

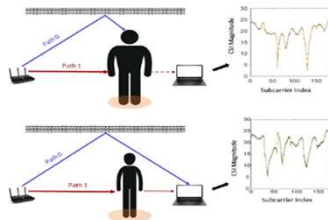


### MOTIVATION OBJECTIVE

- The capability of **recognizing human activities** can facilitate a broad range of **real-world applications**
- Activity recognition is a critical component on **monitoring well-being** and providing suggestions to **improve health**
- **Objective:** implement a **real-time system** using ubiquitous **WiFi signals** to conduct activity recognition in a device-free manner

### CHANNEL STATE INFORMATION

- Describes how Wi-Fi signals propagate from transceivers and represent the combined effect of **scattering, fading, and power decay** with distance
- CSI expressed as an array of **complex number streams**, corresponding to different frequency bands that could be partitioned into **30 subcarriers**
- Amplitude and phase at each subcarrier could be used for extracting representations of human movements

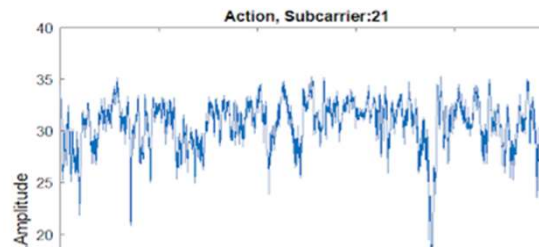


### SEGMENTATION AND CLASSIFICATION

- **Data segmentation** is to determine whether a segment of CSI measurement contains human activities
- Utilize a sliding window function to calculate the **variance** and **mean** value to segment the large movements such as sitting, walking and running
- Segments are suitable for classification through an RNN - specifically an **Long short-term memory (LSTM)**
- LSTM takes the extracted CSI stream input in time and can flush its input buffer upon reaching the beginning of a new segment

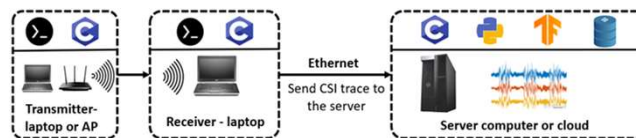
### GRAPH & DATA INTRODUCTION

- CSI - Channel State Information
- Simple Sequence - Time sequence
- Spikes - ambient noise or tiny movements
- Larger Amplitude - Increased movement
- Smaller Amplitude - decreasing speed



### IMPLEMENTATION OF REAL-TIME SYSTEM

- **Hardware:** two Dell laptops installed with Intel 5300 WiFi NICs, a server computer
- **Transmitter:** the system starts by **transmitting WiFi packet**
- **Receiver:** the receiver **reports CSI** and **sends the CSI trace (binary CSI data) to the server computer** via TCP/IP for data processing
- **Server computer:**
  - Decode the binary CSI received from the receiver
  - **Segment CSI** corresponding to human activities
  - **Recognize activities** based on profile matching
  - Visualize the activity recognition result



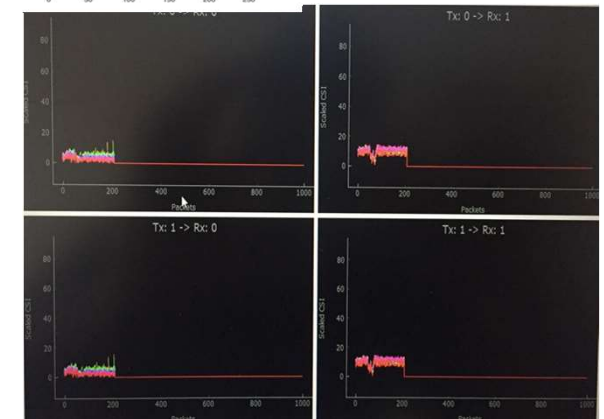
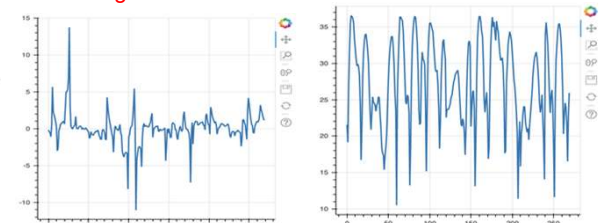
Real-time CSI collection

### OBSERVATIONS

- Based on observations on CSI fluctuations, we find that **different activities** lead to **distinctive patterns in CSI**, which can be explored for activity recognition

### VISUALIZATION TOOL

- Visualize the real-time CSI with two Python libraries: **QtWidgets** and **Bokeh**



Real Time CSI data collection (Python)

### ACKNOWLEDGEMENTS

We would like to thank our supervisor Prof. Yingying Chen and our mentors Cong Shi and Zhenzhe Lin. We appreciate their guidance and supports.

### REFERENCES

- [1] Daniel Halperin, Wenjun Hu, Anmol Sheth, and David Wetherall. "Tool release: Gathering 802.11 n traces with channel state information." ACM SIGCOMM Computer Communication Review 41, no. 1 (2011): 53-53.