E2.14 – Wi-Fi Sensing

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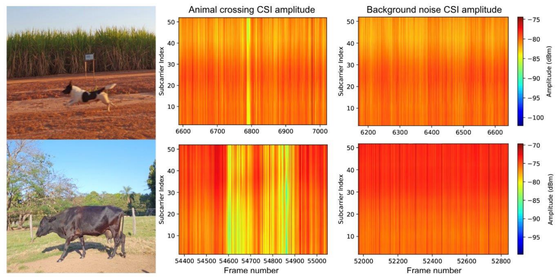
SHINE LAB

Overview



Wi-Fi is already deployed in homes and businesses around the world. With the introduction of the IEEE 802.11bf standard, Wi-Fi networks can be used for sensing tasks in addition to communication. Our project explores Wi-Fi sensing techniques capable of detecting human motion, falls, respiration, and other subtle activities using existing Wi-Fi infrastructure. A research paper was written, with plans of being expanded on in the future.

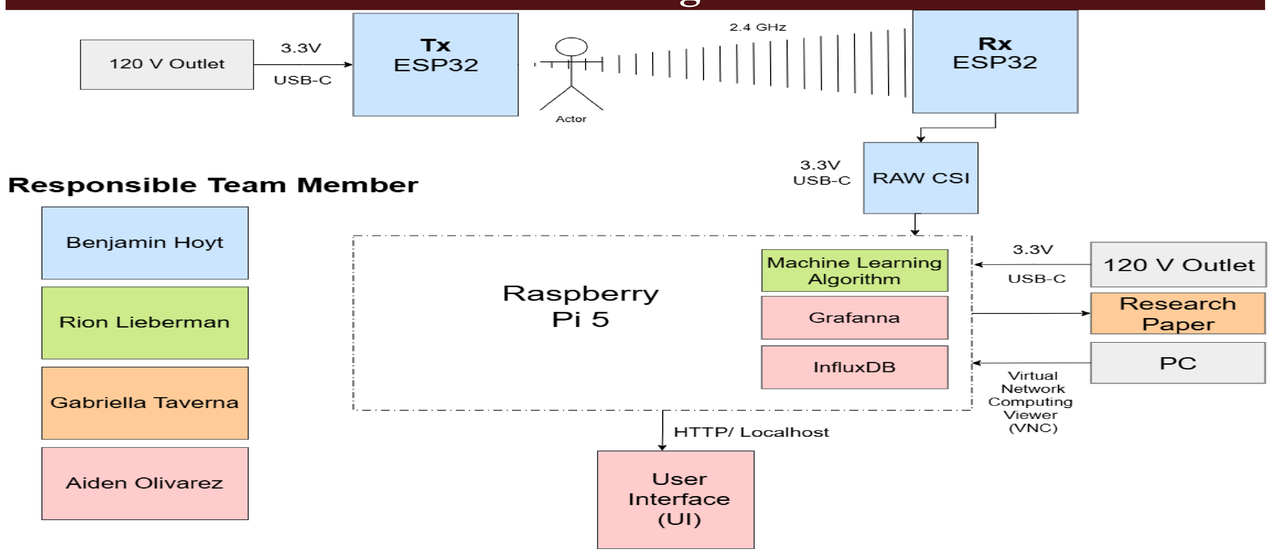
D2 Accomplishments

- Trained CNN-GRU model
- Implemented linear regression RSSI slope
- Live updating user interface utilizing Grafana, machine learning model
- Tested network for potential accidental DDOS during sensing
- Developed conference-ready research paper

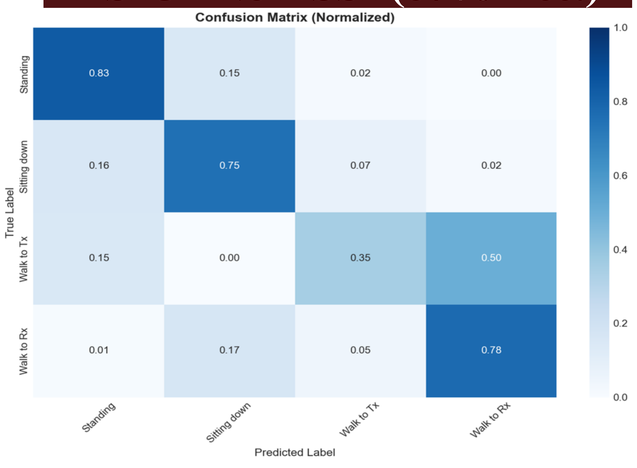
Roadblocks

- Insufficient data for ML training
- Omni-directional antenna in a crowded environment

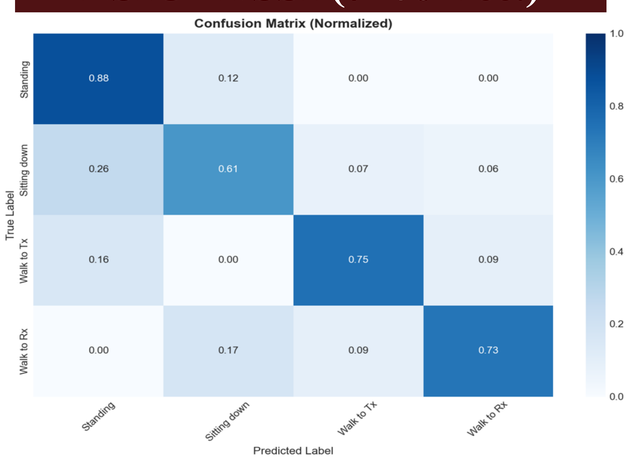
Block Diagram



ESP32 No RSSI (67% Acc.)

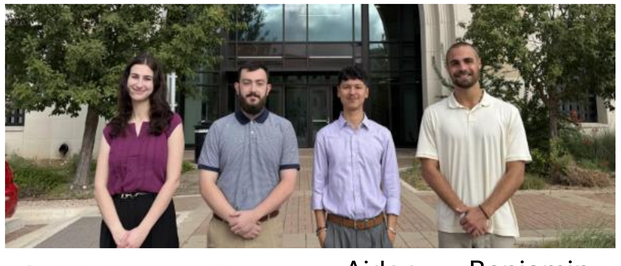


ESP32 RSSI (74% Acc.)



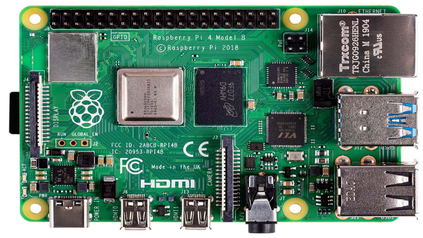
Channel State Information

- CSI shows how a Wi-Fi signal changes as it travels through the environment
- Captures tiny variations from motion, breathing, and other activities.
- CSI frames extracted from receiver ESP32, capturing amplitude and phase info across 52 subcarriers



Gabriella Rion Aiden Benjamin

Raspberry Pi



- Processing Node (16 GB RAM)
- The Raspberry Pi host machine learning model, python script parsing raw CSI, and locally host Grafana

ESP32-C6

- Low Cost, Easy to Program, Non-Proprietary
- Omnidirectional PCB trace antenna

RSSI Linear Regression

$$\beta_{RSSI} = \frac{\sum_{i=1}^{N}(t_i - \bar{t})(r_i - \bar{r})}{\sum_{i=1}^{N}(t_i - \bar{t})^2}$$

t_i = Packet index
r_i = RSSI magnitude index
$\bar{t_i}$ = Mean value of packets
$\bar{r_i}$ = Mean value of RSSI

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