enable night vision. All sensor data (including part of the video) will be available physically in case it is needed for an insurance claim or a police report. Additionally, the overall system itself should be scalable, so any IoT sensor can be incorporated without having to be wired directly onto the main board.

At this point, the user can monitor their home using a webpage that is hosted on the ESP32. If the user is far away from home, and an emergency arises the user is notified (specifics on whether to use SMS or a Whatsapp client have not been decided) and given the option to check the website to confirm and subsequently contact the authorities.

The system is installed by mounting the basic set of sensors in a strategic position. A connection to an outlet is necessary. The top corner behind the front door is a great starting point. Then, it should connect to a bluetooth-compatible device to get the wifi information. After that, threshold parameters for sensors are configured (i.e. warn authorities automatically, enable/disable a specific sensor, etc.).

It is crucial that the power supply design is meticulous, because the product will be plugged into the outlet 24/7. Additionally, the embedded intelligence should support multi-threading, since it will need one for the wireless stack, and another one for sensor fusion and actuation.

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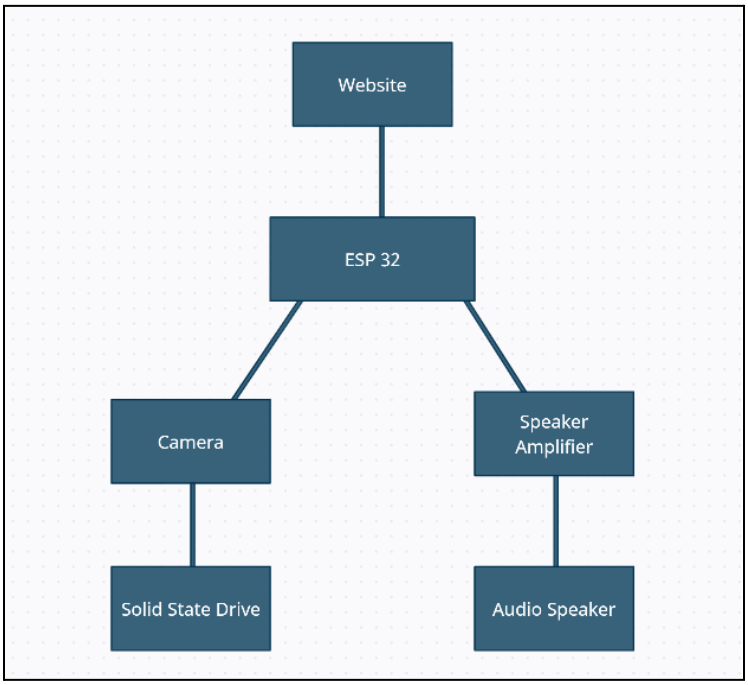
4 System Block Diagram

4.1 Overall System:



4.2 Subsystem 1 and Interface Requirements:

WiFi communication: Each sensor will have to communicate back and forth with the ESP32 through WiFi. We will use an SPI protocol because it allows for uninterrupted data transmission and the ability to choose which slave to send information to at any given time, which will be important with multiple sensors being used.

4.3 Subsystem 2 and Interface Requirements:

Website: In order for the user to interact with their home security system, a website will be made. This website requires a live video stream from the camera, so that the user can check in on his house at any time. It also might require buttons that can turn on or off the siren sound. We could also make it have a capability that would wipe the stored data if the user wants to create more room for more data.

4.4 Future Enhancement Requirements

The system itself should be able to interface with any IoT-based embedded intelligence as long as it uses the same protocol to connect to WiFi. If there is time remaining at the end of the project, this will be implemented. It will be tested with prototype hardware consisting of an ESP32 development module attached with a sensor.

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5 High Level Design Decisions

The ESP32 is the only fixed component. It is worth highlighting that it is suitable for this project because it has multiple cores and supports WiFi. A set of wired sensors are the best option for a starter home security that is affordable. An ESP32-compatible camera allows video data to be captured using a SPI bus and forwarded to the web page using WiFi so the user can monitor their home.

Logging is necessary, since evidence will be required if the user wants to make any claims or report with the police. For this feature, an SD card or a SSD are considered. The tradeoff between both options is size and ease of interface. The SSD is more convenient for video data due to size, but it also constrains the latency of the system because it takes more time to write to. The SD card is easier to interface with, but its lack of space is a burden for handling video data.

The webpage should be user friendly and accessible wherever there is a device with internet connection. It should be password protected so only authorized people can access the home monitoring system. Additionally, it should be able to handle multiple connections from multiple ESP32 if scalability is a feature to be included in the future.

Finally, the notification system should contact the user whenever there is a potential emergency with a link to the webpage and an option to call the authorities. The method as to how the user should be notified is still in debate.

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6 Open Questions

- What is the best option for logging data?
- How will our program send messages to the user (either with SMS or WhatsApp)?
- Should the user be notified when video data is about to be wiped out from the log?
- What additional security measures can be implemented for access to the webpage?

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7 Major Component Costs

- Solid State Drive - (Crucial CT500P2SSD8) **[$50]**
- Speaker Amplifier - (LM386 Module) **[$8]**
- ESP Compatible Camera - (OV2640 Camera) **[$8]**
- LDR-Photoresistor - (02-LDR1) **[$0.20]**
- Audio Speaker - (9 Ohm Speaker) **[$10]**
- Circuit Board **[$50]**

Total price- **[$156.20]**

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8 Conclusions

Our design is useful to the consumer in three primary areas.

Cheap Cost: Oftentimes security systems for homes can be expensive in addition to costs from complementary features such as monitoring services which might be required for the system to properly operate. Our design is more approachable to individuals who make lower incomes who want to be alerted to common household threats.

Scalability: This security system is easily scalable in its capabilities. Should the user have a higher income or want to be alerted to particular types of threats not provided by the current implementation, the system can be amended with the inclusion of additional sensors.

Ease of Use: The user is able to easily view the information and access it with minimal effort. This creates an appeal to older users and those with lower income (who would be drawn to this product with its lower cost initially) in alleviating their fears of not being able to benefit from it due to lack of technical knowledge.

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9 References

- Solid State Drive (Store Link)
- Siren/Speaker (Store Link)
- Camera (Store Link)
- Photoresistor (Store Link)
- Speaker Amplifier (Store Link)
