精读

Exploring LoRa for Long-range Through-wall Sensing

Summary

- LoRa (chirp-based) for human respiration sensing (25m, 15m for through wall) and tracking (30m, from one room to another room).
- Key idea: the proposed Ratio of Received signal of two Rx.
- System Implementation
    - LoRa node (Arduino Uno) with one Tx and two Rx
    - Gateway (USRP B210 and GNU Radio)
- Experiments
    - Sensing range: 18m~35m (outdoor), 25m~50m (indoor)
    - Sensing Granularity: 1mm (25m)

Novelty

- Propose to utilize the **Ratio of signals** received by two different antennas at the Rx, which helps to
    - cancel out the noise and improve the sensing range (by the **division operation**) according to eq.5.
    - cancel out the negtive impact of random signal phase offset caused by the time-asynchronization between the Tx and Rx (because the phase offset is the common divisor on the two Rx antennas).

Strength

- long-range (5m to 25m, 5m to 15m for through wall) human respiration rate sensing
- mm-level movement (back and forth) sensing for long-range sensing.
- Robust to indoor environment changes as the LoRa signal can penetrate the wall as wall as these furniture.

Weakness

- The theoretic assumes that the complex signal on the I/Q plane can be a circular. But it is not true in realistic which lacks related discussion.
- The so-called tracking: the walking direction estimation is not convincing. Only take forward/back into consideration?

泛读

WiBorder: Precise Wi-Fi based Boundary Sensing via Through-wall Discrimination

Summary

- Proposed a innovative technique for accurate determination of wifi sensing boundary: DCM-CSI, a novel CSI metric from the conjugate-multiplying CSI, capable of distinguishing direct and indirect signals.
- Proposed
    - a wifi intrution detection system: 99.4% detection rate
    - an area detection system: 97.03% detection rate

Intuition of WiBorder

- the impact of inside-wall and outside-wall activities (i.e., direct and indirect/through-wall reflected signals) to wifi can be different, which can be utilized for intrution detection.
- the mathematical relationship between human movement and DCM-CSI is the derieved variation parameter after applying conjugate operation to one of the two antennas' samples.

Experiments

- Intrusion detection
- Area detection: multiple Rx

Weakness

- The impact of environment changes?
- what determines the threshold of discrimination? is the distance between the Tx and Rx?

MagHacker: Eavesdropping on Stylus Pen Writing via Magnetic Sensing from Commodity Mobile Devices

Summary

Solved Problems

- Using only one magneticmeter on the commodity device to eavesdrop compared with other works using multiple custom magnetometers.

Main Idea

The magnetometer readings can be divided into small segments and translated into writing trajectories for letter recognition.

The proposed sytem

- segmentation: exploit the fluctuation of human's speed of hand movement in writing which changes less frequently in transition between letters.
    - compute mean amplitude of CWT spectrum --> the highst derivative after each valley of mean amplitude can be considered as the starting point of writing next letter.
- handwriting trajectories: coordinate projection and transformation
    - 3D magnetometer data --> 2D plane trajectories
- Recognition: CNN (with training data augmentation)

Experiments

- Setup:
  - Stylus pen and smartphone with a distance of 10cm.
  - Three English letters every time: L1L2L1
  - Repeat five times for each
  - Uppercase and Lowercase letter are **separately** collected.
- Results:
  - Lowercase/uppercase: 77.7% / 80.1%
  - 15cm/20cm: 70%/60%
  - Writing speed: 1 letter/sec(>75%)
  - Different position (the speaker of smartphone cause great degradation on the performance)
  - Different stylus pen models (87.1%)
  - Different surounding electronic devices, i.e., laptop aside, wearing watch on the left hand (around 85% without great variation)