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Master's Thesis

Breath Pattern Monitoring and Recognition Analyses with mmWave Sensor

Abstract

Millimeter-wave (mmWave) radar sensing offers a powerful, contactless approach for capturing subtle physiological motions associated with respiration. The temporal dynamics of breath- ing behaviors like normal respiration, deep breathing, hyperven- tilation, and apnea encode valuable information about human respiratory health and metabolic activity. This thesis explores the use of advanced radar-based sensing for analyzing exhaled breath dynamics, with a focus on respiratory pattern recognition and health anomaly detection. Using the MR60BHA2 60 GHz mmWave sensor and ESP32-based platform, the student will per- form systematic experiments across a wide range of conditions. By exploring how the sensor detects breath variations through chest movement, this thesis contributes to establishing ground truth for bio-inspired sensing, non-invasive health diagnostics, and respiratory monitoring.

Content

This thesis aims to evaluate the MR60BHA2 60 GHz mmWave sensor with an ESP32 setup for monitor- ing and analyzing diverse breath patterns to support respiratory diagnostics.

- Literature survey on breath pattern recognition and familiarizing with the mmWave sensor
- Data collection and parametric evaluation of sensor under distance, orientation, occlusion, etc.
- Quantitative analysis of signal quality, stability, and robustness under real-world conditions
- Extraction of both time-domain and frequency-domain features
- Implementation of machine learning pipelines to classify breath patterns
- Mapping features to potential clinical applications like sleep apnea detection, infection/fever screening, etc.

Requirements

- Basic understanding of Signal Processing and Pattern Recognition
- Basic understanding of Molecular Communication is preferred but not mandatory
- Good practical skills in MATLAB or Python programming languages
- Interest in hardware design & development

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