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Remote Sensoric Detection of Human Vital Signs

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IT SPY

Motivation & Problem

- Remote **breathing** assessment for **industrial** settings (e.g., CERN LHC tunnels) with slow responder access; wearables often impractical due to **data privacy**.
- **Goal**: Assess a prototype of the Fraunhofer FMCW radar RR detection vs. clothing, posture, distance, obstacles, and ambient noise.

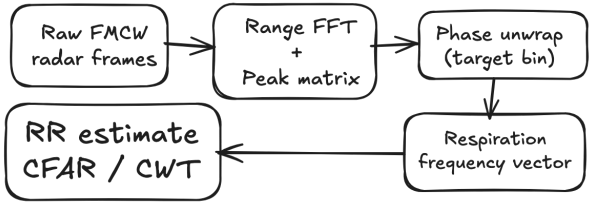
Objectives

- Use 80 GHz FMCW radar to extract RR.
- Validate with PLUX chest belt (contact) and Baumer OM70 laser (non-contact).
- Study limits across **postures**, **patterns**, **clothing**, **distance**, **occlusions**.
- Fig.: 1) radar, 2) laser, 3) chest belt.

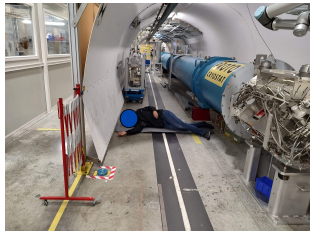
RR sensors

Methodology

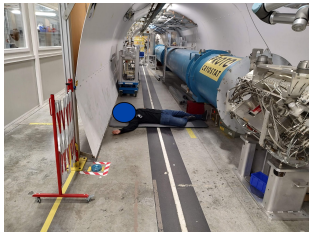
- **Multi-sensor sessions**: Synchronized measurements with Fraunhofer 80 GHz FMCW radar, PLUX chest belt (contact), and Baumer OM70 distance laser (non-contact) for reference and validation.
- **Models**: Evaluated Constant False Alarm Rate (CFAR) peak detection, the industry standard in radar processing, and Continuous Wavelet Transform (CWT)–based detection as an exploratory method. Parameter scans assessed robustness across conditions.
- **Scenarios**: Tested under varied conditions including a person sitting or lying (back, side, stomach), different clothing, distances, and plexiglass obstruction.



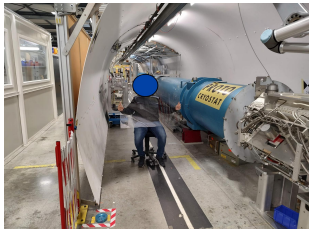
Signal-processing pipeline



Side, front-facing



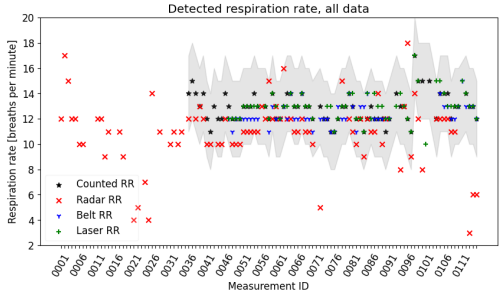
Lying on back



Sitting, plexiglass

Key Results – Overview

- **Data acquisition**: Synchronized datasets from Fraunhofer 80 GHz FMCW radar (prototype, undocumented), Baumer OM70 laser, and PLUX chest belt. Custom software implemented parametric RR models.
- **Respiratory rate detection**: Robust RR identified in several scenarios, showing feasibility despite environmental variability.
- **Signal processing**: Tuned thresholds, outlier filters, and alternative peak detection improved robustness.
- **Application**: Developed *HealthDetection-Sample*, packaged as a standalone containerized tool.
- **Limitations**:
  - **Environment**: requires line of sight; obstacles reduce reliability.
  - **Device**: radar needs active cooling.
  - **Human factors**: diaphragm region most reliable; shallow/rapid breathing and motion problematic.
  - **Models**: limited performance on highly volatile signals.
- **Overall**: FMCW radar is viable for remote RR detection; parametric models increase reliability within known limits.



Summary of detected respiratory rate by sensor.

Key Results – Recommendations

- **Location**: Thorax most stable across postures/clothing.
- **Patterns**: Normal/deep reliable; shallow/rapid weak.
- **Range**: Several meters; obstacles/plexiglass lower SNR.
- **Models**: CFAR/CWT consistent with calibration when well-tuned.

Applications & Impact

- **Industrial safety**: Remote checks in hazardous zones.
- **Rescue robotics**: Pre-arrival status for operators.
- **Healthcare R&D**: Basis for non-contact monitoring.

Contact & Code

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