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

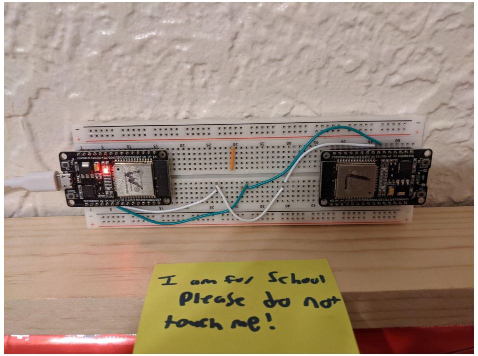
Answering Common Questions From Last Presentation

- Will a ceiling light or glare from the sun make it more difficult to get accurate readings from the sensor?
  - We are using 2.4GHz WiFi waves for our system, not light waves. These WiFi waves run at very different frequencies to visible light, and even IR. As a result, there will not be interferences of this type.

- Will people be required to train their models themselves?
  - Yes, The system will be trained for their specific environment. If the location of the sending, receiving or antenna components changes, the system must be retrained.

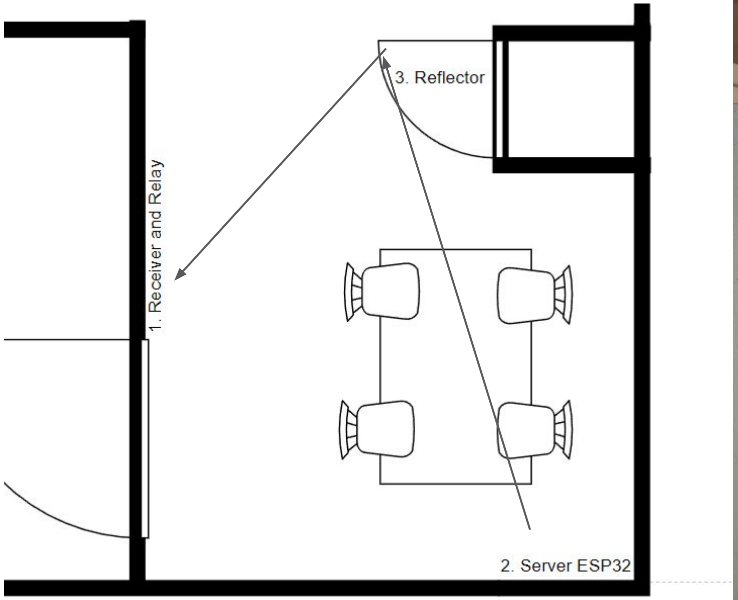
- Were other kinds of sensors considered if that was the route you wanted to go with? Why this particular solution using radio waves with no circuit or devices on the door?
  - The requirement was that there should not be any powered devices on the door. There are powered devices in the system as a whole.
  - Bringing a consumer product that doesn't require external staff to install and minimal disruption to design of the door

Systems Sketch



1. Receiver

2. Server Esp32



4. Layout

3. Aluminum Reflector

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
  - We have a machine learning model making predictions from data
  - We have a dataset creation tool, allowing easy consistent generation of different datasets
  - We have developed a complete testing plan and procedure
- Goals for the Semester:
  - Develop an approach for PCA analysis as well as an efficient implementation of Kalmans filter for hardware data pre-processing
  - Complete acceptance testing of our setup
  - Establish link between server and linear regression model
  - Improve prediction accuracy of the machine learning model to meet the 95% benchmark

Technical Challenges Currently Tackling

- PCA
  - PCA is an inherently mathematically dense operation off the bat
  - PCA Analysis filters our data down to a relevant subset for a certain environment.
  - We must make sure the dataset we run PCA on accounts for common edge cases so that these do not get filtered out.
- Uart
  - Flow Control - Non existent on the esp32
    - Needed as we generate data faster than we consume it
- Mapping ML to server endpoints
  - Integrating model with system
  - Currently our model is accessed locally via a command line. We need to automate this process to be run and predict every time a new datapoint is received.

Thanks for Listening!

Questions?

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