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学术论文

基于LORA信号的远距离非接触感知

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Exploring LoRa for Long-range Through-wall Sensing

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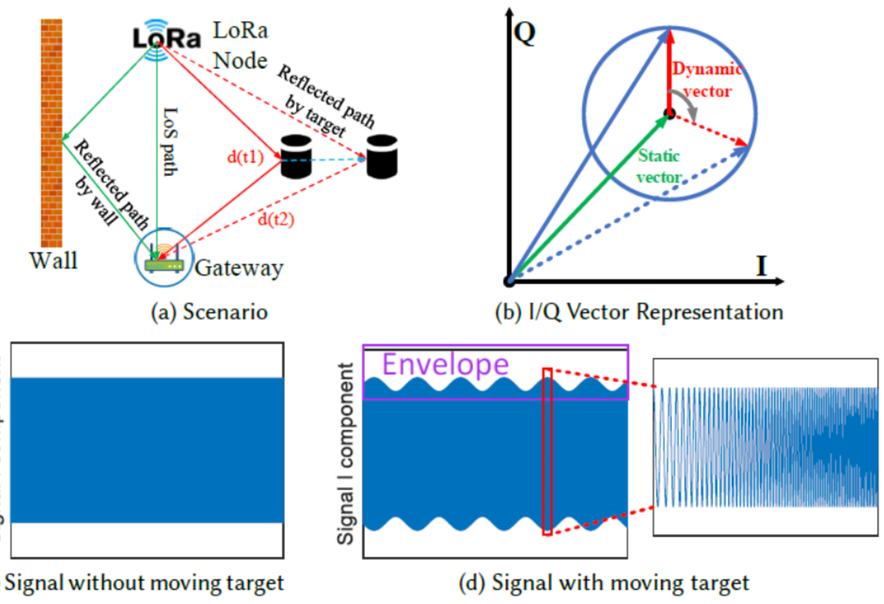
Motivation

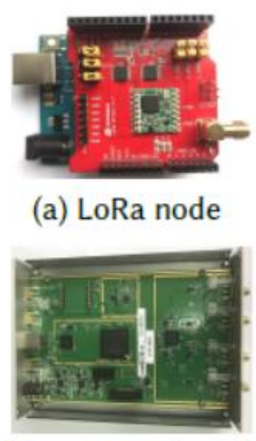
- Wireless signals have been extensively utilized for contactless sensing in the past few years. Due to the intrinsic nature of employing the weak target-reflected signal for sensing, the sensing range is limited.
- We identify exciting sensing opportunities with LoRa, which is the new long-range communication technology designed for IoT communication. This work explores exciting new opportunities to significantly increase the sensing range with the introduction of LoRa. Experimental results show that (1) human respiration can still be sensed when the target is 25 meters away from the LoRa devices; and (2) human walking (both displacement and direction) can be tracked accurately even when the target is 30 meters away from the LoRa transceiver pair.

Understanding LoRa Signal for Sensing

- As the first work on LoRa passive sensing, we analyze the propagation process of the LoRa signal from a LoRa node to a LoRa gateway. We develop novel sensing techniques to increase the sensing range significantly.
- Our LoRa sensing prototype is composed of one LoRa transmitter and one LoRa receiver. The LoRa transmitter is Semtech SX1276 with an Arduino Uno. Our LoRa gateway is based on USRP B210 and GNU Radio.

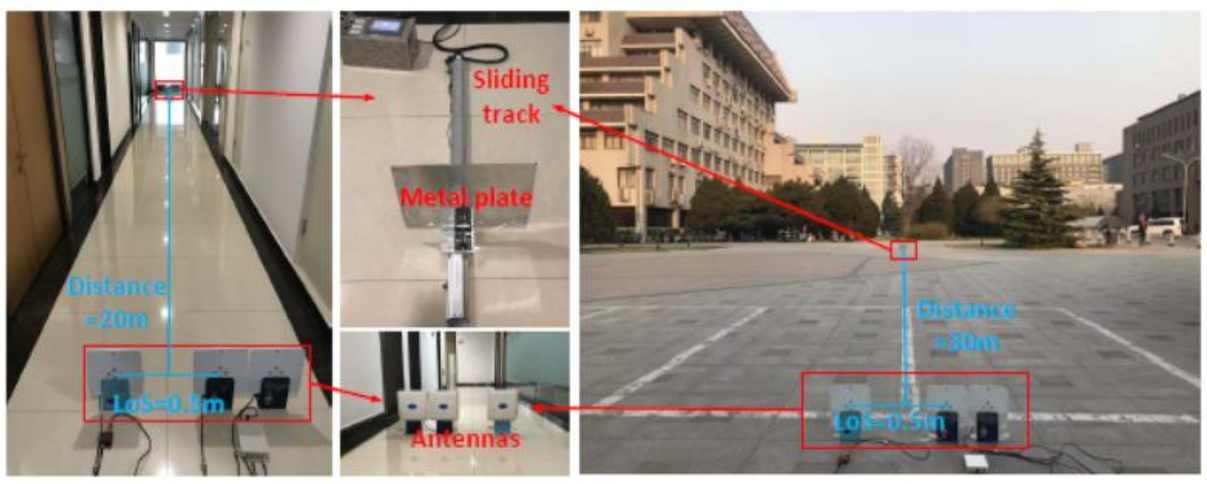


The received signal with/without moving target in the environment.



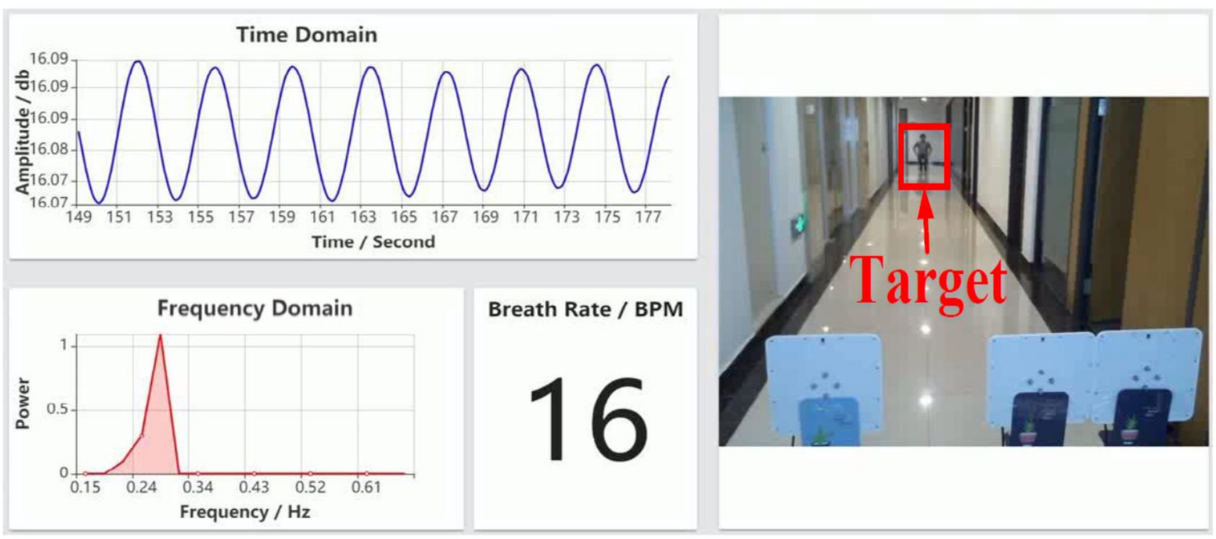
(a) LoRa node

(b) USRP-based gateway

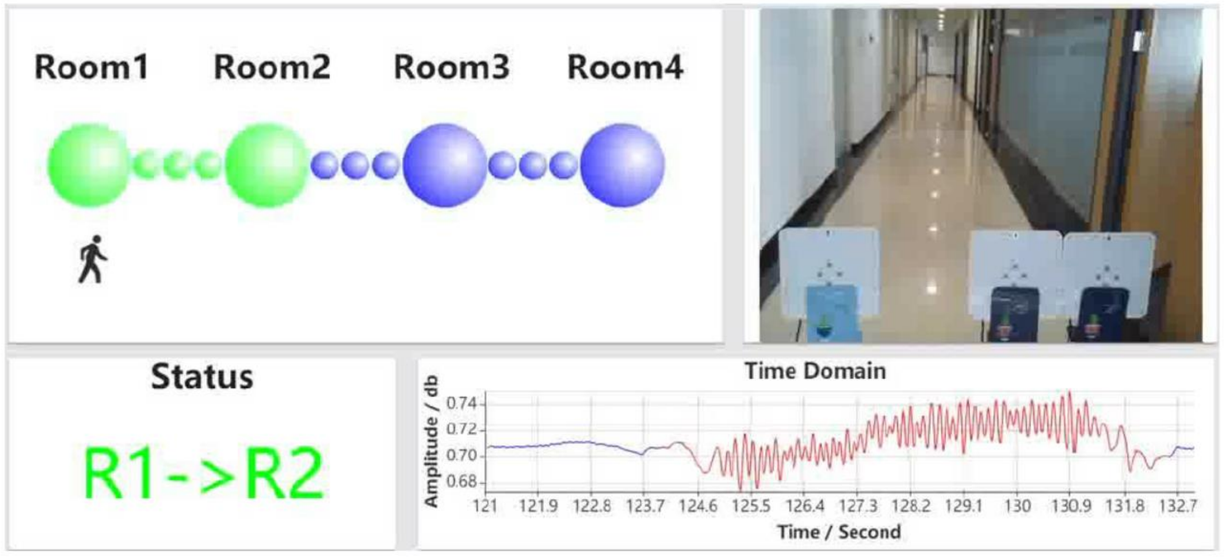


(c) Test environments

Experimental setup.



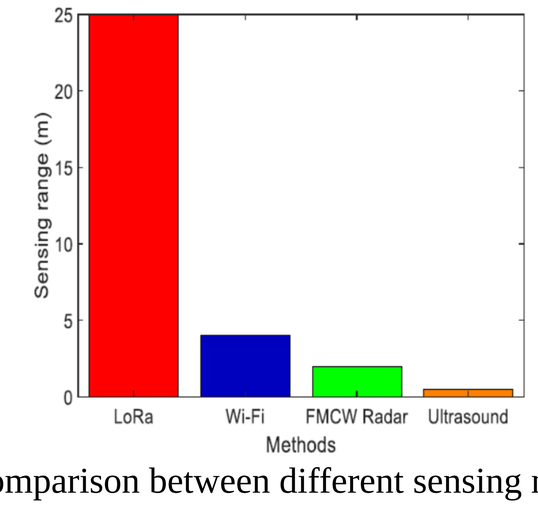
Long range human respiration detection



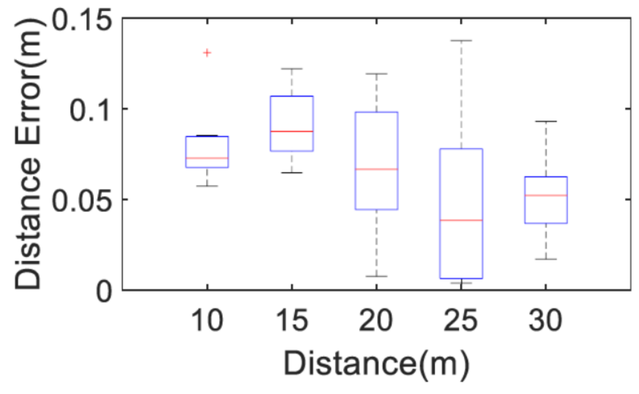
Long range human tracking

Evaluation & Results

- We compare LoRa sensing approach with other existing sensing methods, including WiFi, FMCW radar, and Ultrasound. The sensing ranges for WiFi, FMCW radar and Ultrasound are 4 m, 2 m and 0.6 m, respectively.
- We conduct experiments to estimate human tracking accuracy. We present the displacement estimation errors at different distances. The average displacement error with real human targets is 6.8 cm.



Comparison between different sensing methods



Moving distance accuracy