Non-contact breathing activity monitoring

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Basic principle. The principle relationship between the phase \( \Phi(t) \) and traveling distance \( d(t) \) of a wireless signal is formulated by \( \Phi(t) = 2\pi d(t)/\lambda \), with \( \lambda \) is the wavelength. Hence, by analyzing the phase change of the received signal, distance change between radar and chest surface can be inferred.

Our system is named WiSpiro. In WiSpiro, the chest displacement is inferred to breathing volume through a neural network training technique.

Objectives:
- Estimating volume in fine-grained, not the rate.
- Dealing with non-periodic or irregular body movement during sleep.

System Design:

**SYSTEM DESIGN**

#### MOTIVATION
- Continuous and fine-grained breathing volume monitoring plays an important role in healthcare.
- Diseases such as asthma, chronic obstructive pulmonary disease (COPD), cystic fibrosis, tuberculosis could be detected.
- Existing approaches are intrusive, expensive, or coarse-grained. With the presence of patient body movement and posture changes, long-term monitoring of breathing volume at fine granularity is even more challenging.

#### CHALLENGES
- Respiration volume information is buried in the very minor phase shift of the reflected signal.
- Phase shift is fluctuated as the distance between the radar and subject is changed, or influenced by the imperfection of the hardware circuitry, or the non-linear/abnormal breathing behavior of the subjects.
- A minor non-respiratory movement could cause significant volume estimation error. That movement makes radar beam to new area on human’s body, which leads the estimation inaccurate because different areas on the human chest move differently (while they reflect the same breathing volume).
- Posture change or body part’s movements, e.g., subject’s arms, also might block the chest movements to be seen by radar.

#### ONE-TIME TRAINER

**VOLUME ESTIMATOR**

Correlation Function from One-Time Trainer

**RADAR NAVIGATOR**

Machine Learning Technique (Focus on MFCC features)

**SYSTEM PERFORMANCE**

Volume estimated in stationary case vs. spirometer measurement.
Mean error of 0.0211, max error of 0.0511

**CONTACT US**

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