WiFi Sensing Based Occupancy Monitoring

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Background

- Utilize WiFi signals to detect the physical environment
- Measure the variations in the waves as they interact with objects
- Variations in Channel State Information (CSI) describe how the signal propagate throughout space
- Machine learning uses CSI data to make predictions
- Doesn't require intrusive sensors or cameras

Why It Matters

- Emergency services can determine where to go
- Identify bottlenecks within buildings
- Building management can make informed decisions about space usage
- Leverage existing WiFi infrastructure

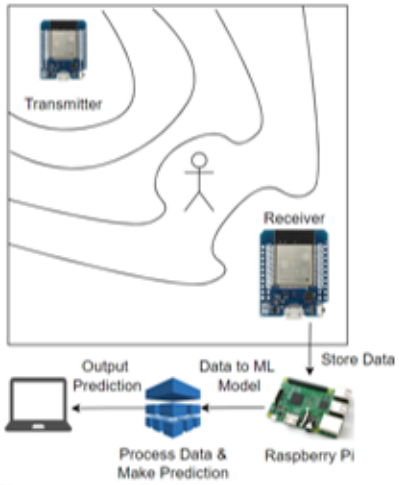
Experiment Equipment

a. ESP32 d1 mini
- Used to collect CSI data

b. Raspberry Pi
- Used to extract data from ESP32

c. Keras API
- Used to train ML models

High-Level Design

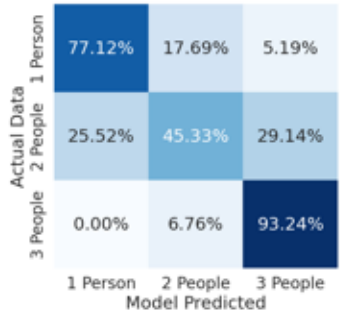


- ESP32 configured as a transmitter outputs WiFi signal
- Wave is disrupted by occupants
- ESP32 configured as a receiver receives WiFi signal
- CSI data stored on Raspberry Pi
- Data file passed to ML model for training and validation
- ML predicts occupancy

Results

Trial	Data Collected On	Accuracy
1	3-Nov-23	33%
2	3-Dec-23	60%
3	13-Feb-24	71%
4	21-Feb-24	92%

Validation accuracy with different data sets



Confusion matrix for 1-, 2-, and 3-person occupancy (validation accuracy: 71.58%)

Confusion matrix for 1-, 3-, and 5-person occupancy (validation accuracy: 92.2%)