UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

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mmW FMCW-RSoC for Biometrics

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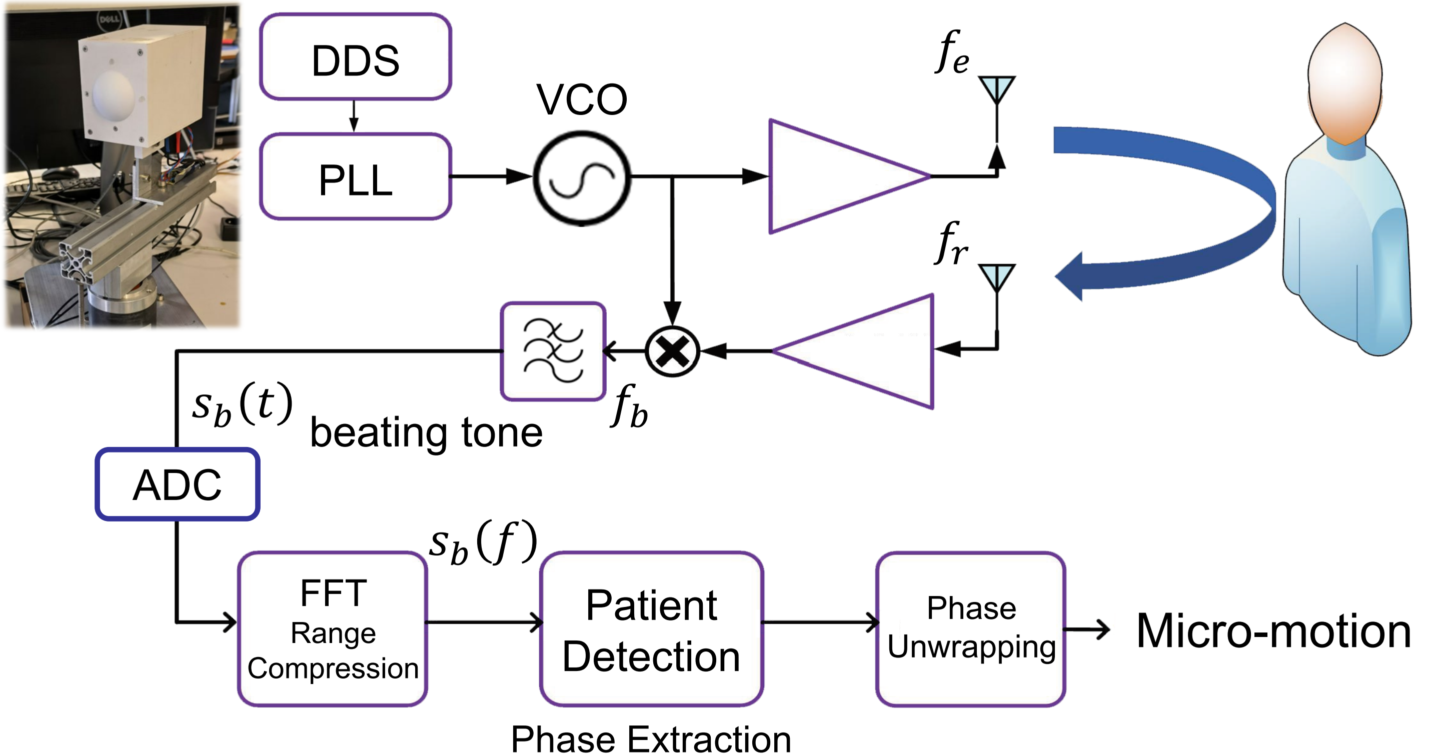
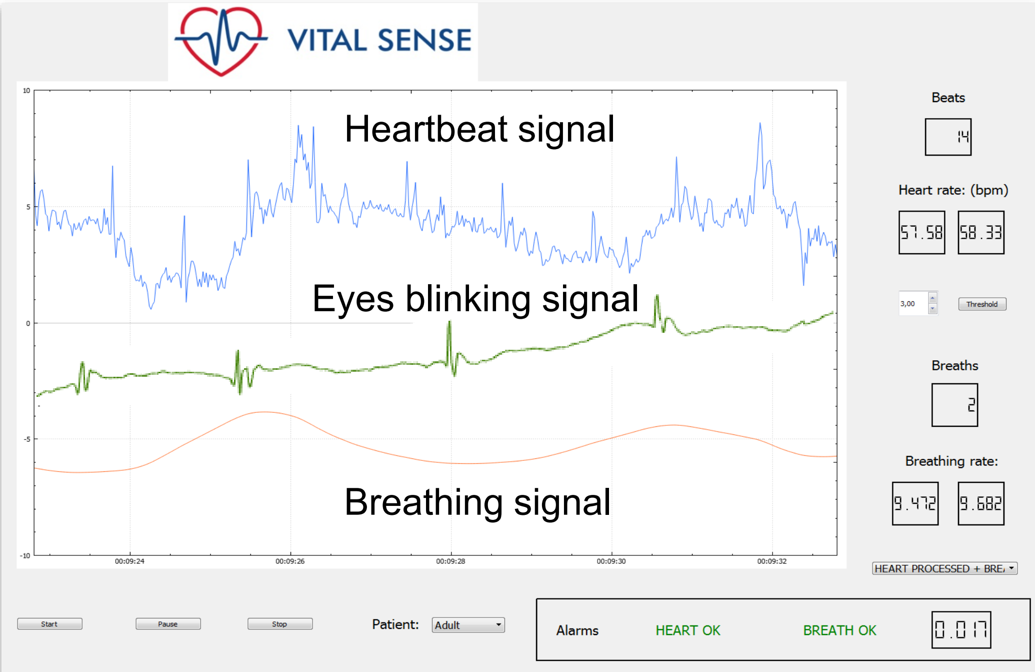
FMCW Radar
Block Diagram



- The FMCW Radar at 120 GHz senses micrometric motion of the body without contact
- Textiles are transparent at radar frequencies allowing monitoring in all situations

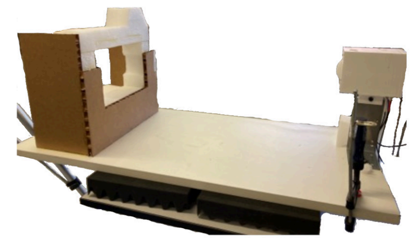
Sensed Vital Signals



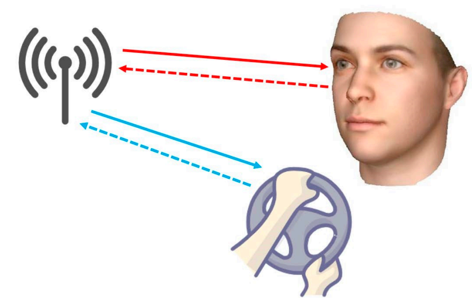
Real Time Vital Parameters monitoring with 120GHz Radar

Eyelid detection:

Case 1: Clinical Assignment



Case 2: Driving Behavior



J. Hu et al., "BlinkRadar: Non-Intrusive Driver Eye-Blink Detection with UWB Radar," 2022 IEEE 42nd International Conference on Distributed Computing Systems (ICDCS), Bologna, Italy, 2022.

Breathing/hearbeat signals:

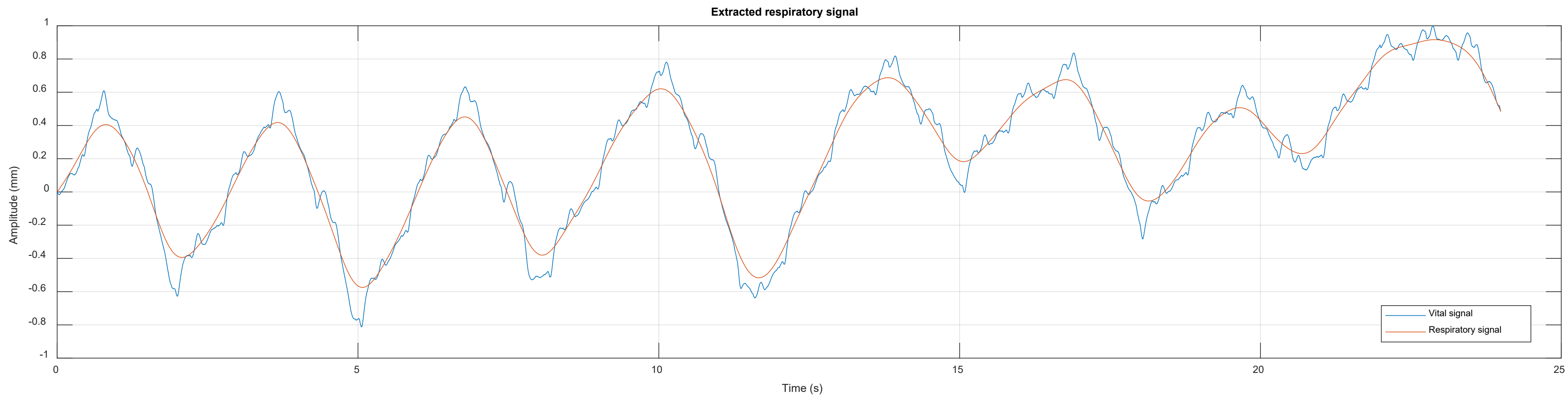
$$s(t) = R_0 + A_b \sin(2\pi f_b t) + A_h \sum_{n=0}^{\infty} p_h(t - nT_h) + N$$

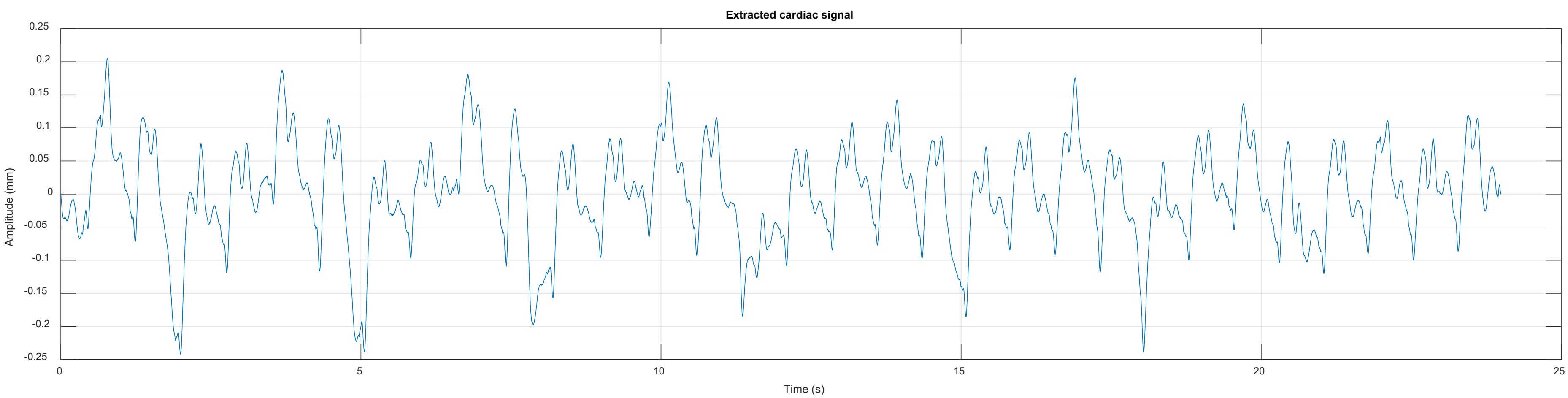
Eyelid signal:

$$s_e(t) = A_e \sum_{n=0}^{\infty} p_e(t - nT_e) + N + A_m M(t)$$

Results
Signal Separation

- Extract breathing signal s_b with FIR linear-phase filter
- Heartbeat signal $s_h = s_{vital} - s_b$





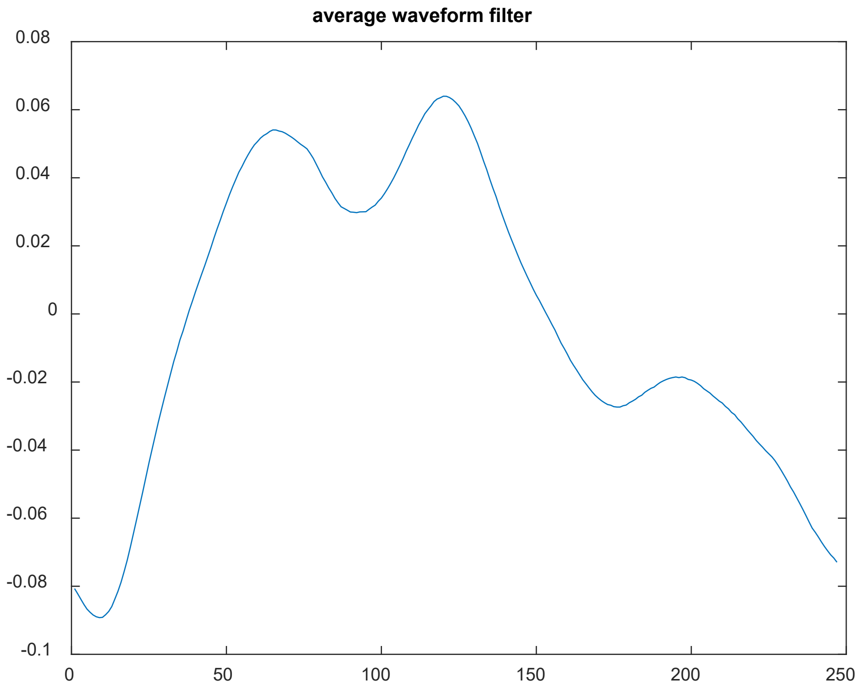
Results

Repetitive Waveform Adaptive Matched Filter

The developed real-time RWAMF has 3 main components:
Phase A: Iterative pulse period estimation
Phase B: Pulse waveform reconstruction -> Adaptive Matched Filter
Phase C: Final cardiac waveform parameters extraction

Main Outcomes:

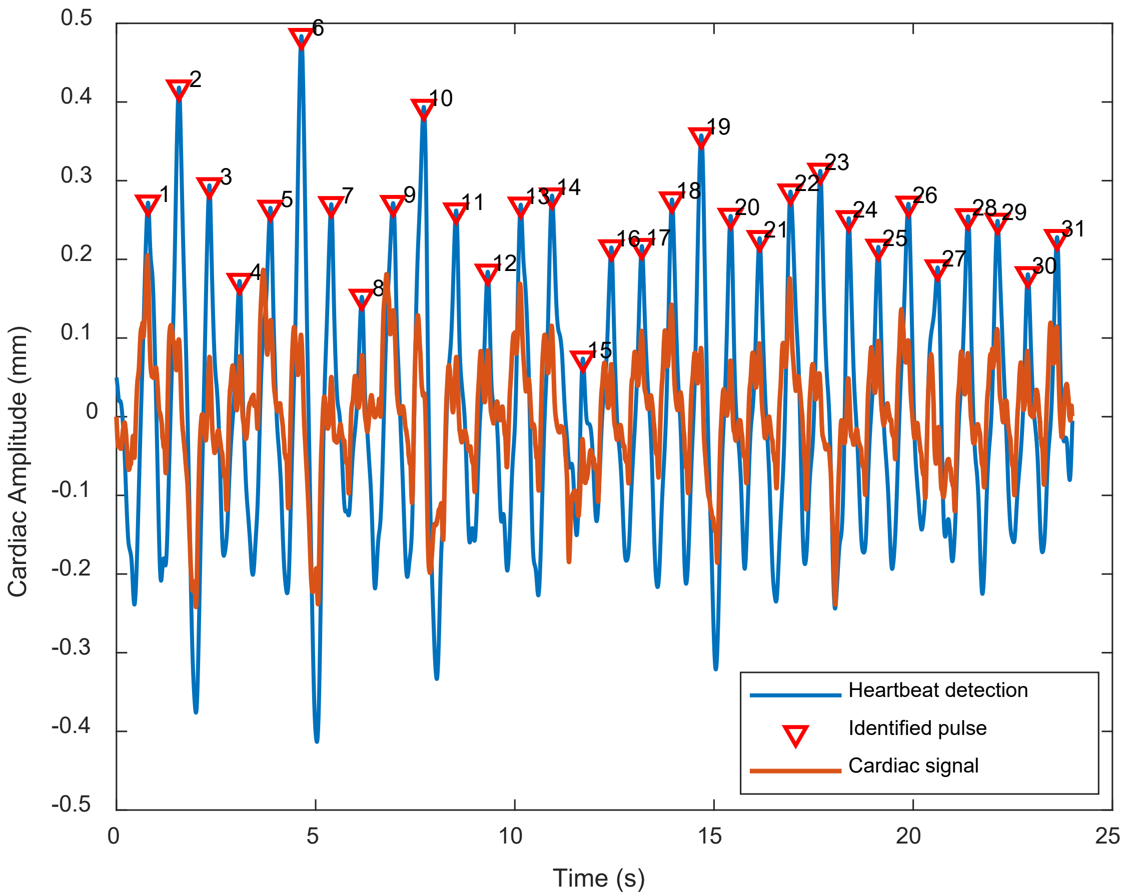
1. Pulse repetition interval, Heartbeat rate, Detection of abnormalities
2. Blood pressure waveform



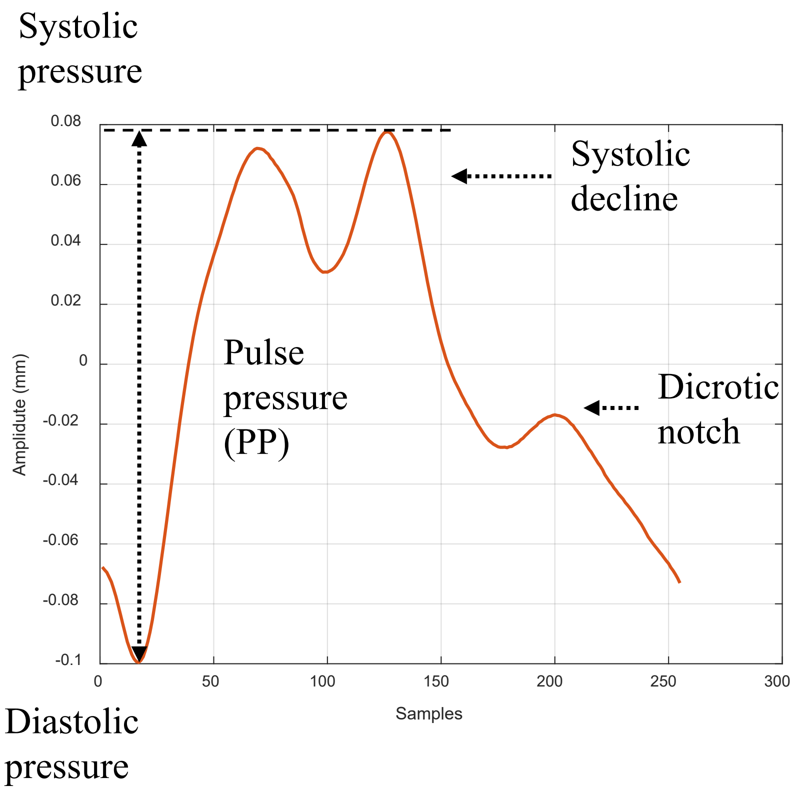
Results
Cardiac Pulse Identification

Phase C

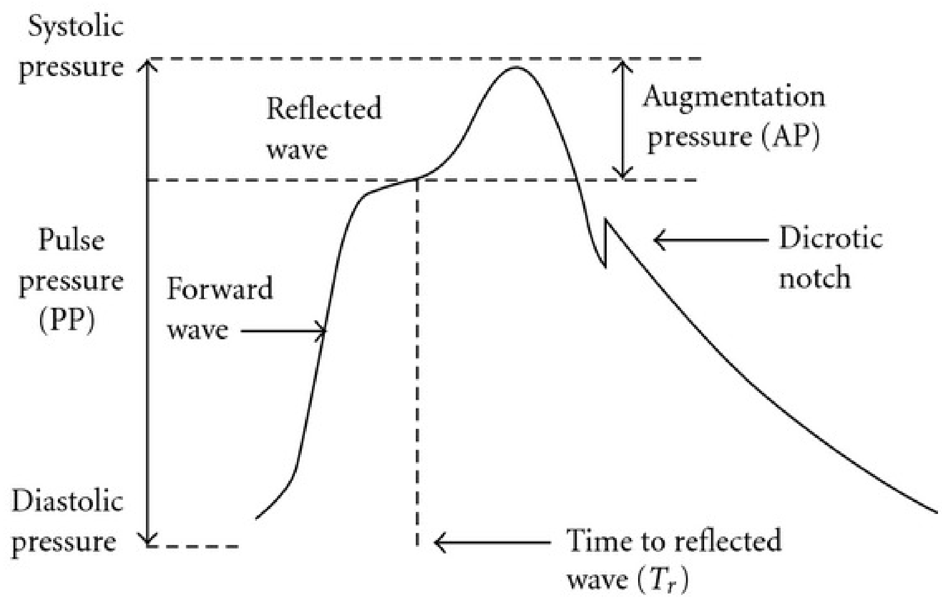
- Adaptive matched filtering
- Peaks and periods estimation $\rightarrow T_d$
- Blood pressure waveform reconstruction



Results
Blood Pressure Waveform Example



Radar sensed Blood Pressure Waveform



Blood Pressure Waveform from contact sensor

Reproduced from Stoner L, Young JM, Fryer S., "Assessments of arterial stiffness and endothelial function using pulse wave analysis". Int J Vasc Med. (2012)

Overall Result