

# **Fine-Grained Vital Signs Estimation Using Commercial Wi-Fi Devices**

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# Applications



HR 100 60 **80** BPM

NBP 160 90 **120/60** mmHg

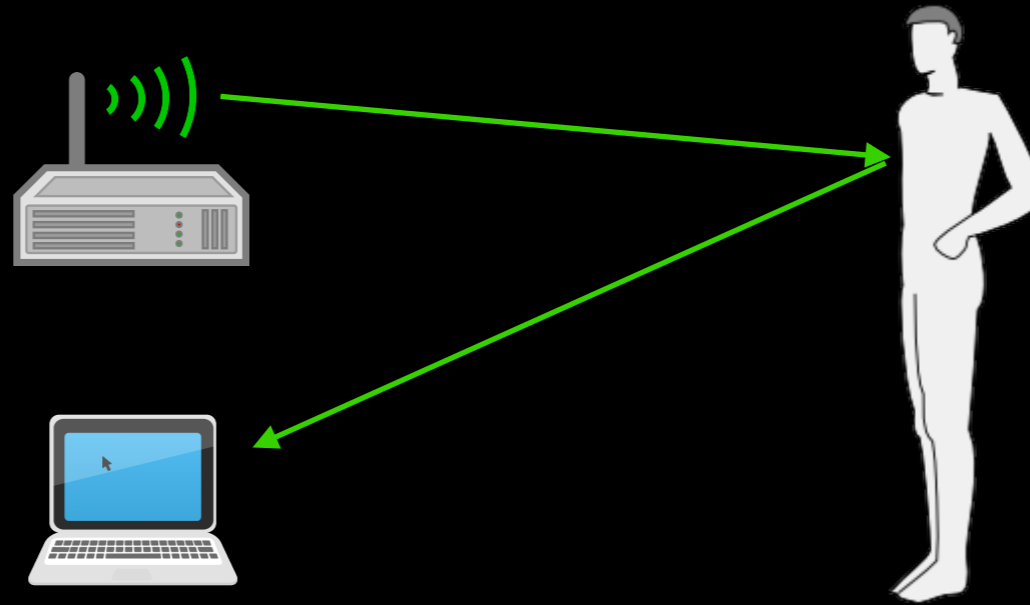
SV 100 55 **75** ml

TEMP 1, 2 °C  
39  
36  
(1) **36,6**  
(2) **36,7**

# Applications



# Wi-Fi Based Vital Signs Estimation

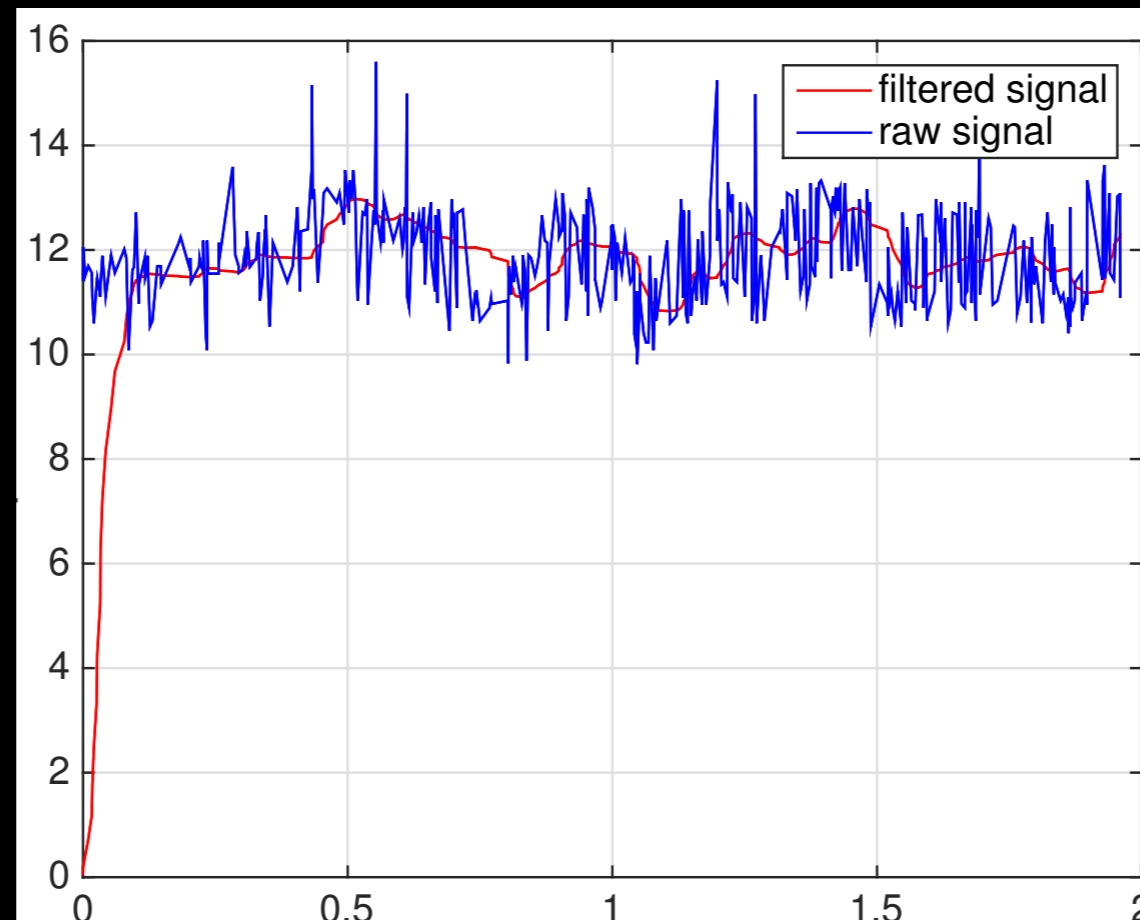


Advantages compared with traditional approaches

- Work without lighting
- No need to wear sensors
- Less intrusive to user privacy
- Lower cost

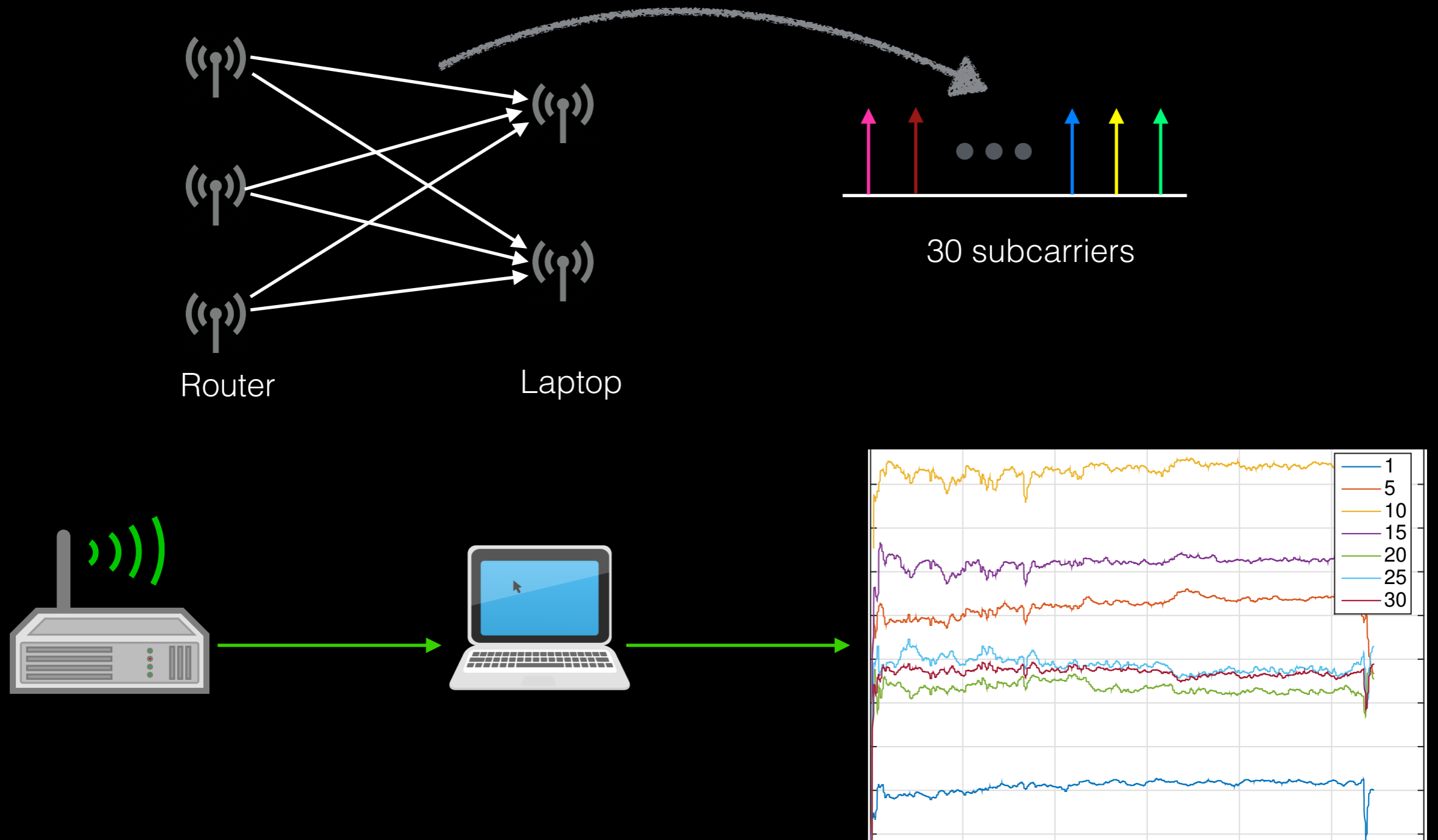
# Observations

- Human chest movement can influence the Wi-Fi signal.
- We can get enough Channel State Information measurements within the duration of human chest movements.



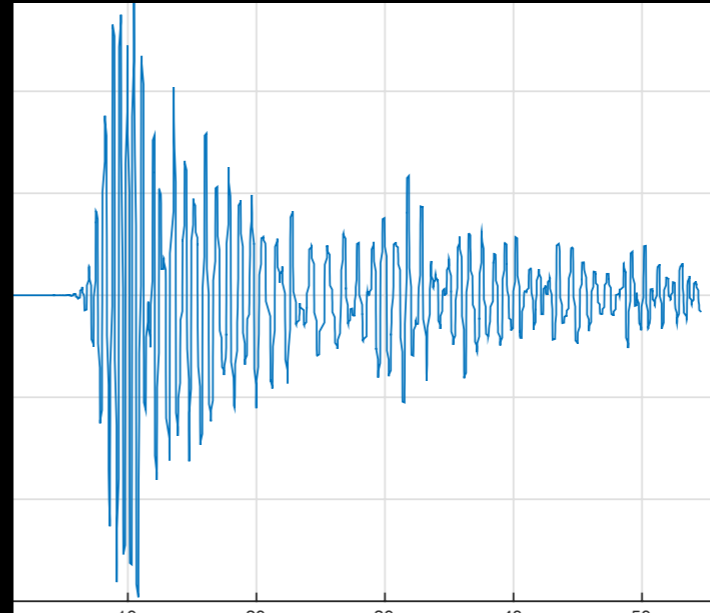
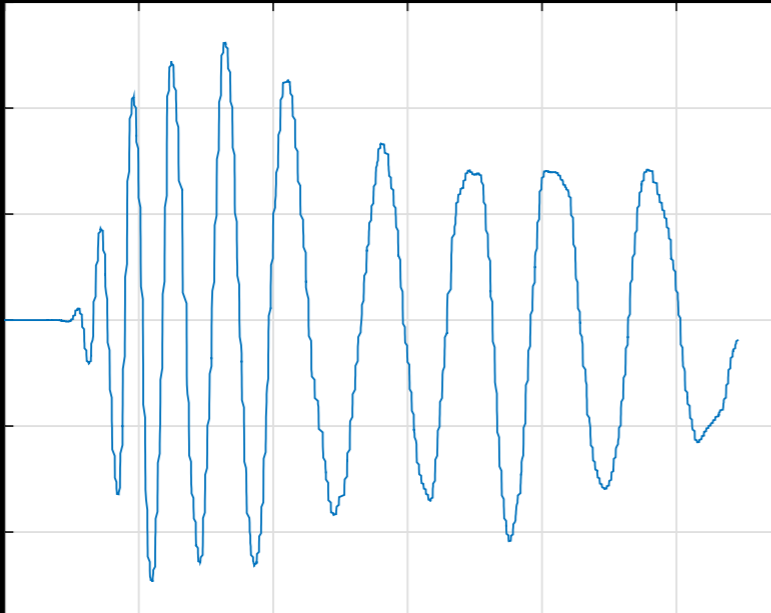
# Solutions

## Data Collection and Subcarrier Selection



# Solutions

Breath and heartbeat have different frequencies.



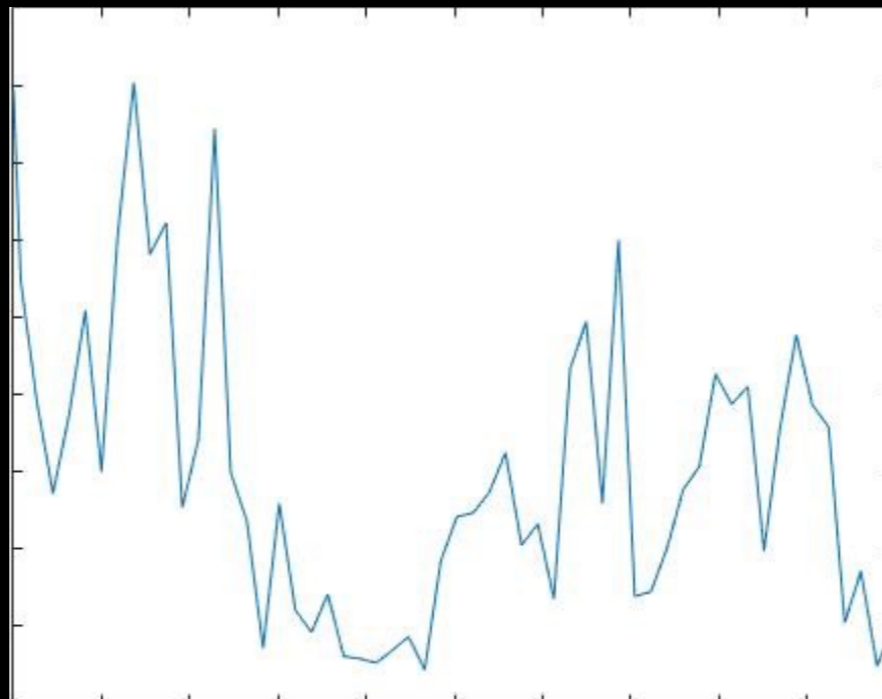
Then we can use the classic peak finding algorithm to find all the peaks within a time period

# Additional System Component

What if the object has similar activities (like hand waving)?

→ We need to eliminate these similar activities!

We will treat multiple peaks in a spectrum as possible chest movement frequencies and exploit Mean Squared Errors of time intervals between two neighboring peaks in each narrow frequency band.





# Experimental Evaluation

## Hardware Setup

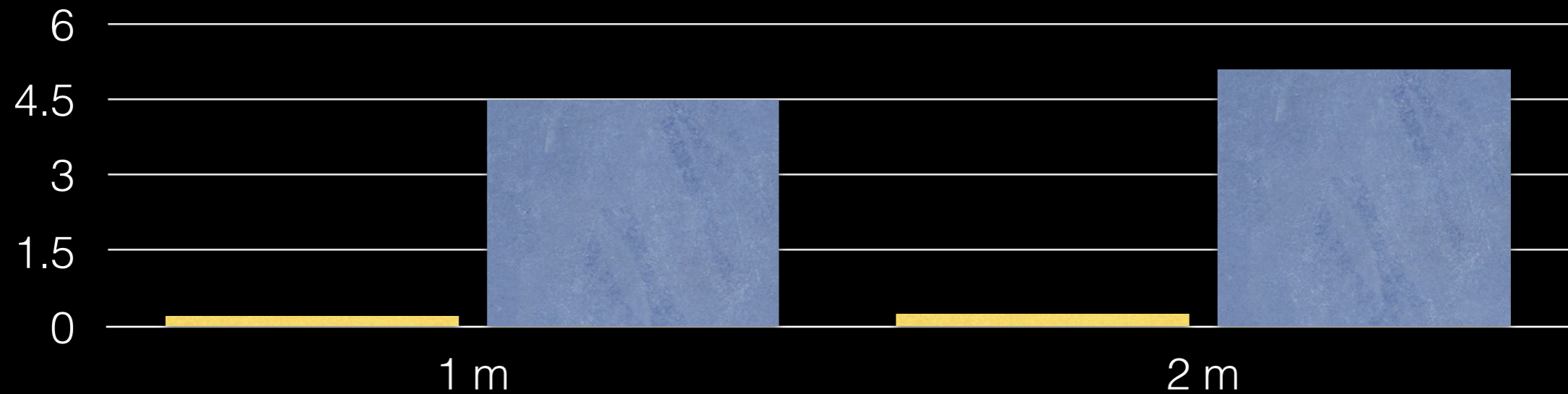
- Transmitter: TP-Link TL-WR1043ND Wi-Fi router
- Receiver: Lenovo X210 with Intel Link 5300 Wi-Fi NIC card
- Kernel modifications to the iwlwifi driver in the Ubuntu kernel

# Experimental Evaluation

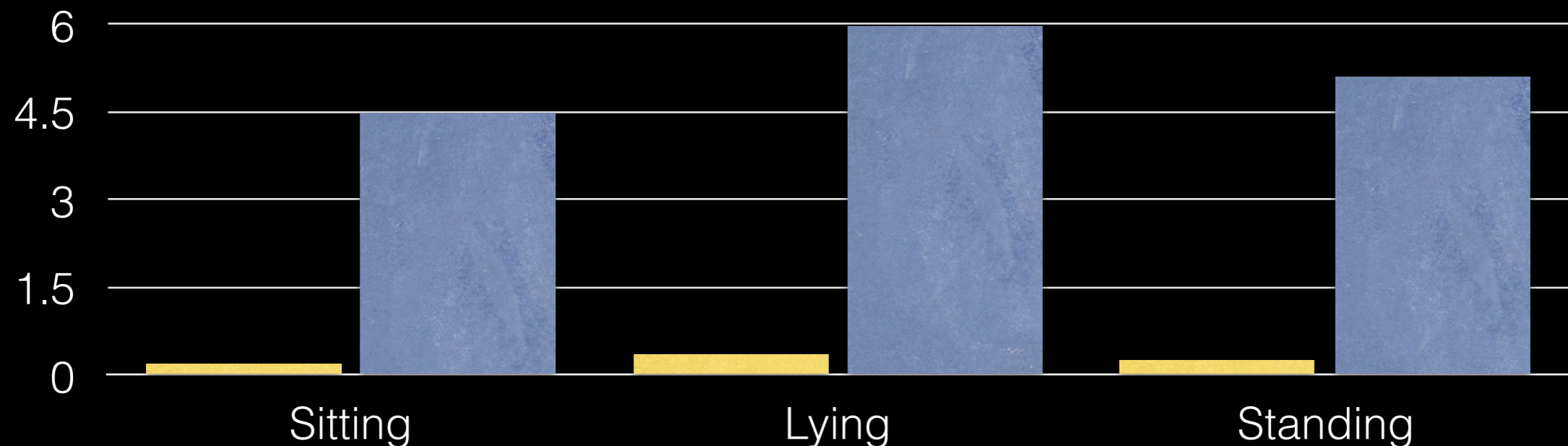
■ Breathing rate

■ Heart rate

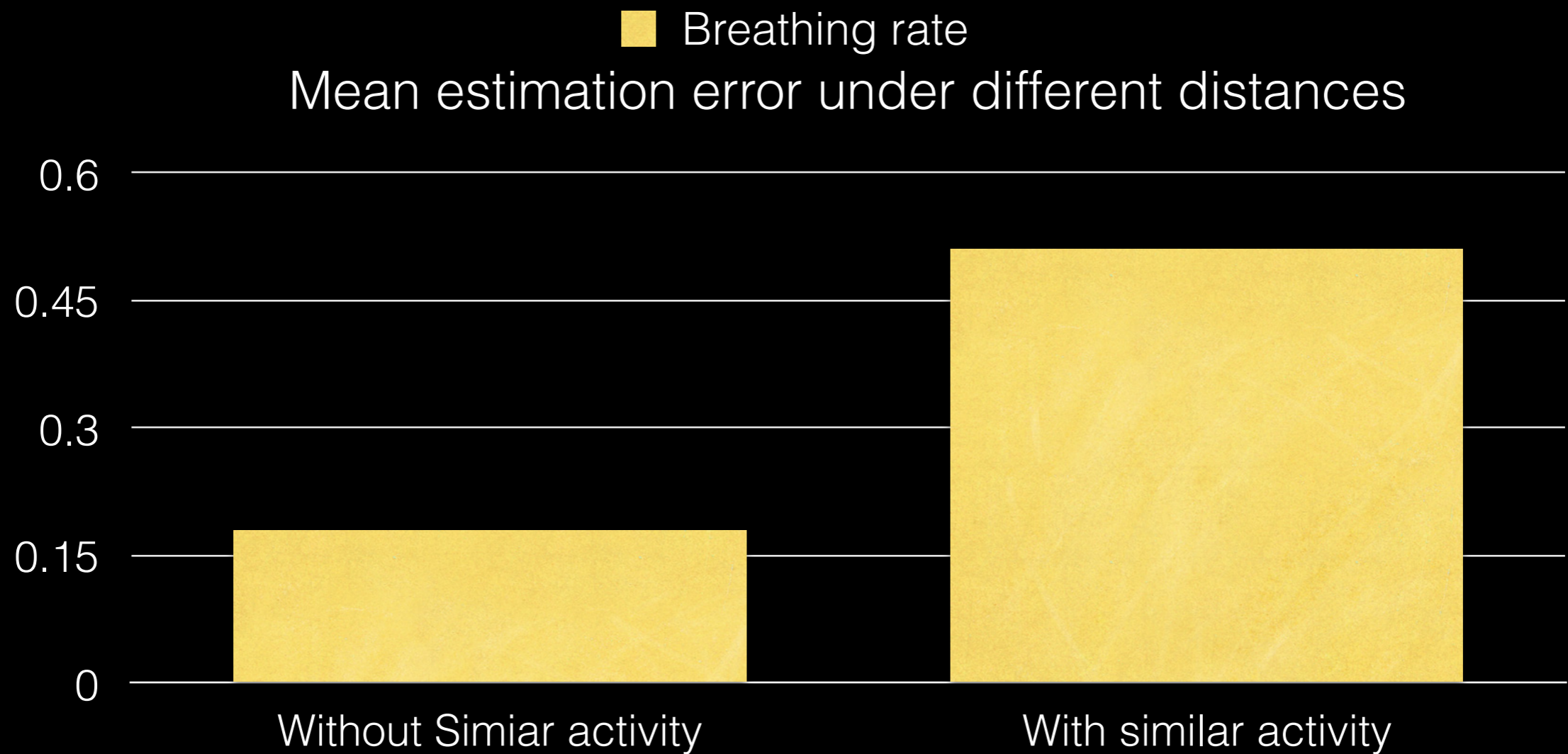
Mean estimation error under different distances



Mean estimation error under different postures



# Experimental Evaluation



# Conclusion

- We show that Wi-Fi signals can be used to detect living people and estimate vital signs in rescue environments using commercial Wi-Fi devices.
- Our system can accurately estimate human vital signs under different distances, postures, and the influence of similar activities.