Magic Sensors

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Problem Statement

"Currently in the market, door sensors (used in home security systems) are battery powered or need to be wired to a control unit.
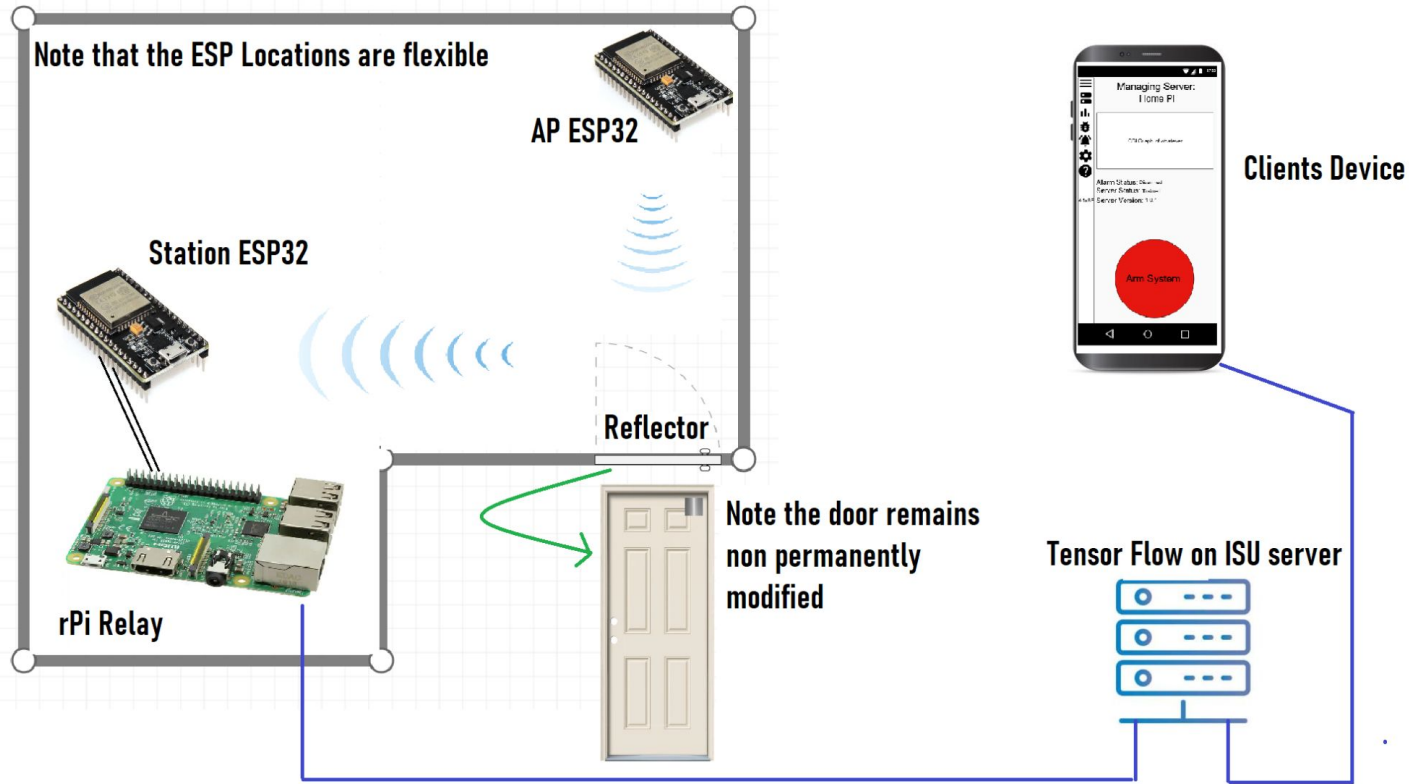
The goal of this project is to design and implement innovative 'magic sensors' which are wireless and batteryless.

These 'magic sensors' will 'report' the status of the door (whether it is open or closed) to the control unit without a power source [on the door or frame] (such as battery)." (Professor Qiao, Project Abstract)
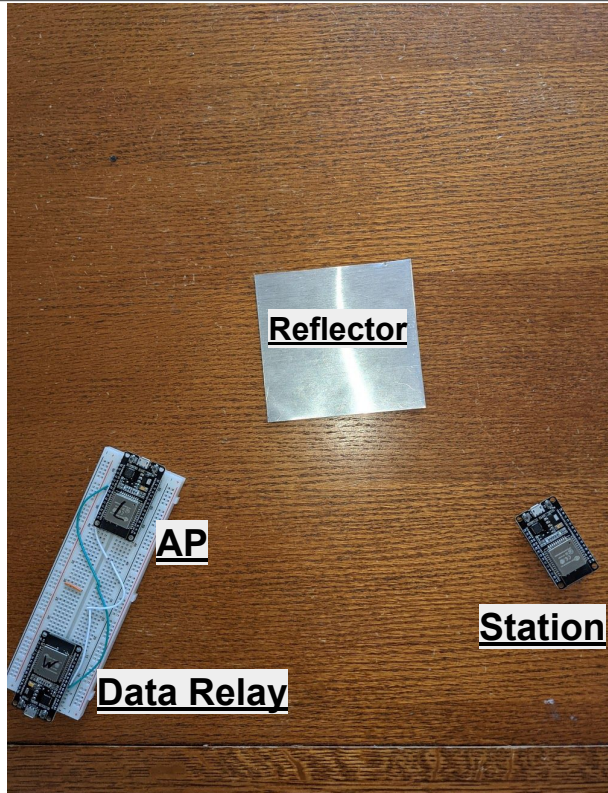
Functional Requirements

- Detect if a door is open or closed with 95% accuracy with false-positive and false negative reports falling under 5%
- Detect a door's state up to 10 feet away from the base unit
- No powered no wired sensor on the door
- Alert customer via an application on their phone within 5 seconds if a door opens or closes
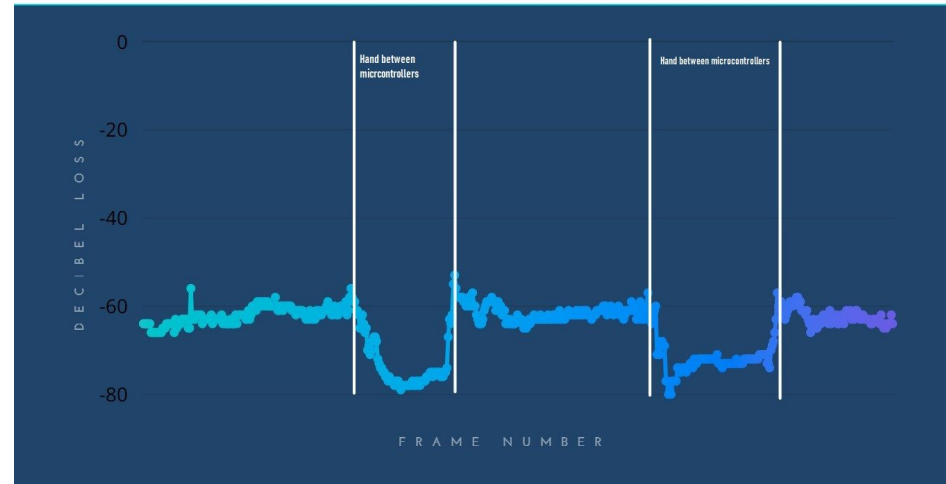- Capable of arming and disarming system

Conceptual Sketch

Note that the ESP Locations are flexible

AP ESP32

Station ESP32

Reflector

rPi Relay

Note the door remains non permanently modified

Clients Device

Managing Server:
Home Pi

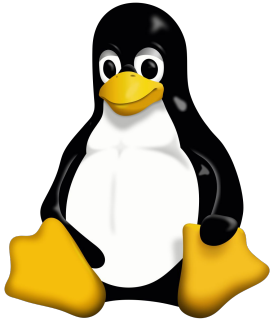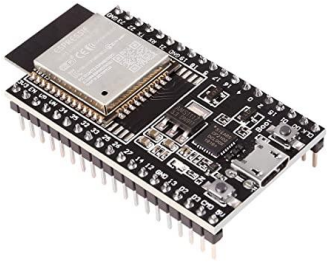Arm System

Tensor Flow on ISU server

Prototype Implementations

RSSI Data Demo #1 - Proof of Concept

Hardware and Software Technology Platforms Used
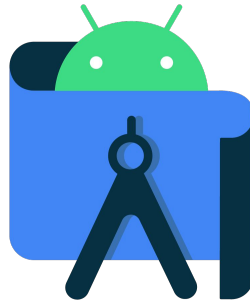
Current Project Status and Goals

- Current Project Status:
    - We have all our core systems in place, with constant CSI data harvesting
    - We have this data forwarded to a server
    - We have the backbone of an application to interface with the system
- Goals for this Semester:
    - Develop an approach for PCA analysis as well as an efficient implementation of Kalmans filter for hardware data pre-processing
    - Develop a plan for training the system
    - Establish link between server and linear regression model
    - Finalize a test plan and begin testing the system
    - Improve prediction accuracy of the machine learning model to meet the 95% benchmark

Test Plan

- Tests
  - We are still currently developing the infrastructure for testing
  - Component testing will be mostly focused around connectivity of components
- Metrics
  - The machine learning model can provide metrics for the prediction which can help determine false positive and negative rates during acceptance testing
  - Will measure the amount of time taken from door opening to app reporting the change

Technical Challenges

- Develop Door Module
  - The reflective piece of metal will not be able to create the binary representation that we need, so we will test various ideas to determine the best design to proceed forward
- Develop ESP CSI Harvesting Network
  - Data will be large in quantity and potentially low in quality. There are existing algorithms we will implement to mitigate this
- Develop Inferencing on Server
  - The server could be compromised, as such, we will implement passwords and use Iowa State's built-in protections
- Develop Android Application
  - The android app getting a notification that the door state has changed is heavily dependent on the server being able to push a notification.

Thanks for Listening!

Questions?
Email us at:
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