



**Le Quy Don Technical University**  
Department of Microprocessor engineering

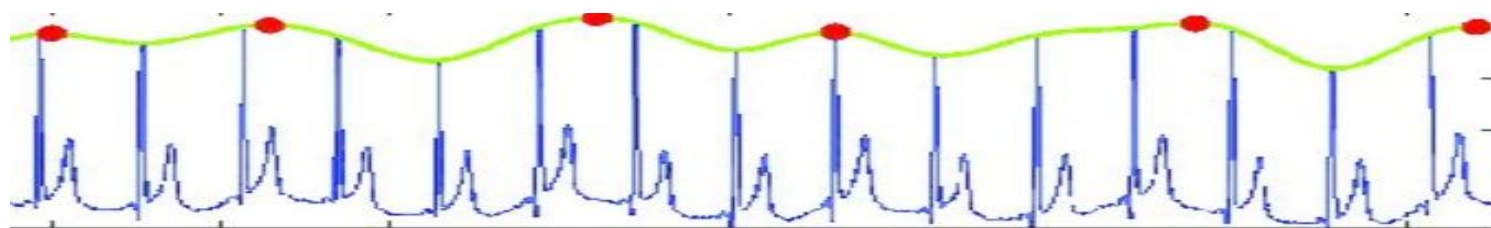


**HealthCare**

# Non-contact Vital Sign Monitoring for Smart Healthcare System

**Hoang Thi Yen**

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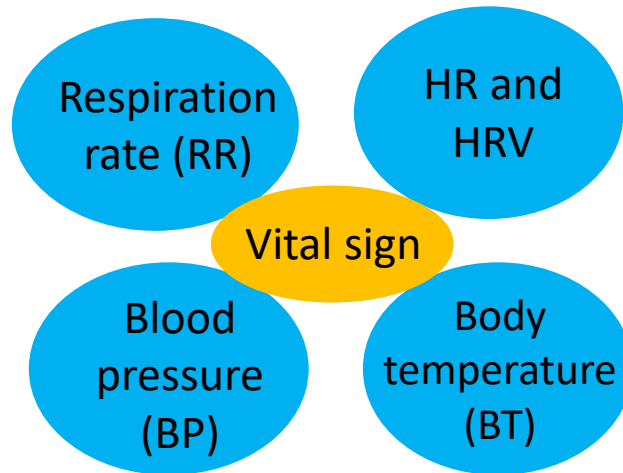
**Conference for young researchers**  
24/4/2025

# Outline

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- 1 Introduction
- 2 Why non-contact sensing
- 3 Our contribution
- 4 Future potential

# Introduction



HR: Heart rate  
HRV: Heart rate variability

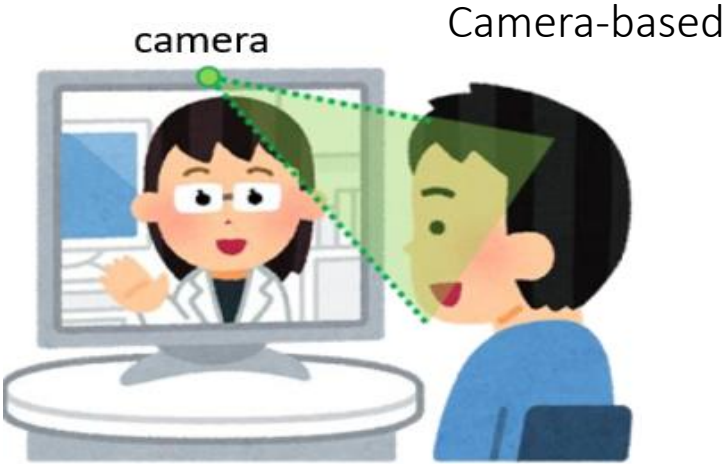
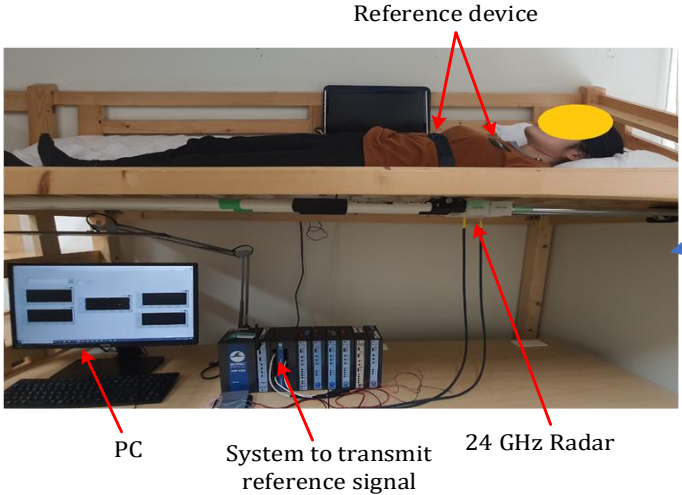
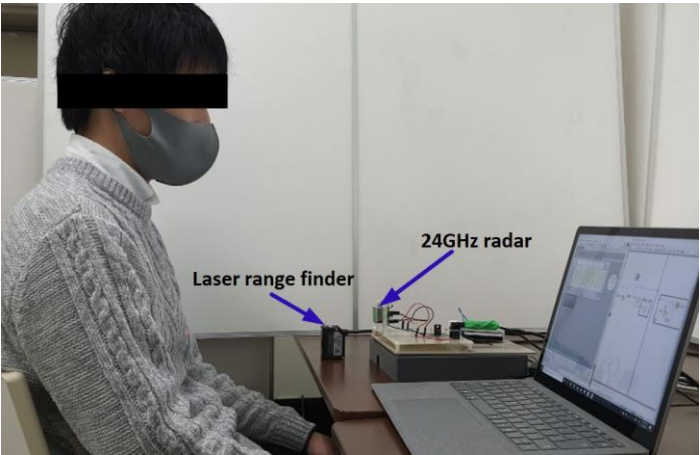
## Traditional contact-method measurements have some limitation

- Uncomfortable
- Not suitable for long term monitoring
- Some device have burdensome system
- Not suitable for pandemic circumstance

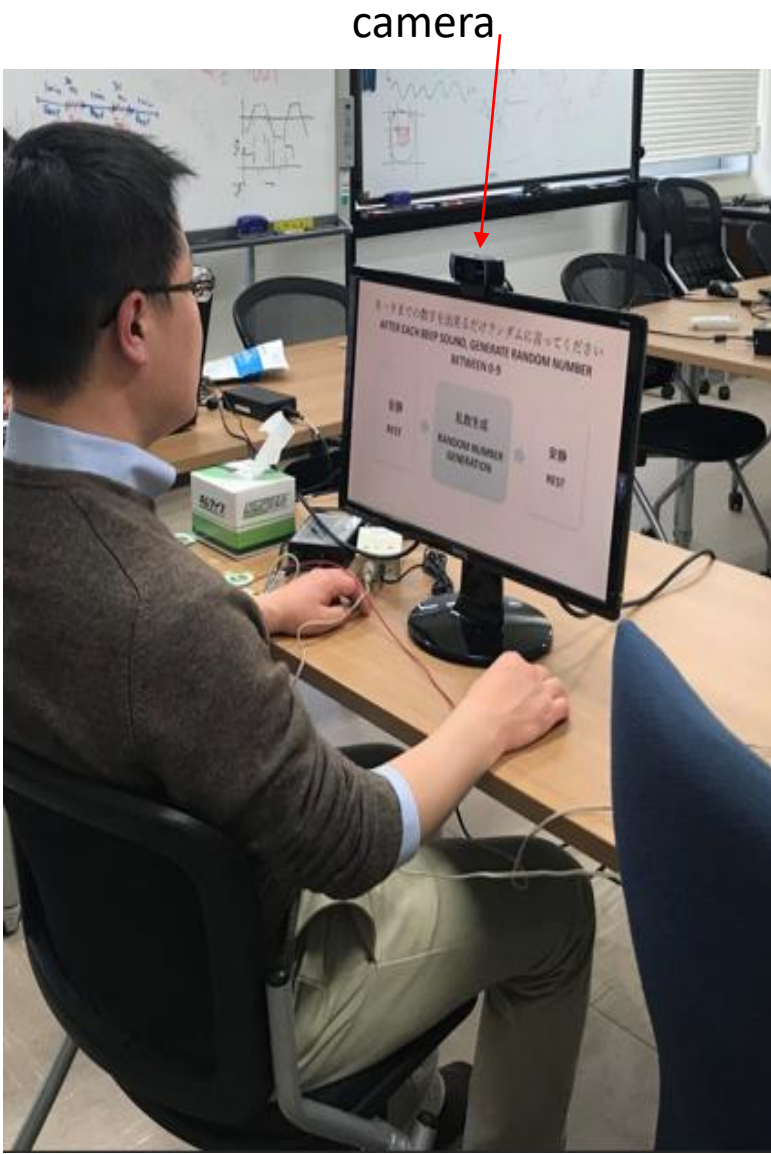
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# Why non-contact sensor

Radar-based

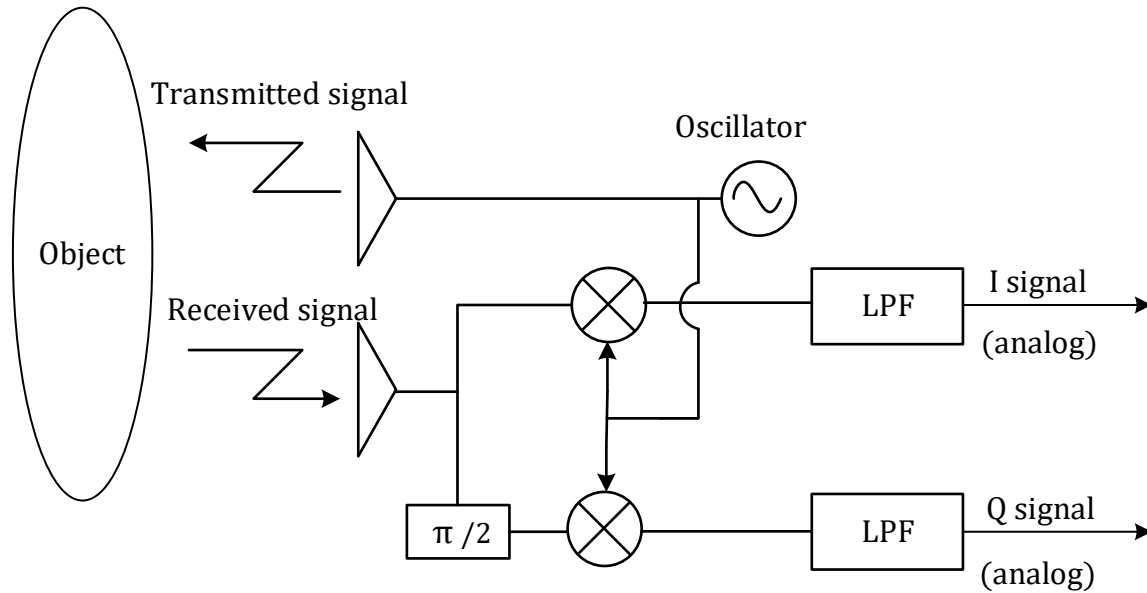


Camera-based



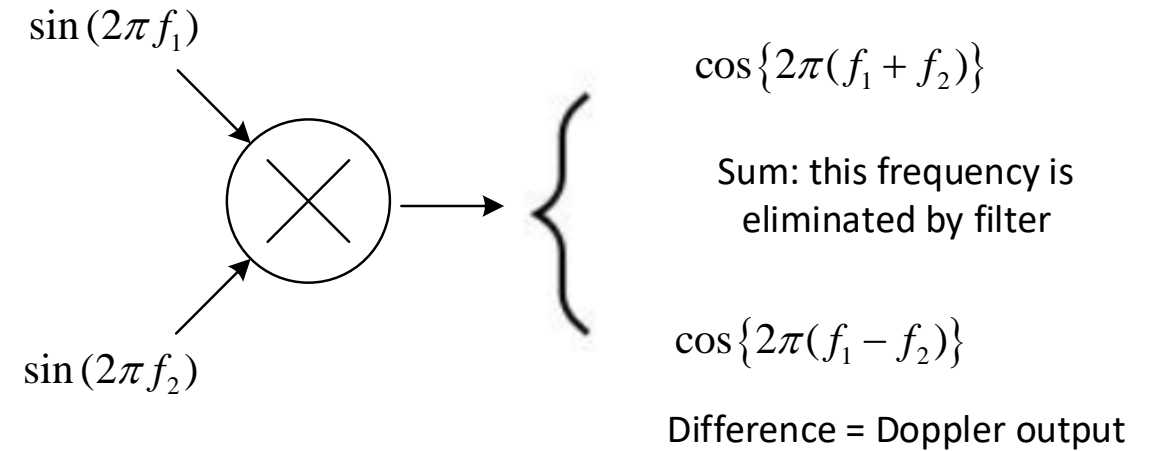
- ✓ Do not require to contact with subjects.
- ✓ Contactless, compact.

# Continuous wave radar based



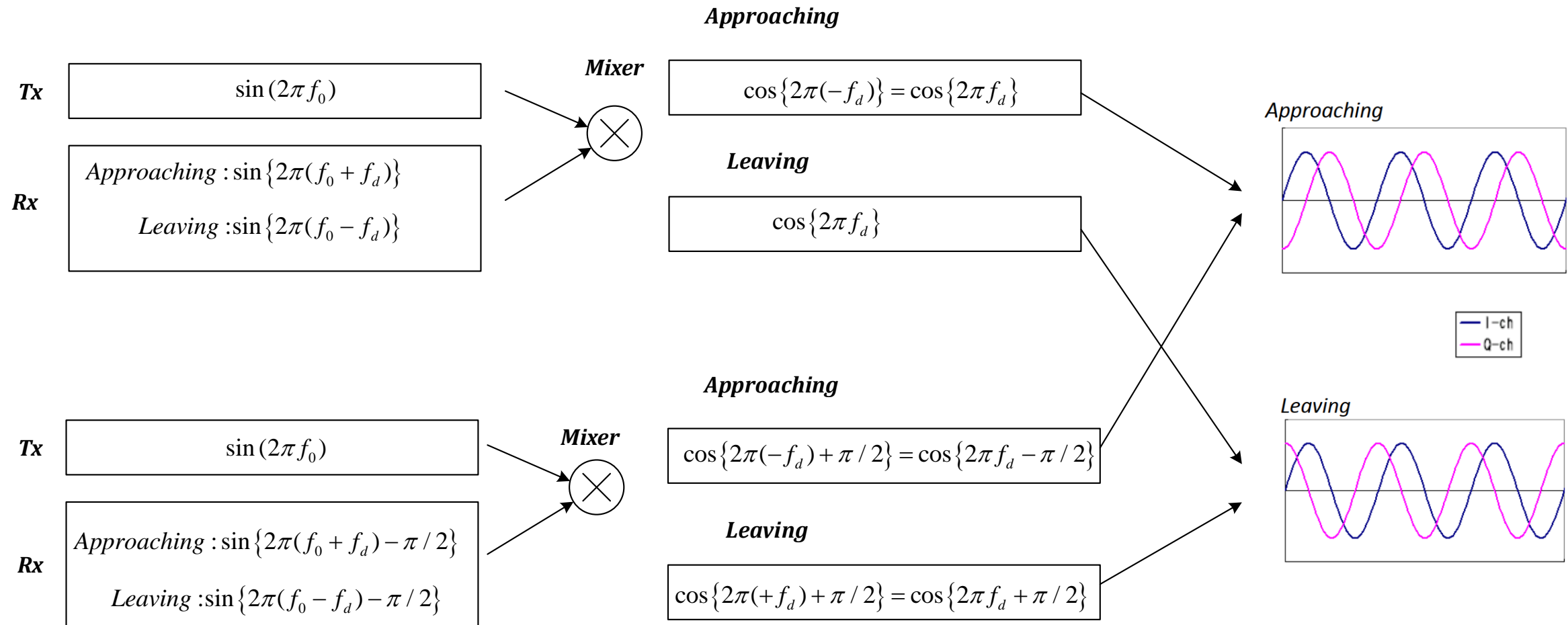
Structure of CW Doppler radar

$$\sin a \cdot \sin b = \frac{1}{2} [\cos(a - b) - \cos(a + b)]$$



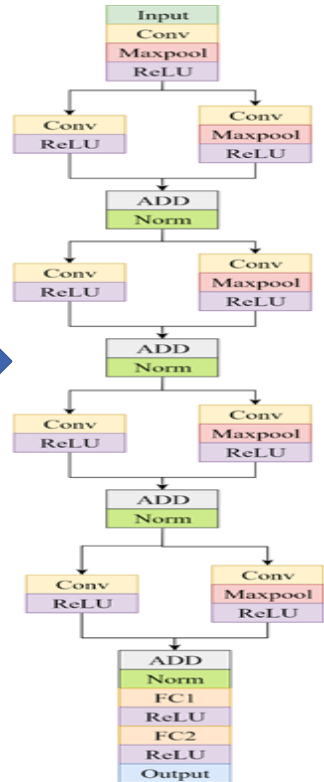
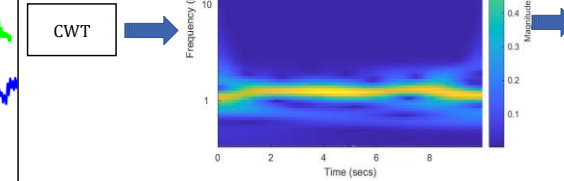
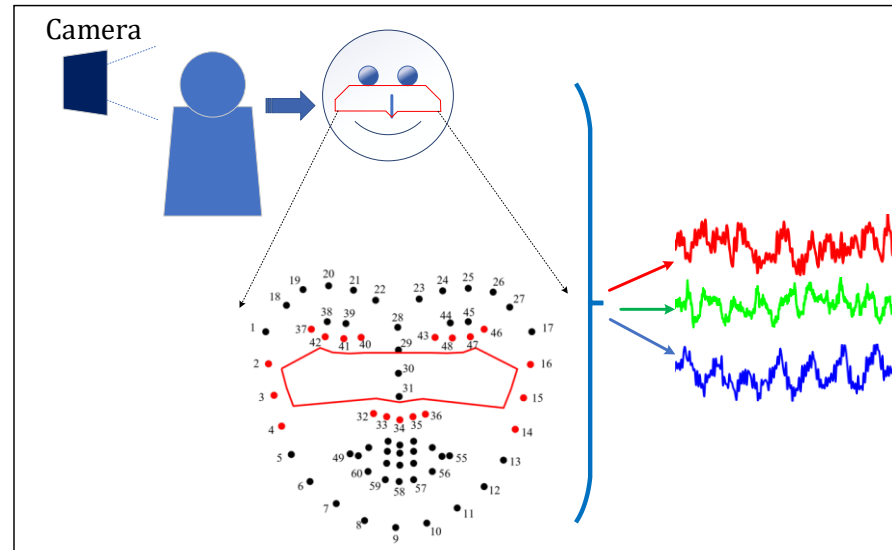
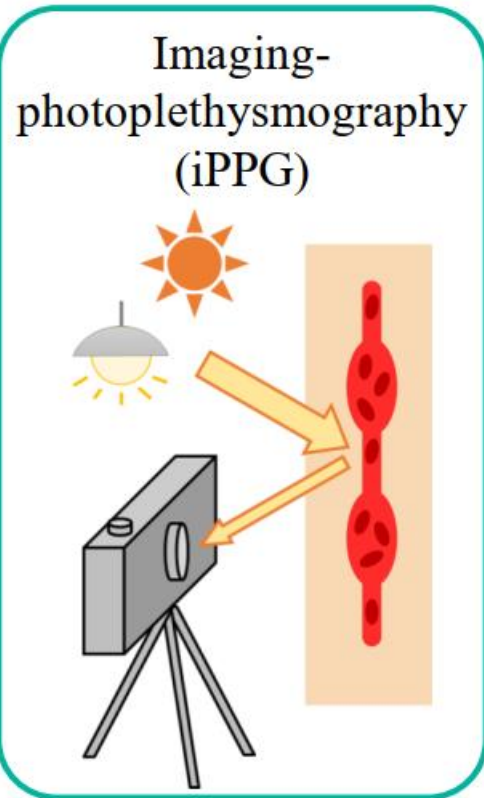


# Continuous wave radar based



Doppler radar principle of receiving baseband signal

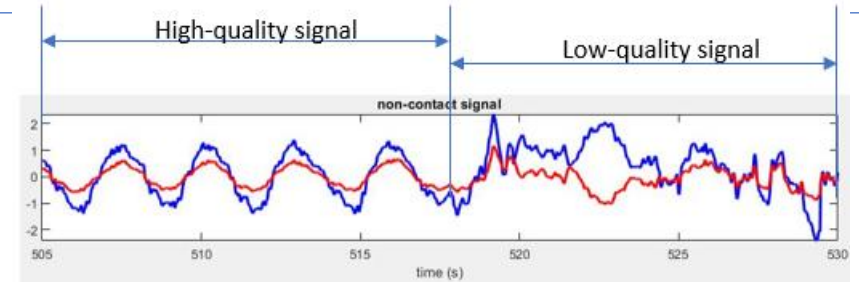
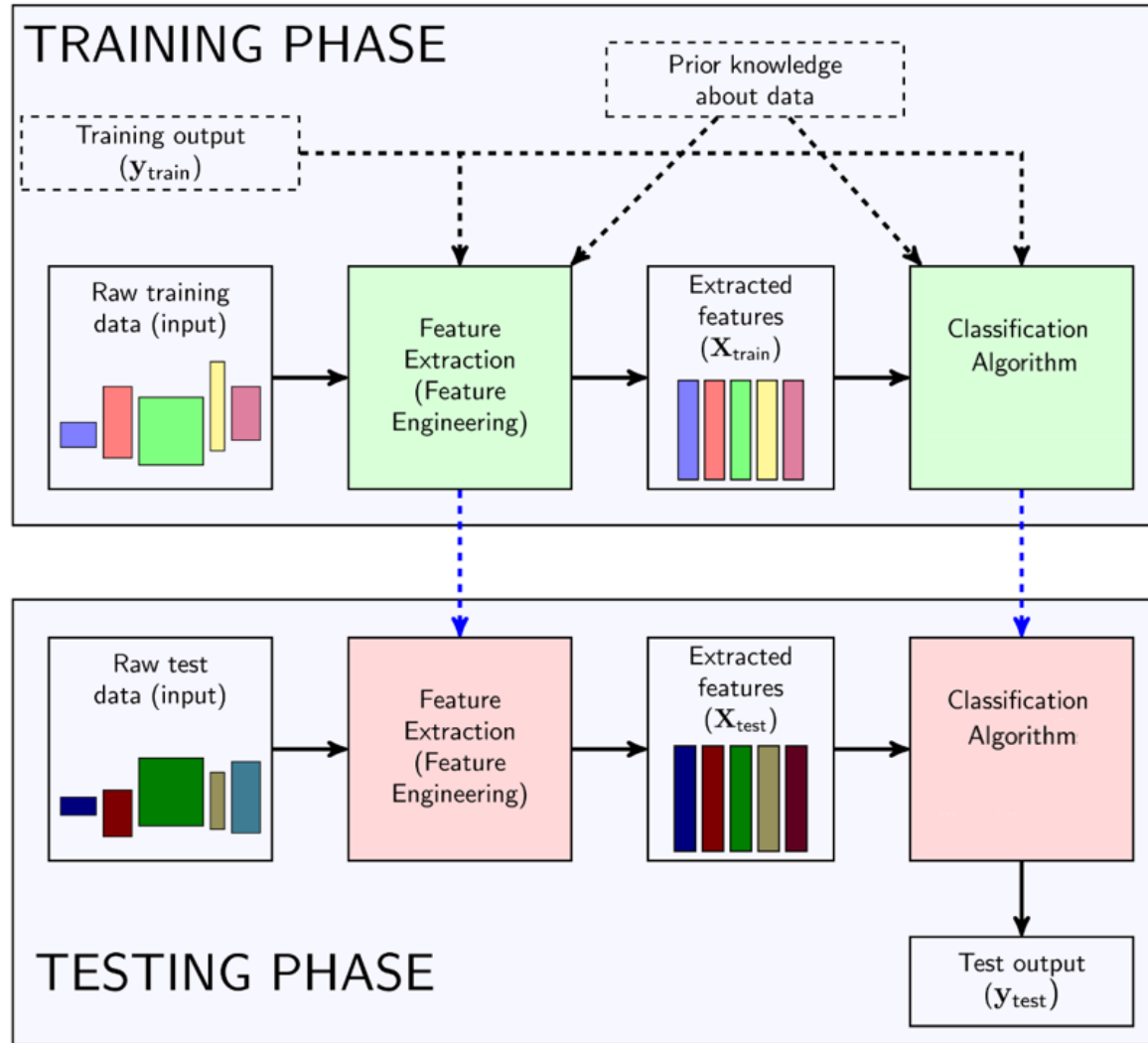
# Camera-based



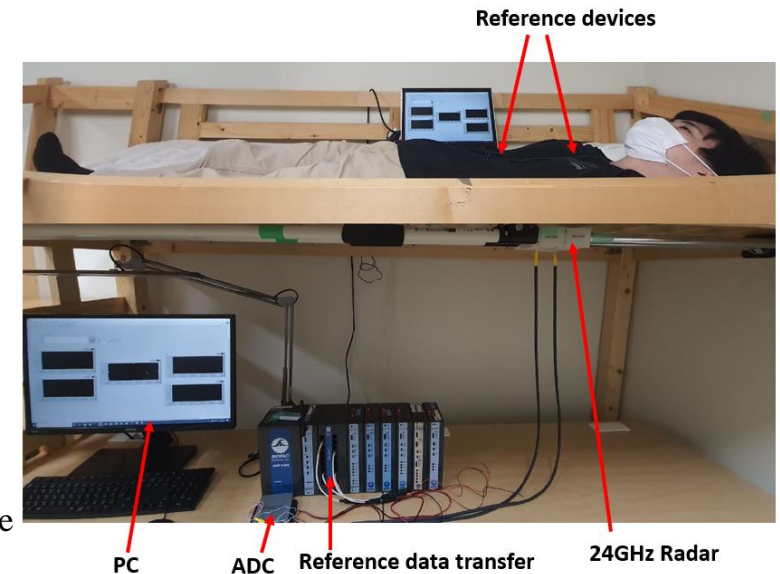
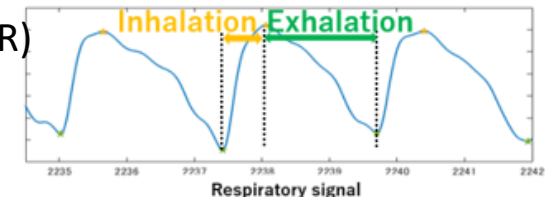


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- 3 **Our contribution**
- 4 Future potential

# Our contribution

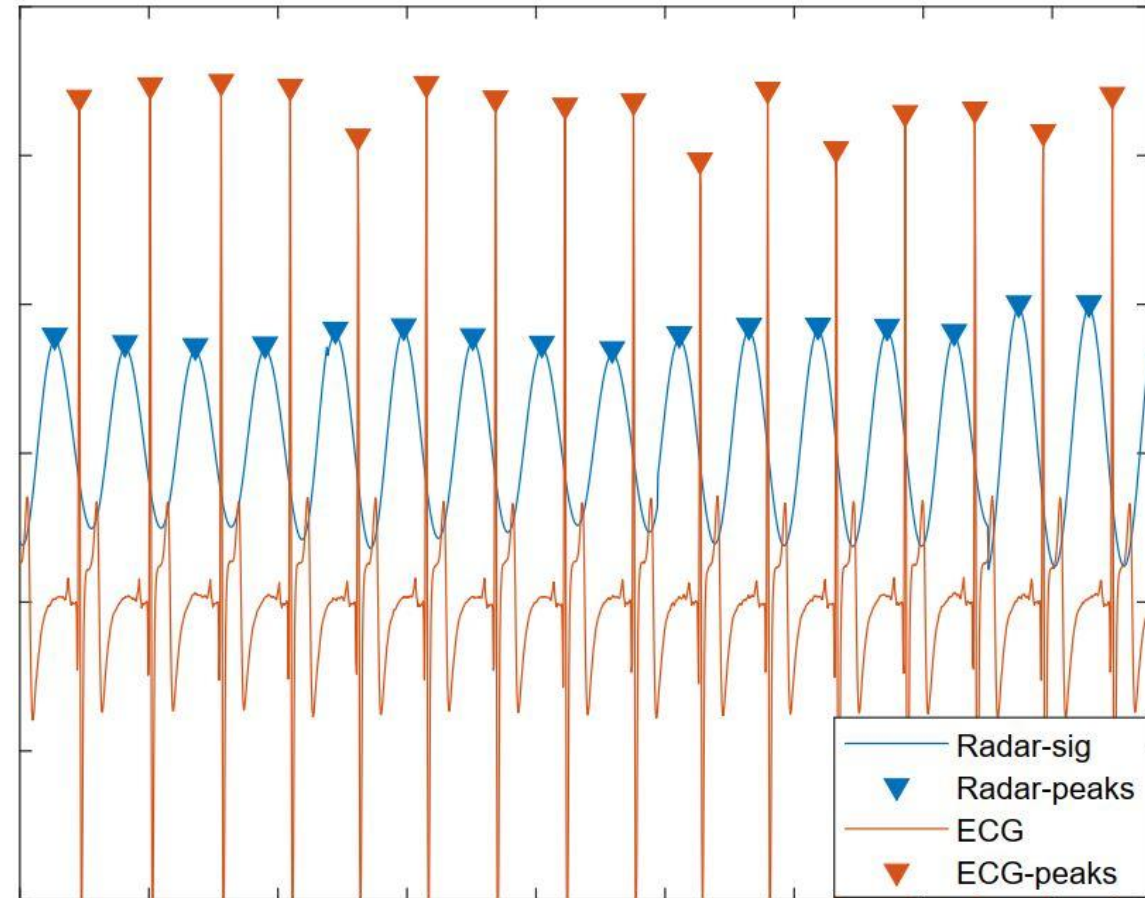
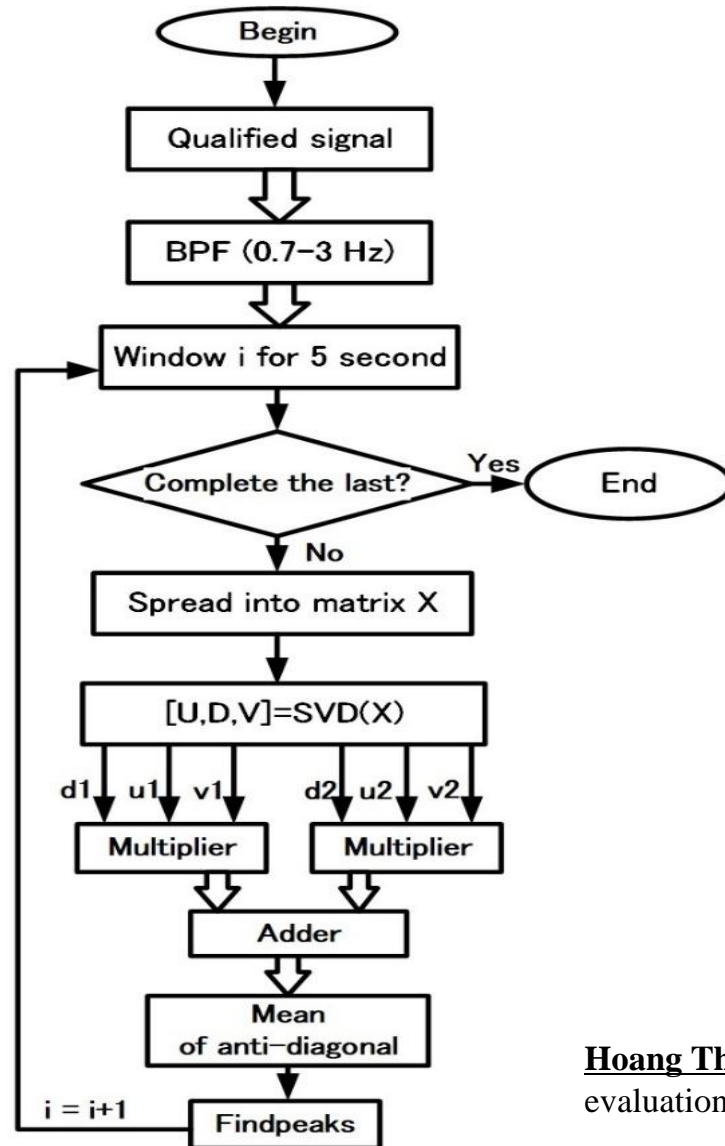


Respiration (RR)  
I:E ratio



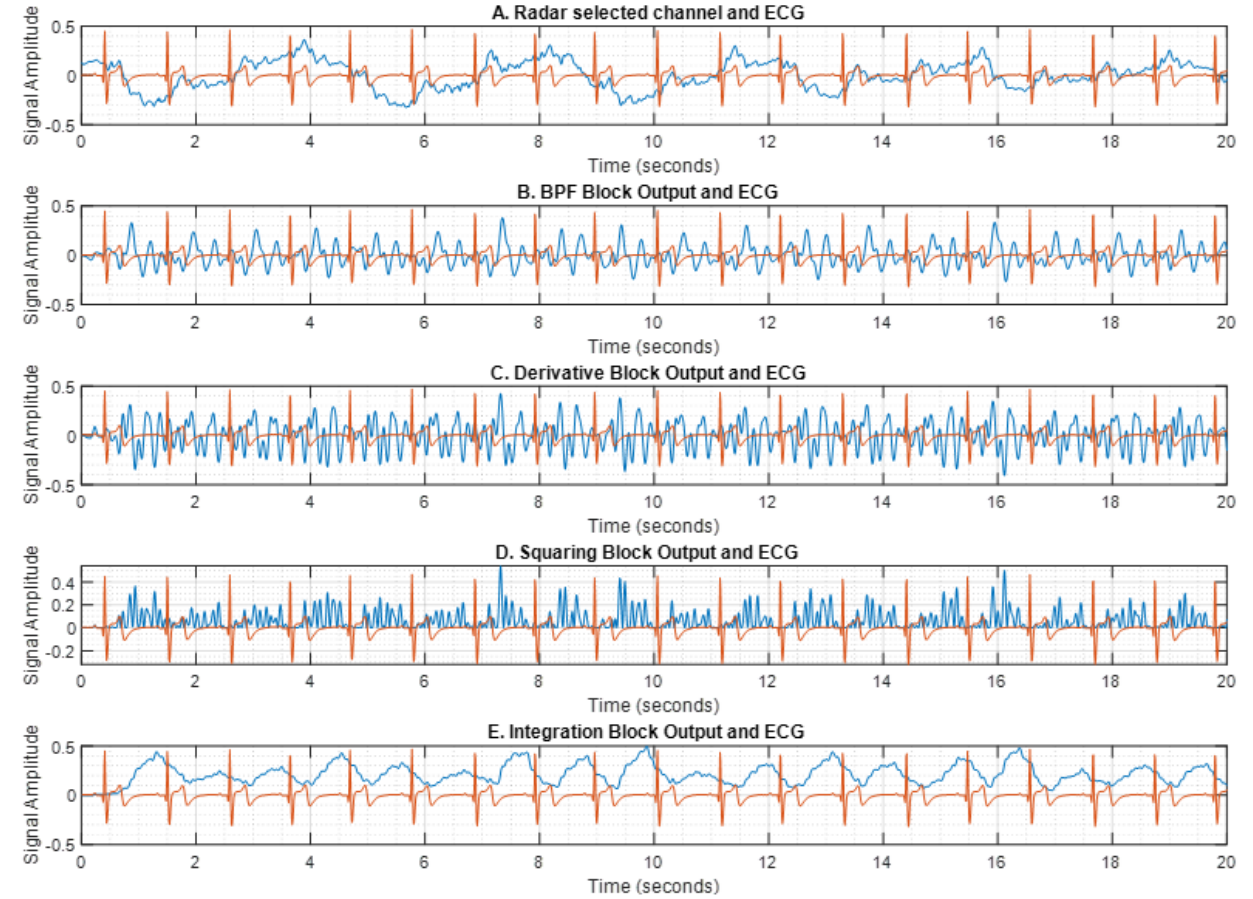
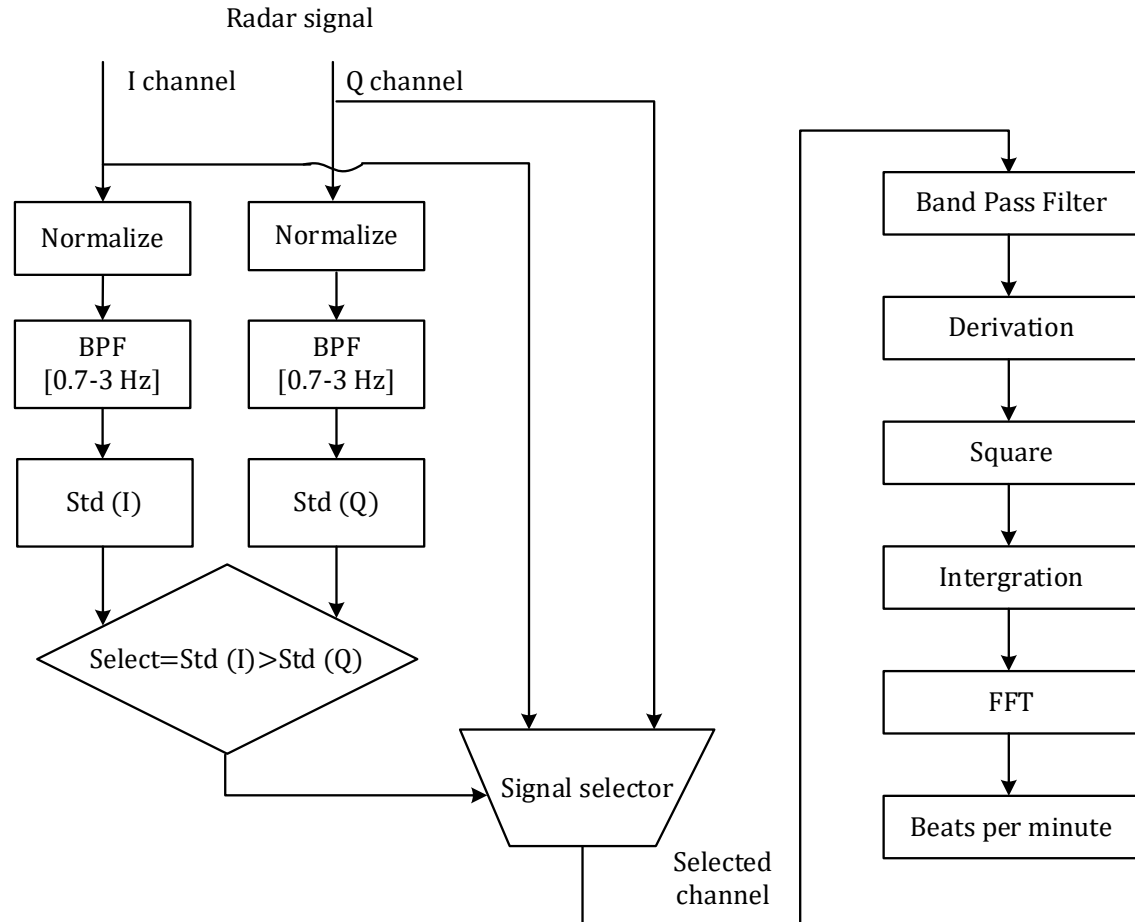
**Hoang Thi Yen**, et al. "A medical radar system for non-contact vital sign monitoring and clinical performance evaluation in hospitalized older patients." *Biomedical Signal Processing and Control* 75 (2022): 103597.

# Heart rate (HR) detection



**Hoang Thi Yen**, et al. "A medical radar system for non-contact vital sign monitoring and clinical performance evaluation in hospitalized older patients." *Biomedical Signal Processing and Control* 75 (2022): 103597.

# Heart rate (HR) detection

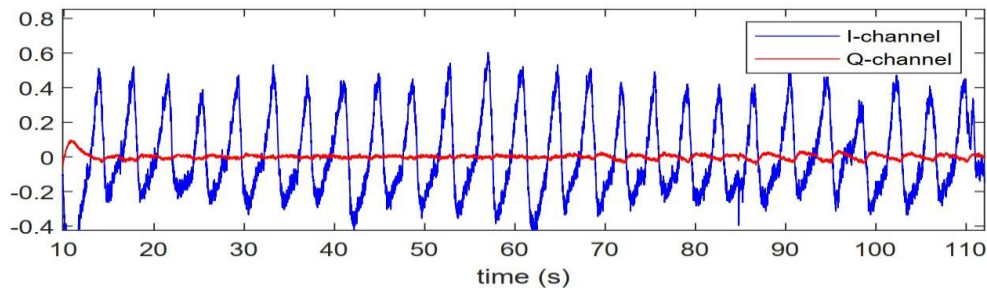


**Hoang Thi Yen, et al.** "Radar-based contactless heart beat detection with a modified Pan–Tompkins algorithm." *Biomedical Physics & Engineering Express* 11.1 (2024): 015007.

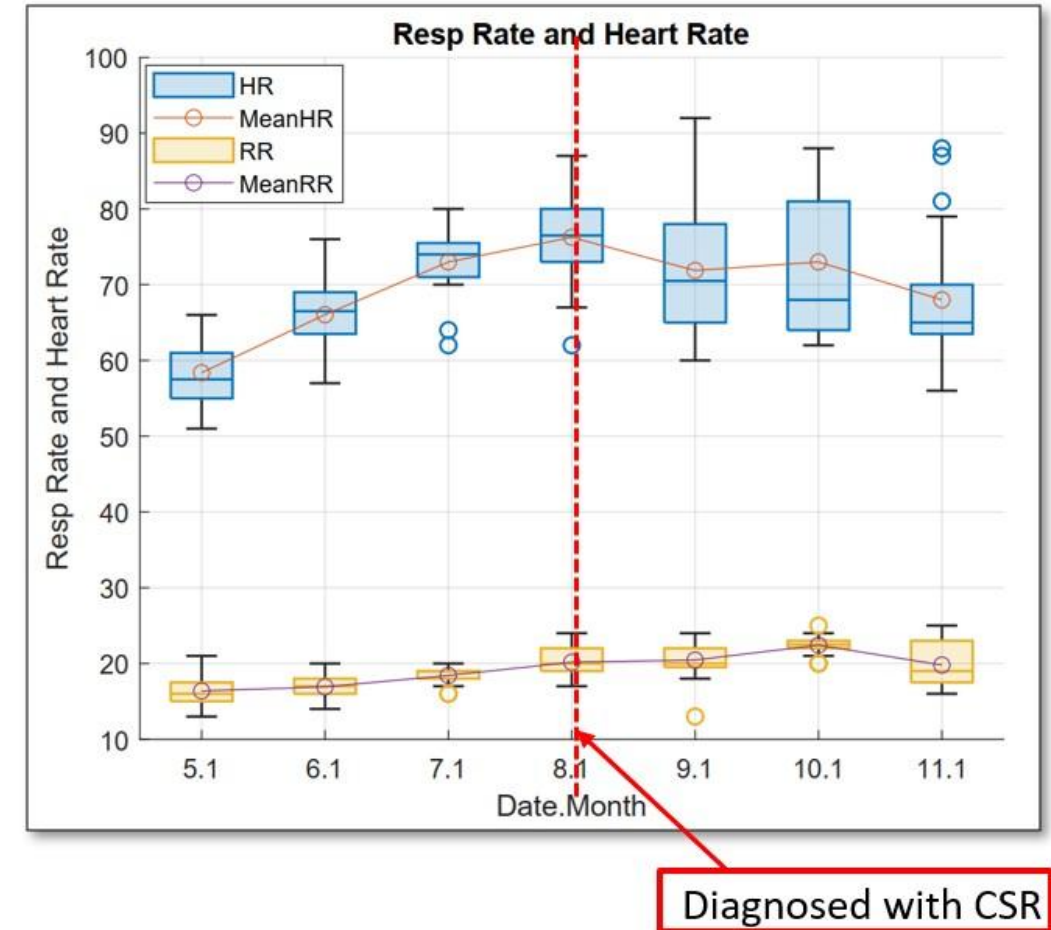
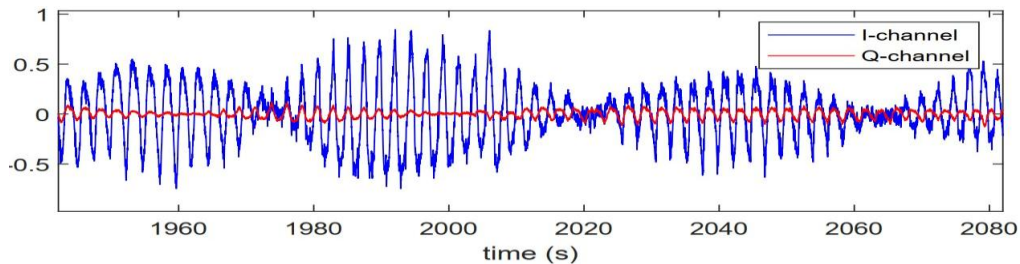
# RR and HR detection on clinical data

- Detect RR and HR of clinical data
- There is abnormal
- This patient was diagnosed with Cheyne-Stokes respiration (CSR)

Before CSR pathogenesis



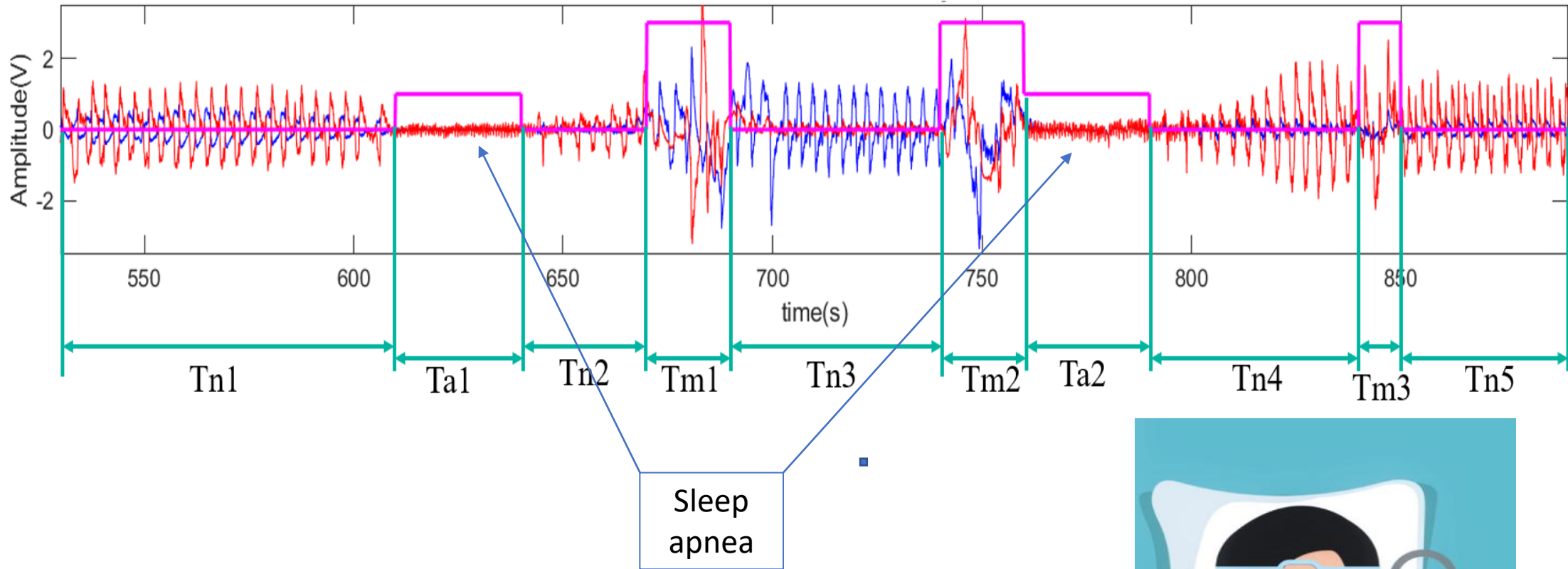
Diagnosed with CSR



**Hoang Thi Yen**, et al. "A medical radar system for non-contact vital sign monitoring and clinical performance evaluation in hospitalized older patients." *Biomedical Signal Processing and Control* 75 (2022): 103597.



# Sleep apnea detection: clinical data

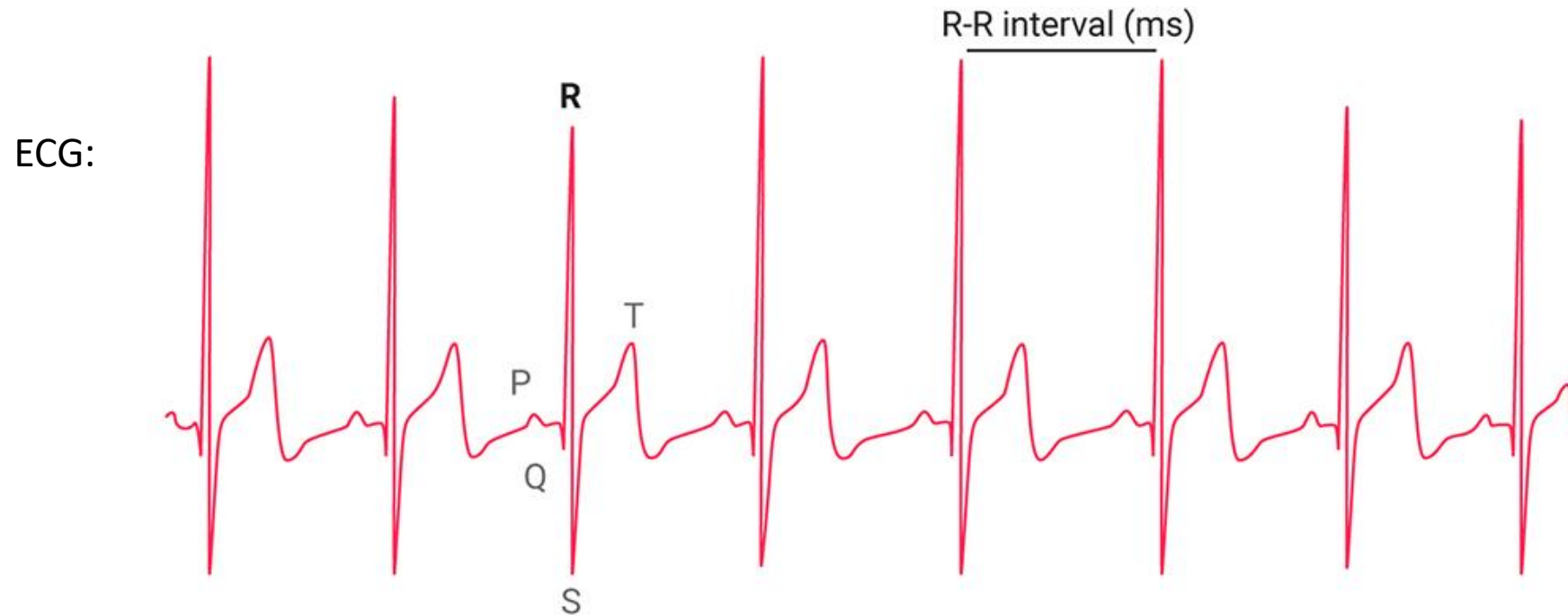


Hoang Thi Yen, et al. "Sleep apnea patient monitoring using continuous-wave radar." *2023 IEEE Statistical Signal Processing Workshop (SSP)*. IEEE, 2023.



# HRV detection

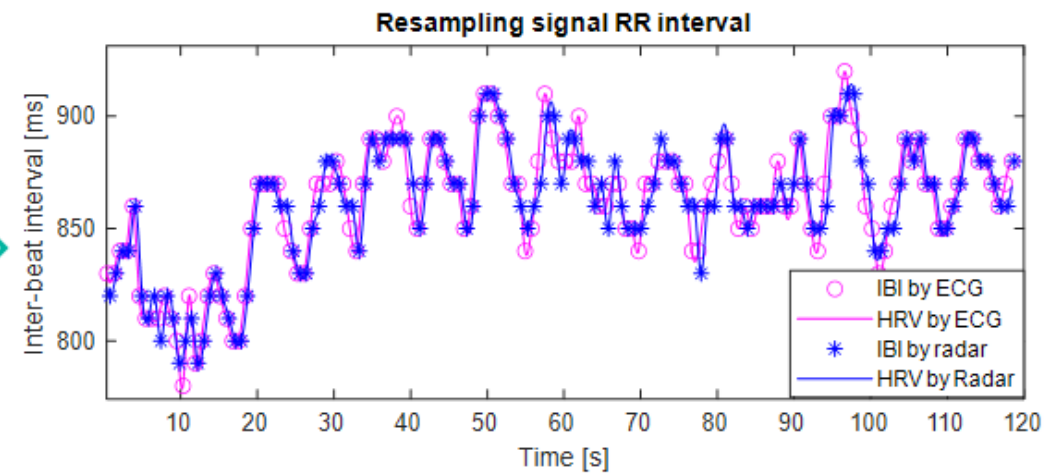
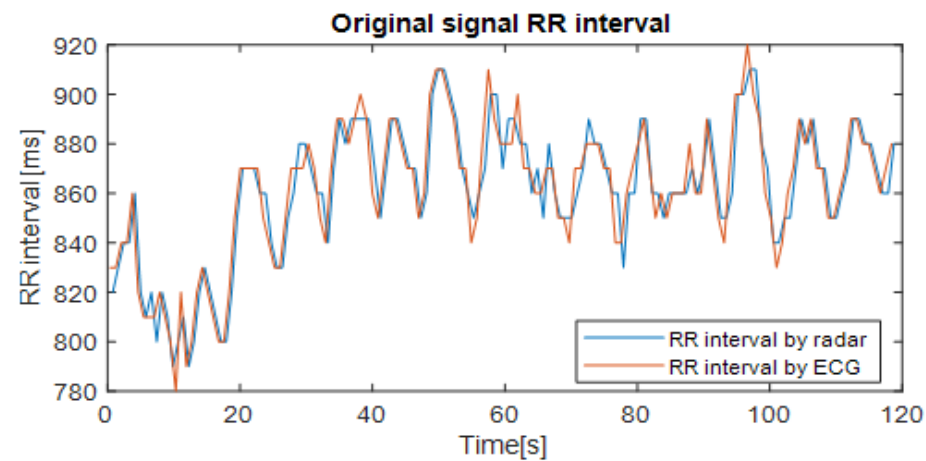
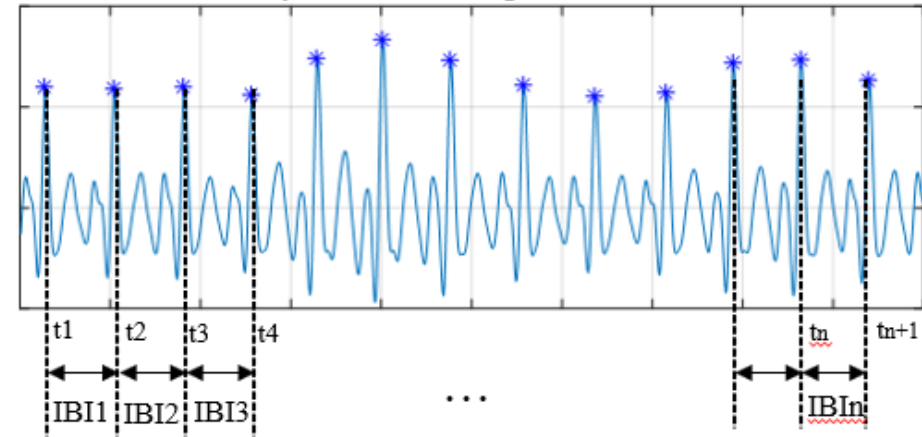
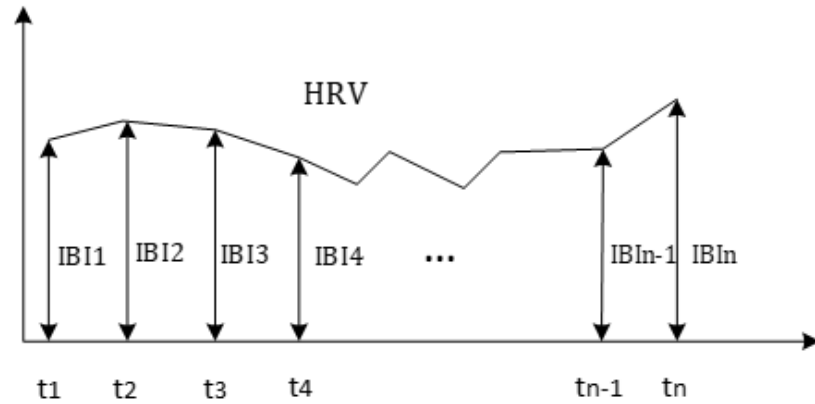
- ✓ Heart rate variability (HRV) is the physiological phenomenon of the variation in the interval between consecutive heartbeats.
- ✓ HRV illustrates the fluctuation in the interval between heartbeats, called the inter-beat interval (IBI) or called R-R interval in ECG, owing to the influence of the autonomic nervous system.



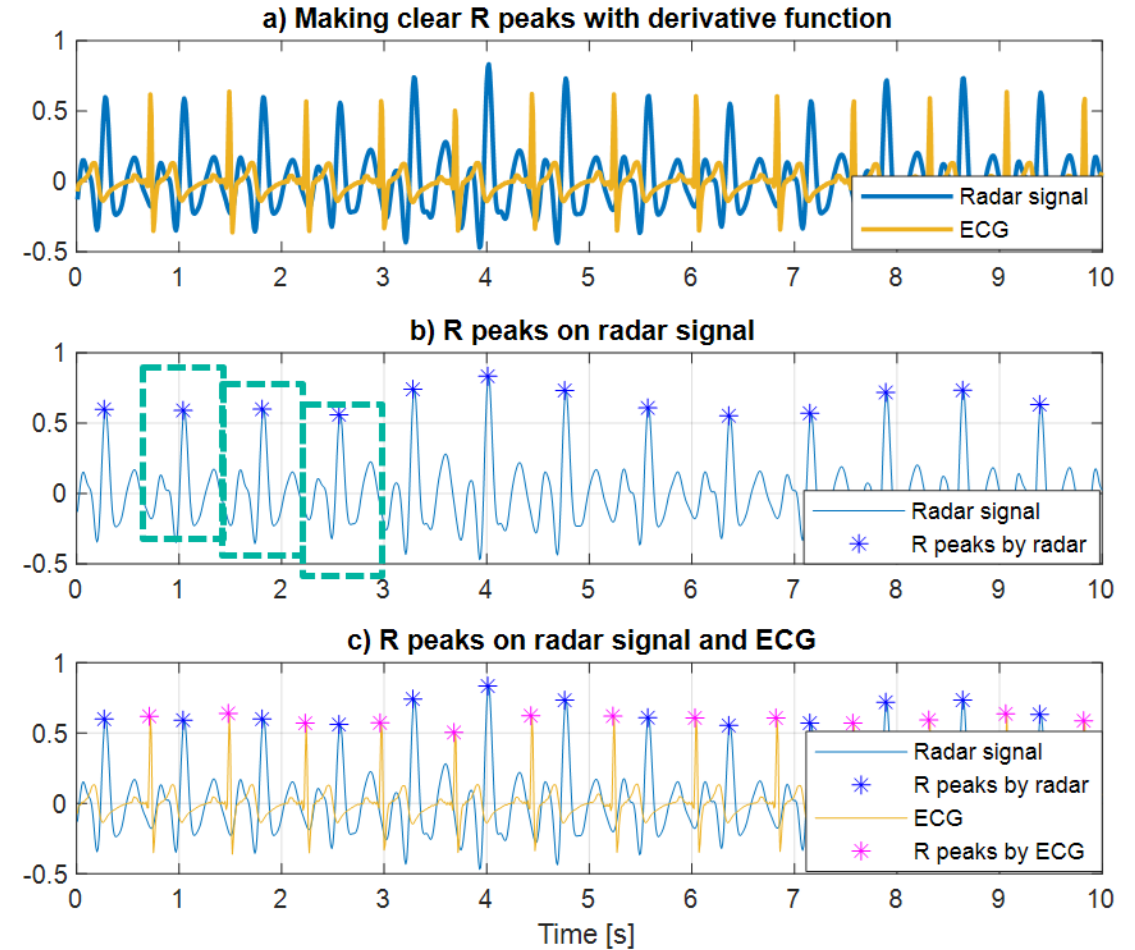
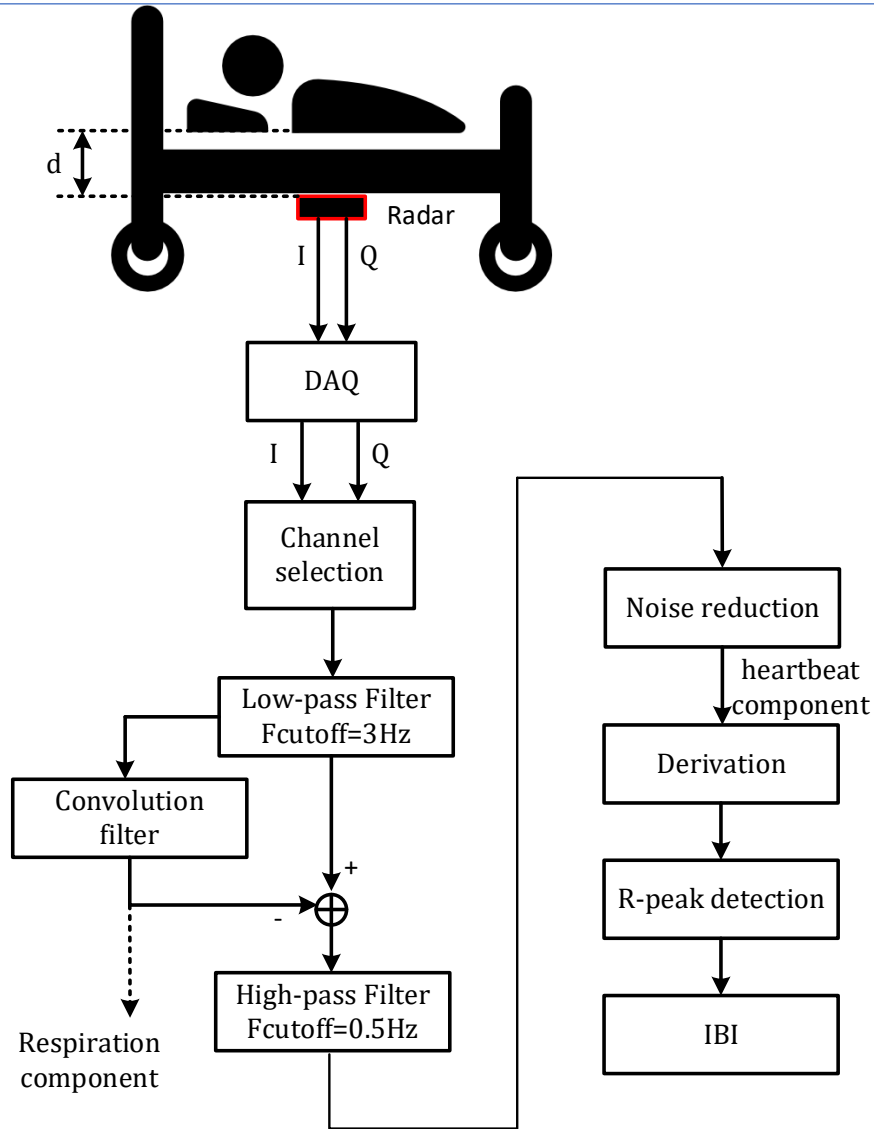


# HRV calculation

## Radar and ECG

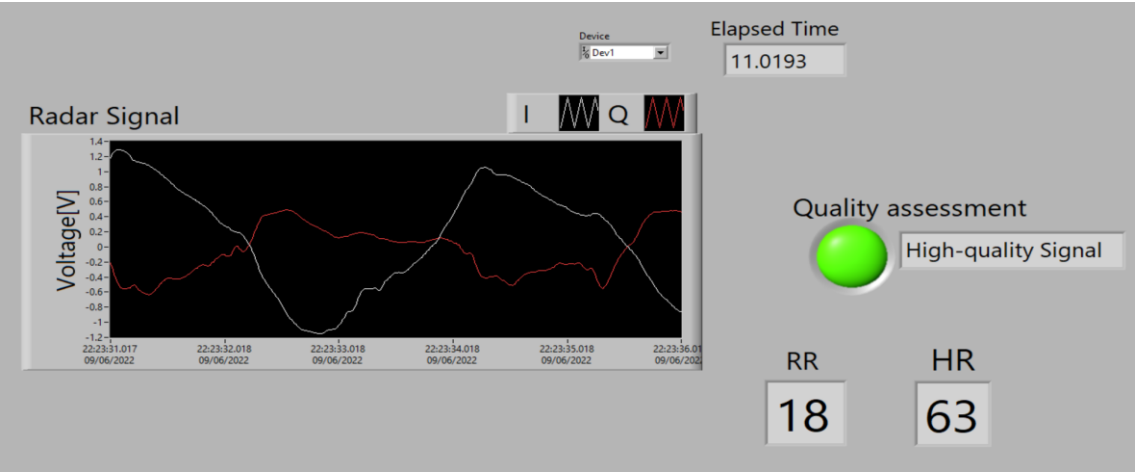
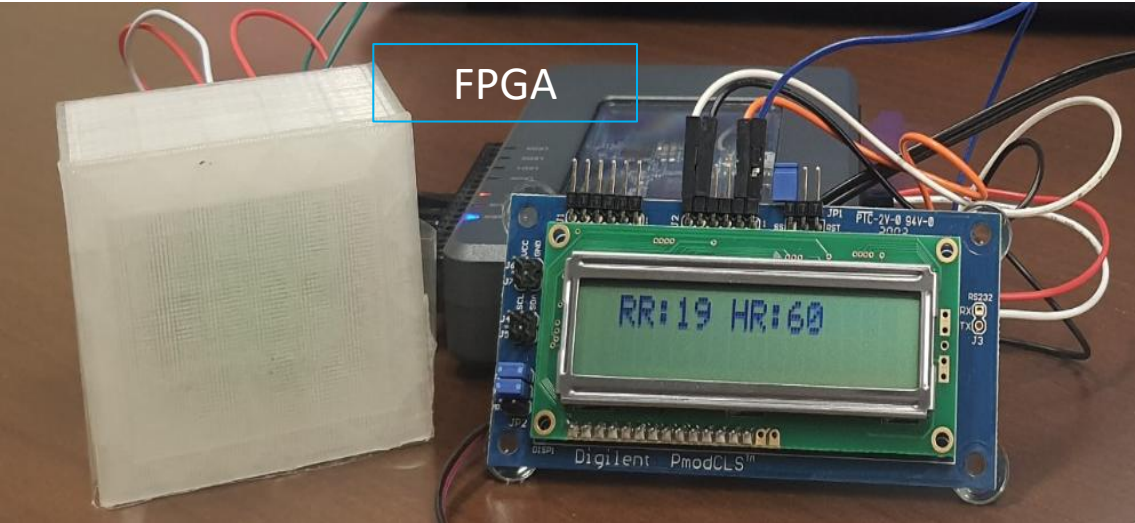
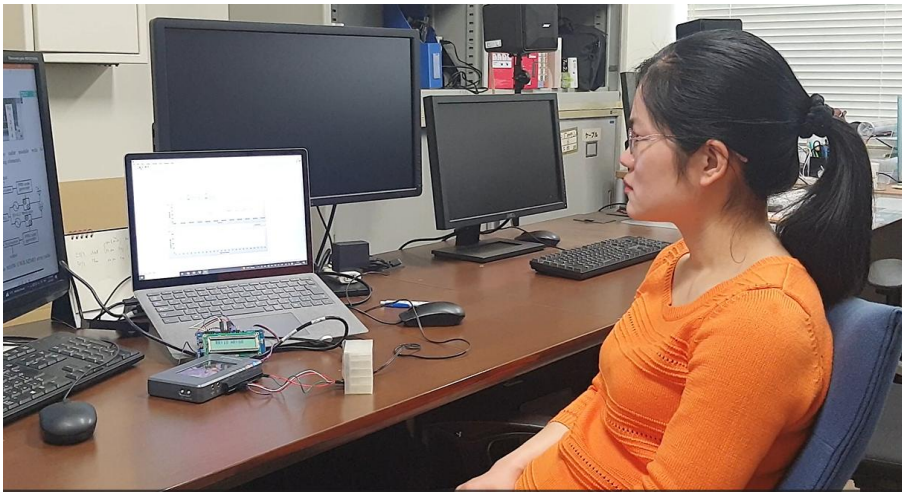


# HRV detection

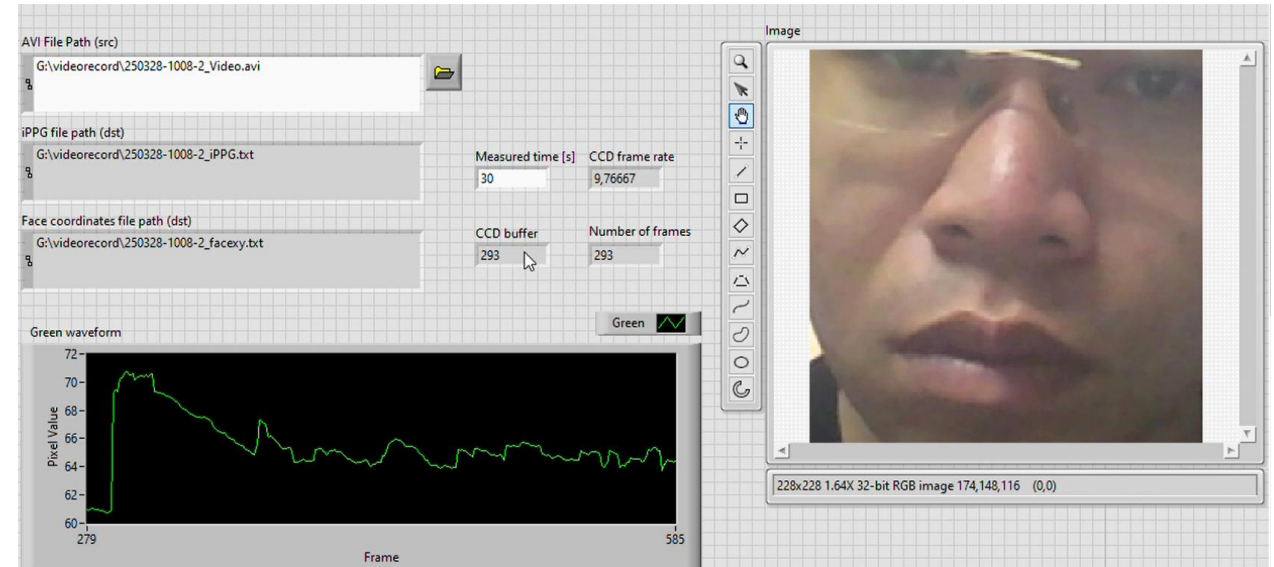
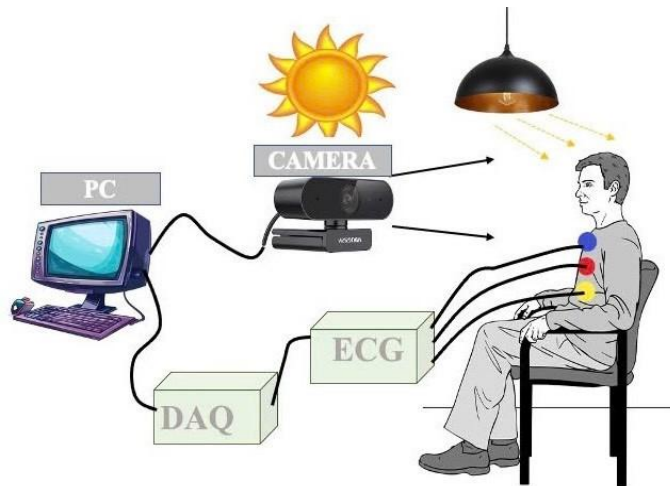
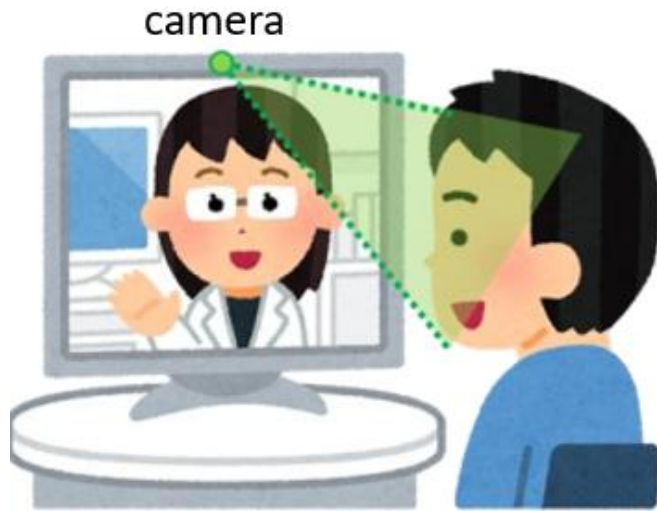


\*Noise reduction by LPNR (Locally projective noise reduction)

# Real-time performance



# Real-time performance



1. Nguyễn Duy Hiếu, Hoàng Thị Yến et al. “Tính toán nhịp tim bằng phương pháp không tiếp xúc sử dụng RGB camera”. REV-ECIT 2024
2. Hoang Thi Yen et al. “RGB camera-based pulse rate estimation using continuous wavelet transform and convolutional neural network”, 2025 journal (under review)

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# Future potential

Monitoring  
in nursing facilities etc.

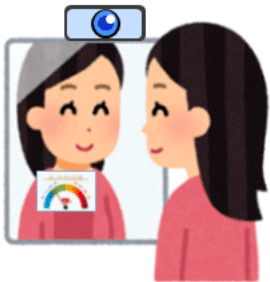
Monitoring with TV  
during dairy life



Monitoring with PC  
at work



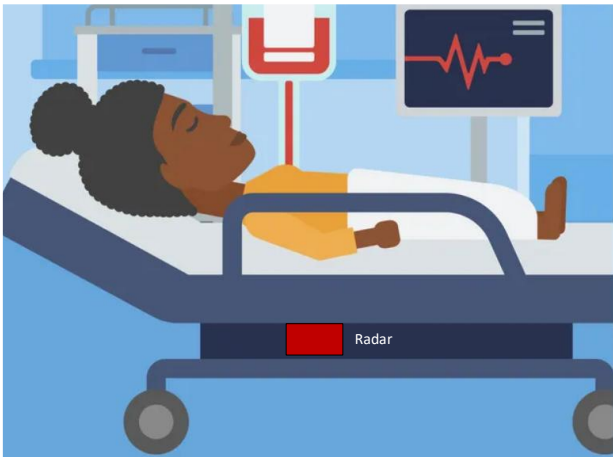
Healthcare mirror



Home use portable



No electrode



Thank you for listening!