WiFi Sensing for Health Application

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Introduction

- WiFi sensing is a method to detect the presence or motion of humans or objects within a wireless network by analyzing signal propagation changes utilizing learning algorithms.
- Wi-Fi provides an easily accessible source of opportunity for people tracking, it does not have the limitations of video-based systems; furthermore, it has higher availability and longer range than other signal-based systems such as ultra-wideband (UWB).
- Vision-based people tracking systems have been widely used recently for different applications such as activity classification, gesture recognition, elderly people monitoring, and people counting. However, these systems have many limitations in NLOS environments, in the dark, through smoke or walls; they are also computationally intensive and have lower localization accuracy.

Applications of WiFi based sensing

1. health monitoring
2. activity classification
3. gesture recognition
4. people counting
5. through the wall sensing
6. emotion recognition
7. attention monitoring
8. Imaging
9. keystrokes recognition
10. step counting
11. speed estimation
12. sleep detection
13. traffic monitoring
14. smoking detection
15. metal detection
16. sign language recognition
17. humidity estimation
18. wheat moisture detection
19. fruit ripeness detection

Fig.2 Some applications of wifi based sensing

WiFi based sensing for detecting human motion

- Physical layer CSI was utilized as a primary indicator for human motion. When a WiFi signal propagates along multiple paths in an environment, a moving target would affect a fraction of propagation paths and be depicted by CSI variations.
- It is considered symptoms related to hand movement as target motion and hypothesized that such movement would cause temporal variations in CSI, which can be collected from commodity WiFi devices.
- To describe the basic model of CSI, the wireless channel in the frequency domain should be defined first:

$$Y = H \times X + N$$

where H is the channel matrix of CSI; Y and X are the received and transmitted signal vectors, respectively; N is an additive white Gaussian noise vector.

➢The variations in CSI amplitude, phase, and phase difference are detected to quantify the target motion. The WiFi devices are set up to collect CSI data when target motion and the collected CSI data is processed as shown in Fig. 3.

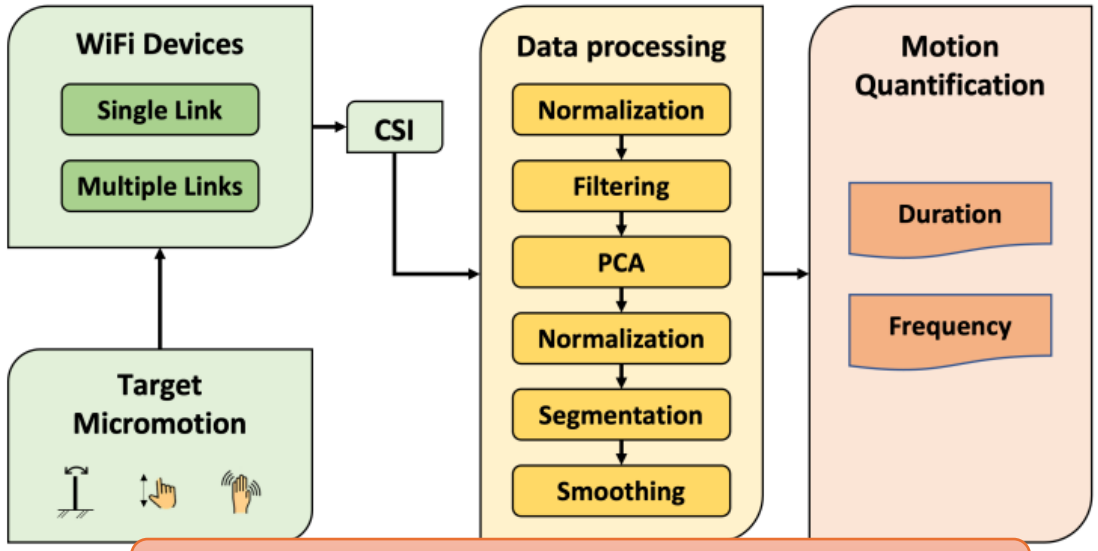

Fig. 3 CSI data processing procedure.

➢A normalization process is applied to CSI, then a Butterworth filter is used to remove undesired noise which could be due to the environment or hardware, from the normalized CSI sequence.

➢principal component analysis (PCA) is performed to find the best presentation of signal response to the target motion. The reason for this step is that the CSI contained data in subcarriers, but only some of them provided useful information related to the target motion.

- Then the best principal component is determined as the one with the largest variation in the normalized amplitude of the data when a second normalization process is applied.
- A short-time energy threshold segmentation is used to distinguish between the active and rest states.
- Finally, a filter with a window length of n is used to smooth the data.

References

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Thank you