Home Security

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Project Description:

This home security system will demonstrate mobile energy efficiency, wireless communication, phone-based applications, cloud-based integration, and user authorization technologies. It aims to detect intruders using several types of sensors, to offer owners smart phone SMS notification of intrusion, and to allow the owner to mount detectors with excellent, many-month battery life.

The team used a PIR motion sensor and a magnetic door sensor to protect homes from intruders. The motion sensor reports an intruder to the central unit upon detecting a change in thermal energy, and the door sensor reports changes in magnetic flux density when the sensor is moved away from a stationary magnet attached to a door frame. The devices 'check in' to the main unit every 33 seconds and maintain Bluetooth capabilities for 15 seconds or, until they are acknowledged by the main unit and forced into Bluetooth dormancy. In this way, the devices maintain the same armed/disarmed state as the rest of the system, without the need for a constant, and much higher power, connection.

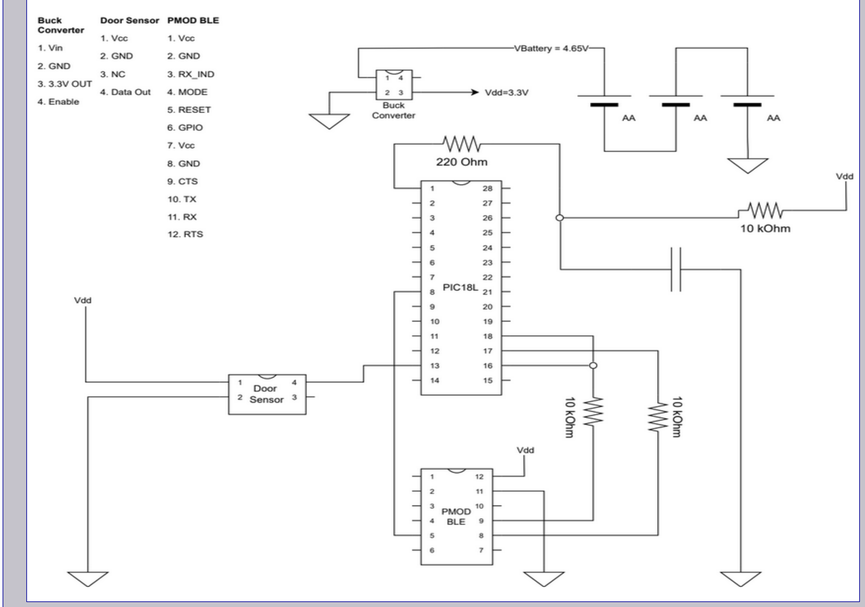
Bluetooth Low Energy (BLE) Was used to communicate between the sensors and the central unit. BLE is a lower-power implementation of Bluetooth that allowed our team to reduce our power consumption even further.

The central unit is built on a Raspberry Pi paired with a 7-inch touch screen display. The graphical user interface on the central unit was developed using the CustomTkinter library to give the device more modern-looking interface. The application utilizes a fingerprint scanner for easy access to the application and can hold a total number of 10 fingerprints at a time.

Sensor Devices

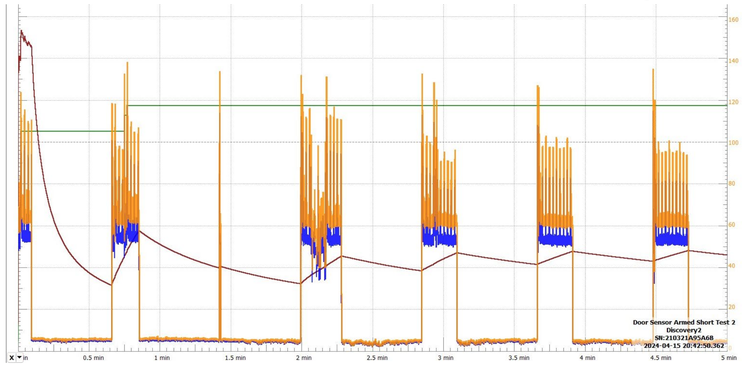
Sensor Device Circuitry

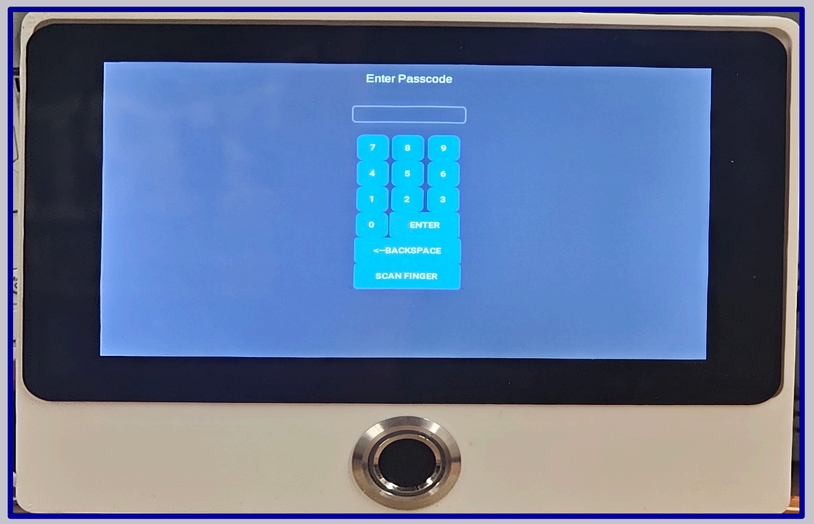
The sensor devices are controlled by a PIC18 microcontroller by Microchip Technologies. The PIC offers 'Extreme Low Power' (XLP) technology that allowed our group to keep power consumption low while still utilizing serial communications via UART and processing sensor data.



Battery Life

One of the major successes of the project was the estimated battery life that was achieved. After 2 8-hour test sampling every 1 second. From that test the team found the circuits had an average current draw of around 450 µA (depending on the device). Then the team graphed several 5-minute test at a 50 ms sample rate to see a more detailed view of the maximum current draw and any missed messages of the circuit. The max current draw observed was 3.2 mA. Based on the data collected, the batteries would be able to last 7 months or longer.



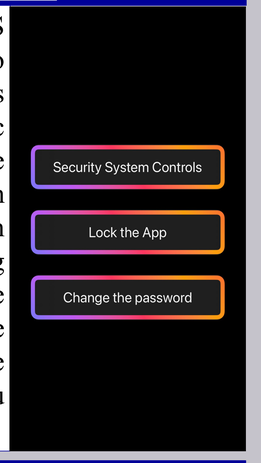


BLE

The Raspberry Pi communicates with the sensor devices using a Bluetooth Low Energy device called a PMOD board with an RN4817 chip by Microchip. The Raspberry Pi continuously scans for the MAC addresses of the two devices and connects when they begin advertising. This allows for the devices to reduce power consumption by turning off the PMOD when not needed and powering on when it has data to send or check in with the Raspberry Pi to ensure it is still operating. The Raspberry Pi can also communicate to the devices when they can be armed and disarmed.

Mobile App And Server

The mobile application was created on an iOS platform using Swift. The Application is able to be unlocked by using a password which is stored in the cloud as well as using biometric authentication with FaceID. Then you will be able to change the password as well and disarm and arm the system or change the system password from wherever you are located as long as you have a WIFI or cellular signal. The server runs a Postgres database to store the disarm/arm status and the system password. The server is being run a basic Dyno on a Heroku Cloud Server.



Credits:

The Home Security System senior design team would like to thank the following for their contributions, facilities, and resources:

- Trine University ECE Department Faculty