Low-Energy and Modular Wearable Device for Wireless Measurement of Physiological Signals

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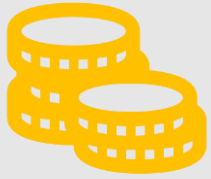
Motivation

Chronic-degenerative deseases

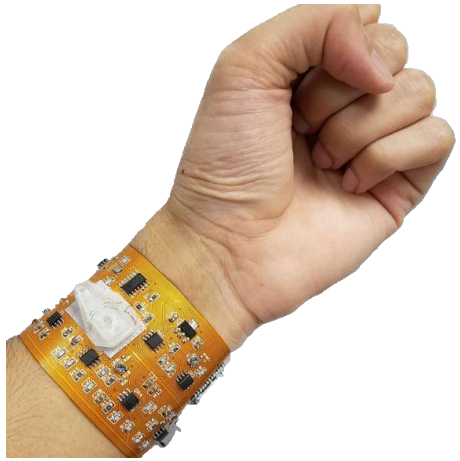
Diagnosis and following



Expensive instruments

Temporal
Spacial
Economical

Background



Mobile technologies

Portables

Wireless comunicatin

Wearables

Small size

Corporal accesories

Low energy comsuption

Flexible electronics

Ergonomic

Comfortable

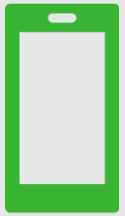
Proposal

Wereable prototype

Modular
Flexible electronics
Physiological levels

Sensors

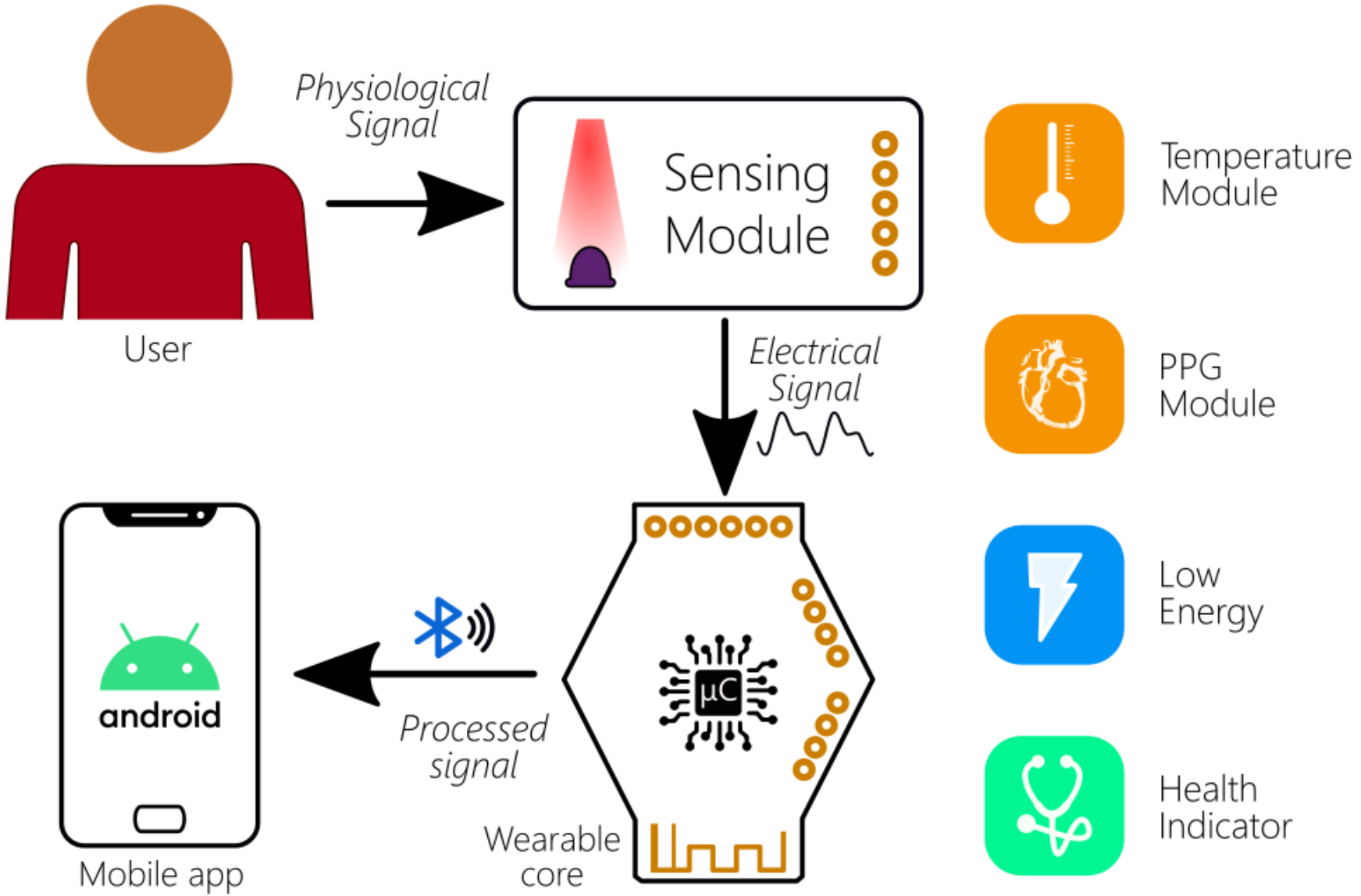
Corporal temperature
Photoplethysmography
- Hearth rate
- Breath rate



Mobile app

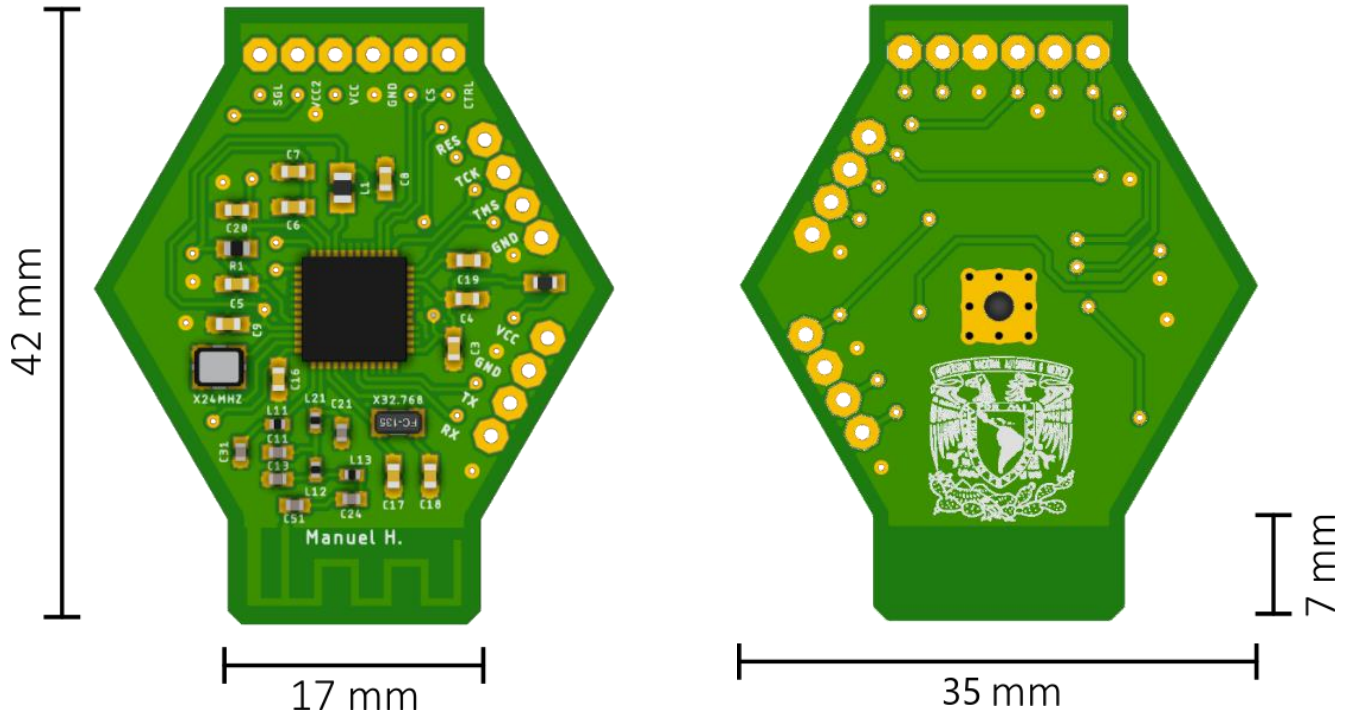
Real-time
Datalogging
Alert system

Description

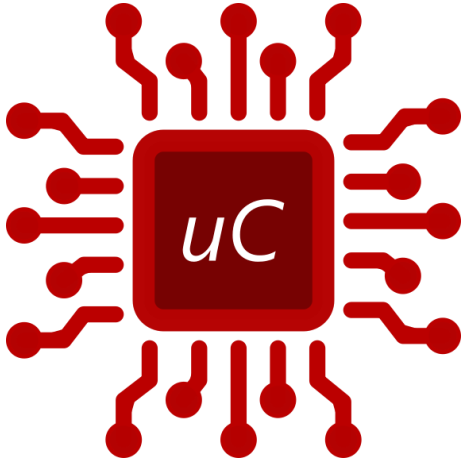


System overview

Wereable Device Core



Modular hardware



Processing unit

Microcontroller
CC2640R2F

Features

32-bit processor

48 MHz, 1.8V – 3.7V

12-bit ADC

Bluetooth Low Energy (BLE)

I/O Ports

2 analog input

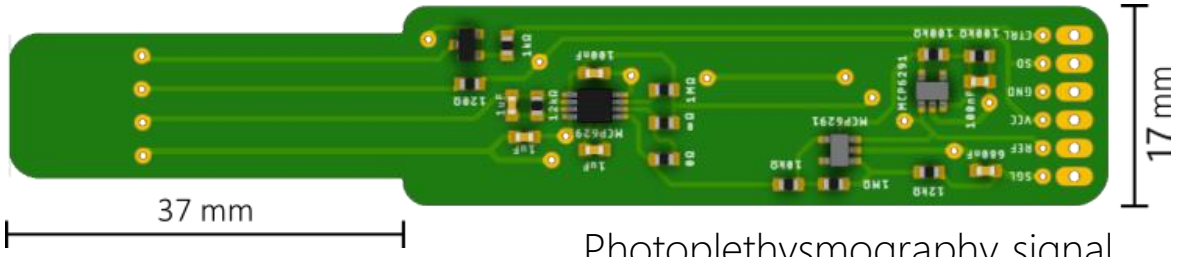
2 supply pins

1 ID

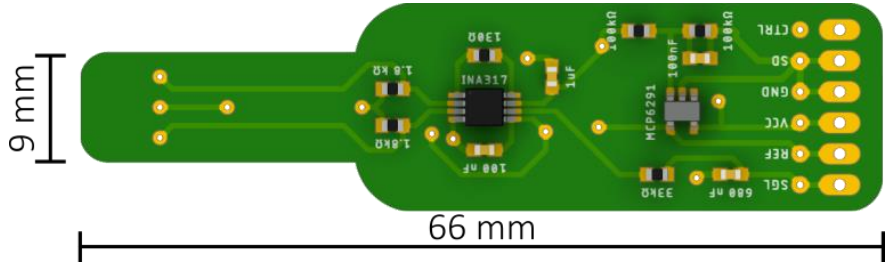
1 Control signal

System overview

Sensing modules



Photoplethysmography signal

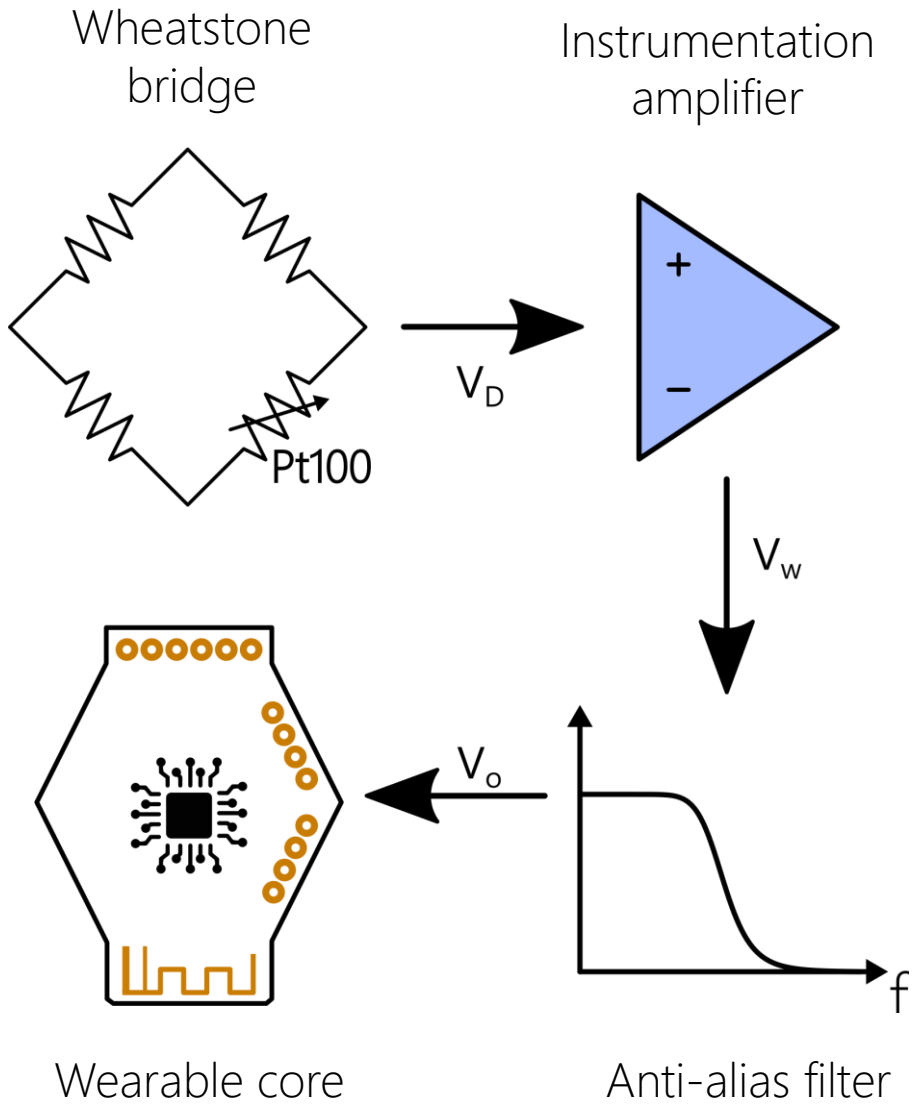


Temperature sensor

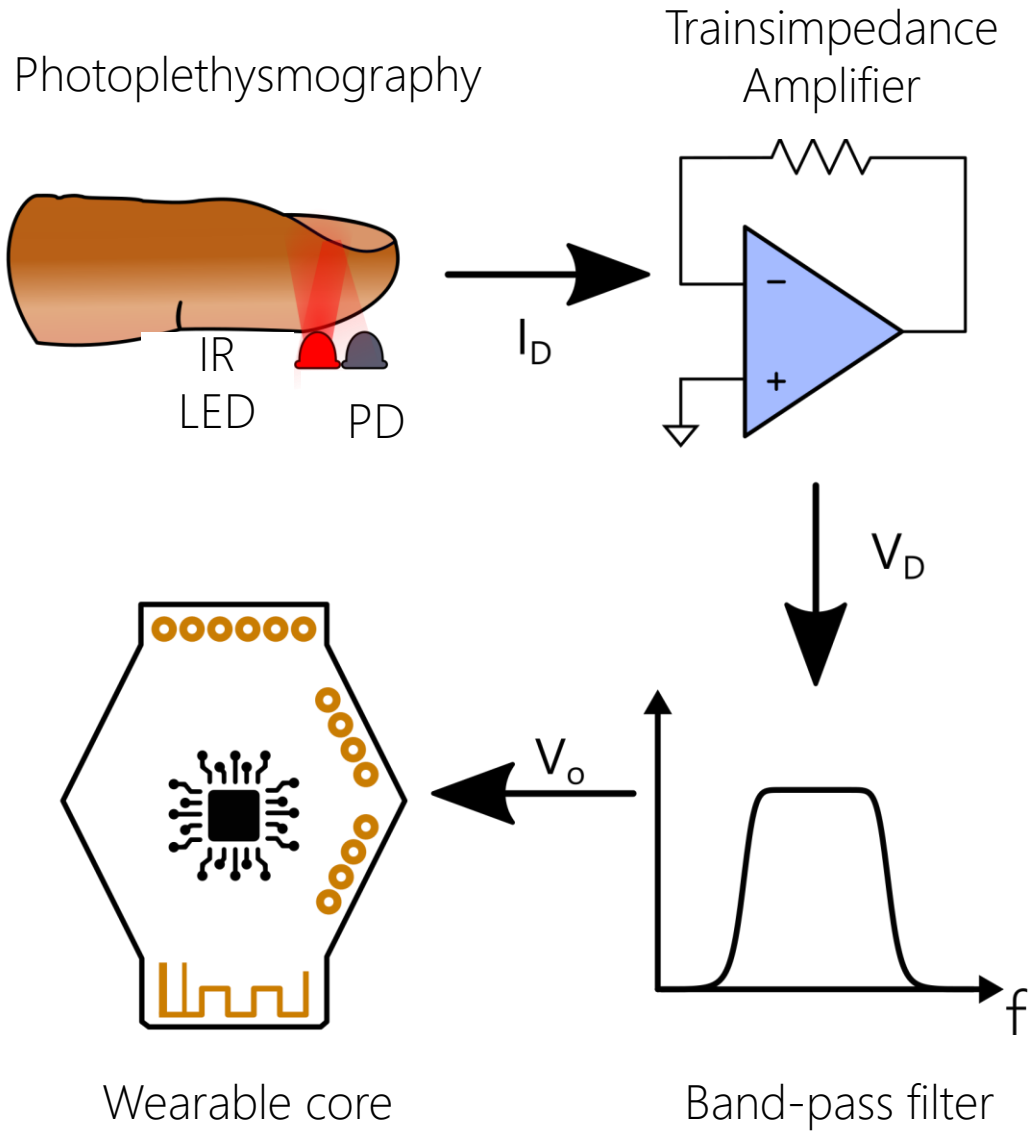
Thermometer

RTD Pt100

(32°C – 44°C)



Heart and Breath Rates



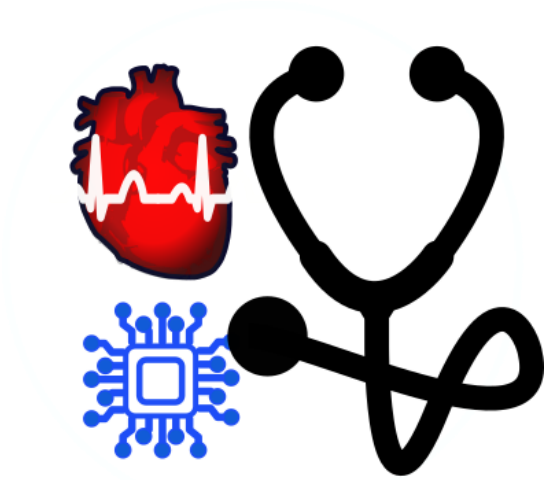
Oxyhemoglobin $\lambda = 940\ \mathbf{nm}$

Infrared reflextion

Filtering stage (0.15 - 13.5 Hz)

System overview

Mobile app

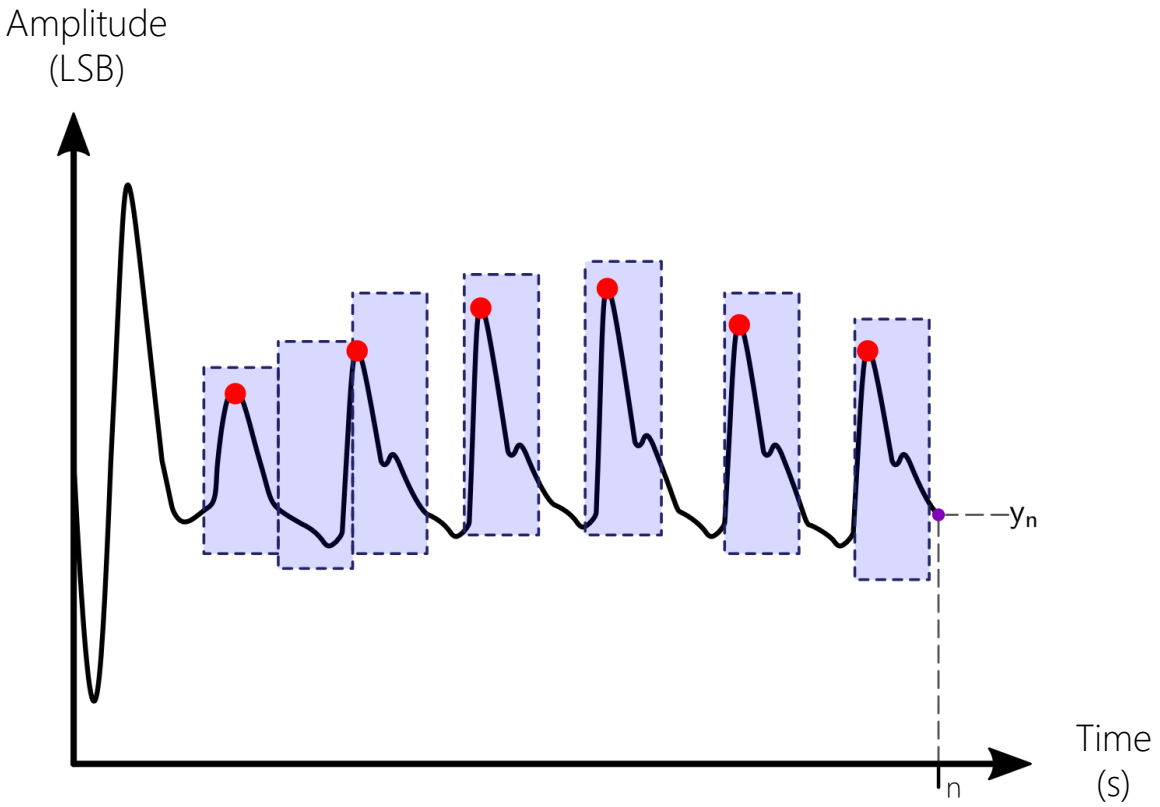


Flexicare

+

android

Peak detection algorithm



PPG – HR and BR.

Local maxima finding

Adaptive filtering

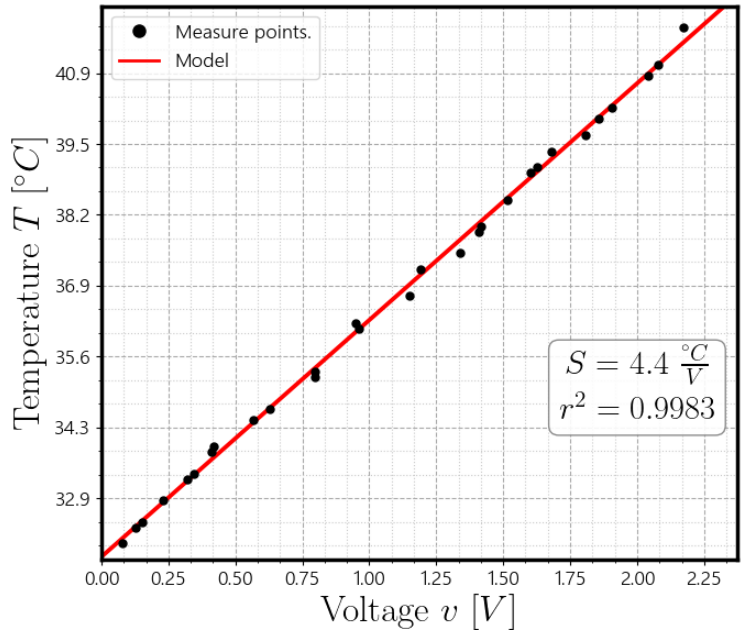
Unstable signals rejection

Frequency extraction

Test & Results

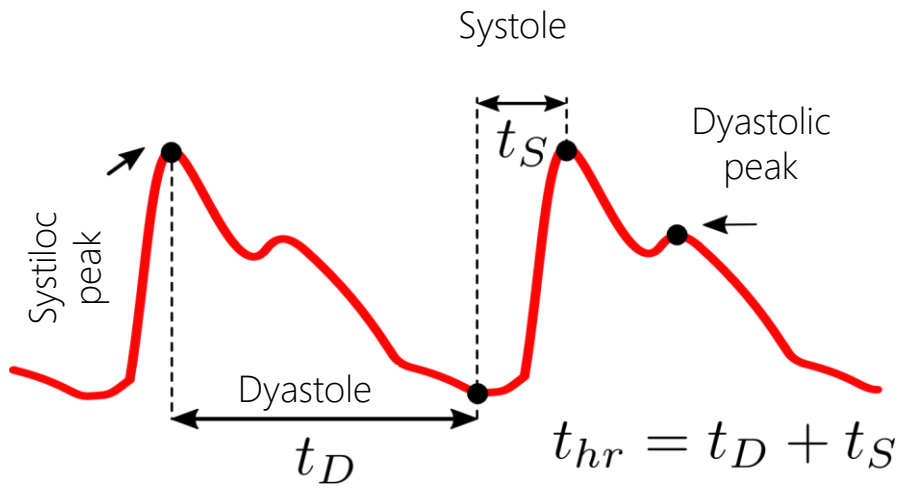
Thermometer calibration

$$T = v\left(\frac{14.53}{V_{cc}}\right)℃ + 31.85℃$$ → Best linear model



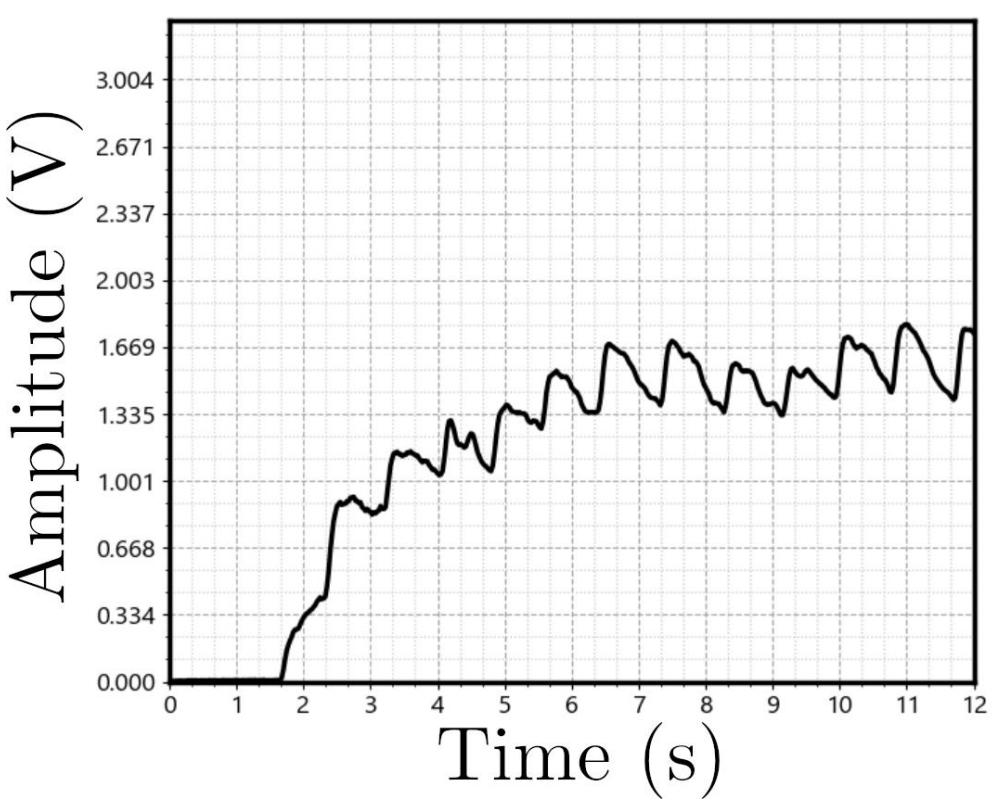
Test & Results

Peak detection algorithm

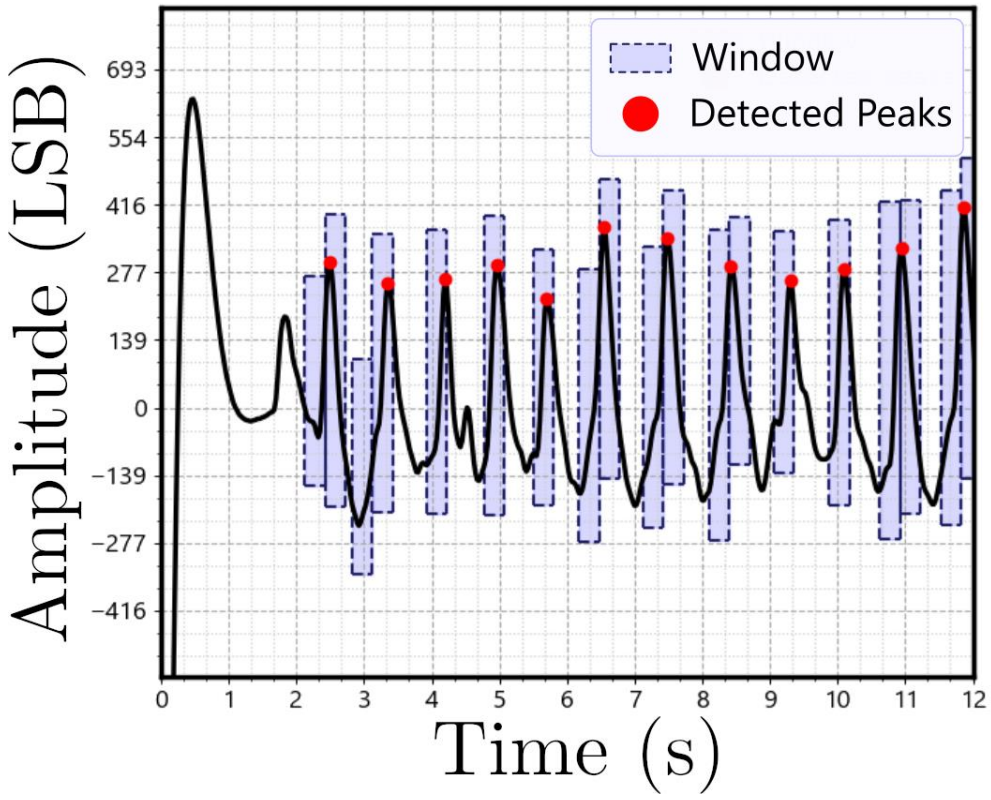


Heart Rate

Raw PPG signal

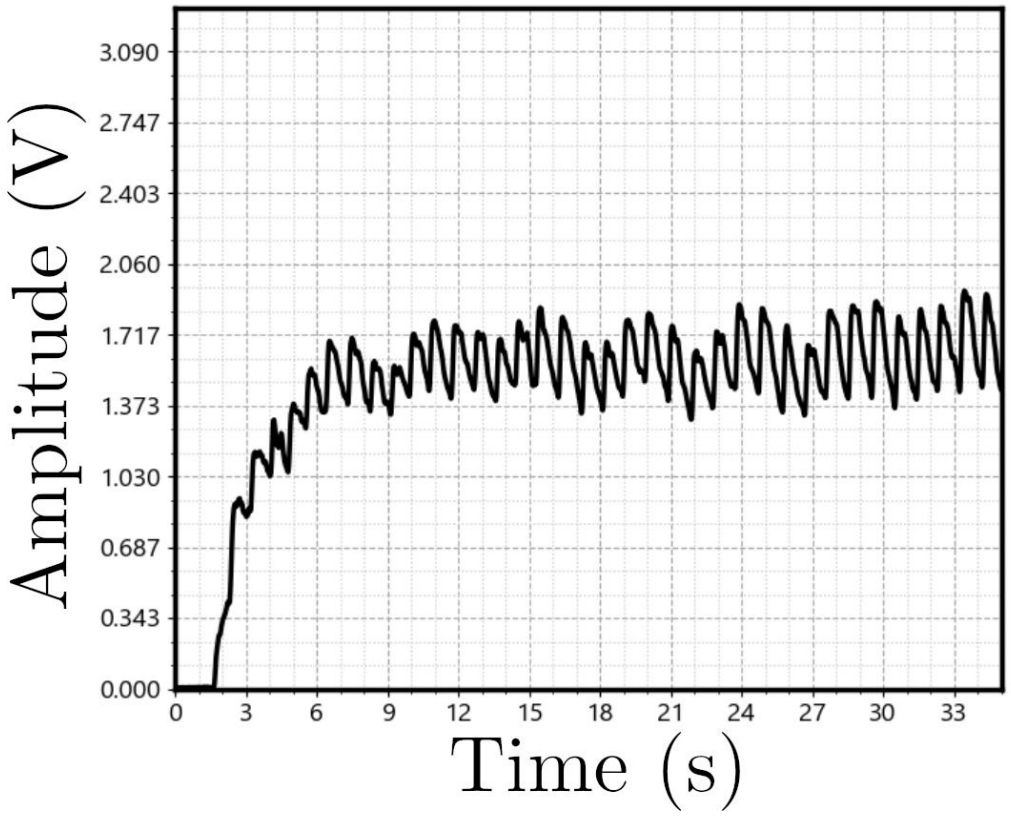


PDA

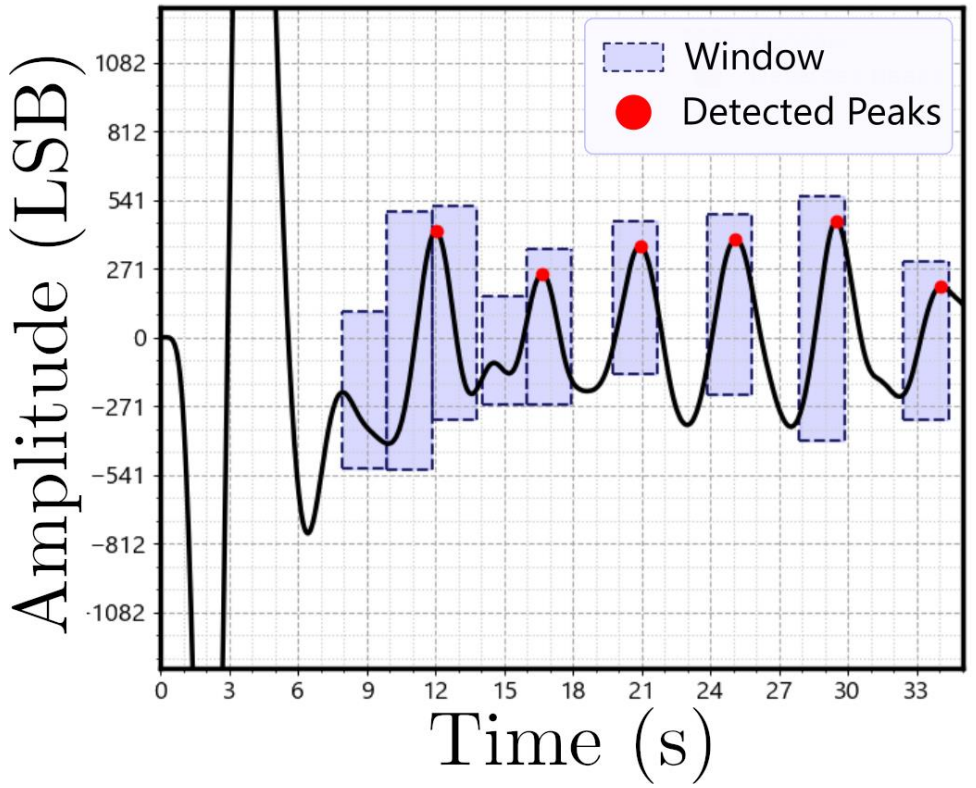


Breath Rate

Raw PPG signal



PDA



Test & Results

WD Energy Consumption

State	Consumption (mAh)
BLE advertising	0.24
Stand-by	0.49
Acquisition & streaming	1.93
Thermometer	+2.42
PPG	+2.77
PPG enable	+16.7

Mean consumption estimation

60 mAh battery

Temperature

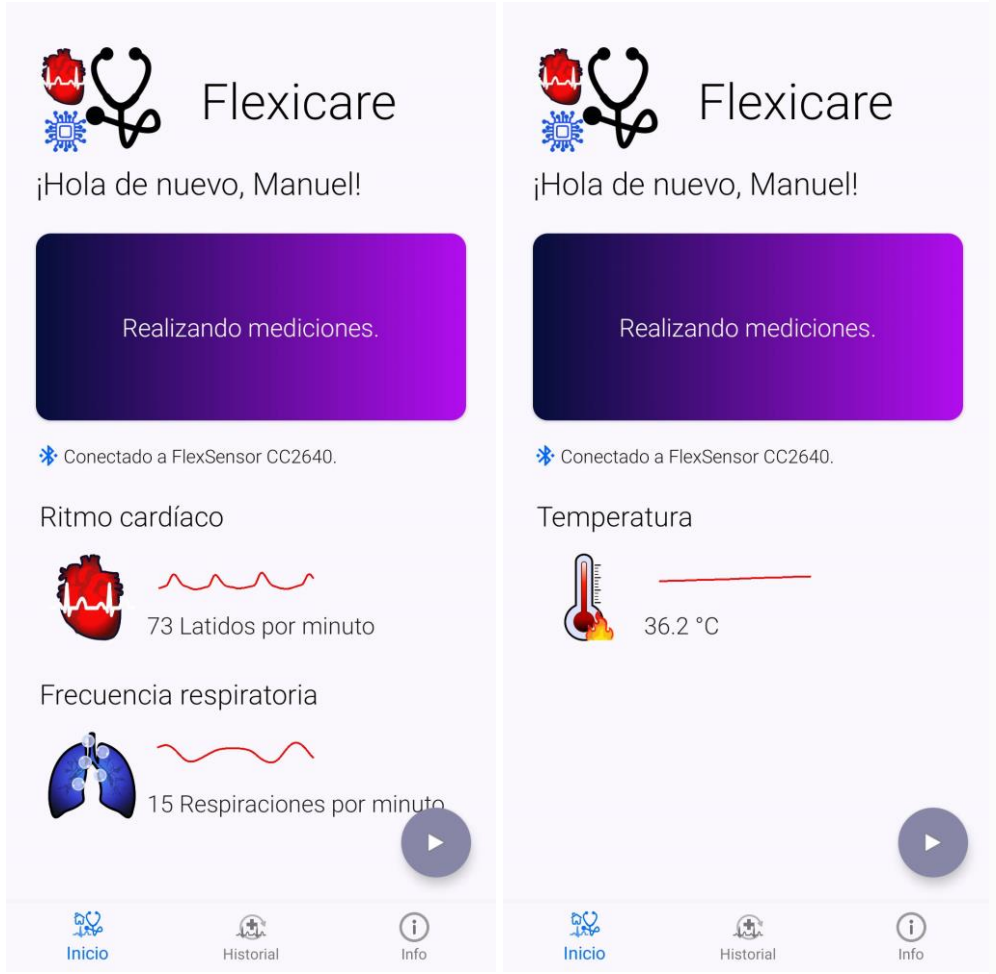
- 13 hrs. & 46 min. continuous acquisition
- 909 measurements
  - 10 s waitting connection
  - 20 s stand-by
  - 35 s data acquisition and streaming

PPG

- 2 hrs. & 48 min. continuous acquisition
- 255 mediciones
  - 10 s waitting connection
  - 20 s stand-by
  - 35 s data acquisition and streaming

Experimental Results

Data display and record



Conclusions

- High-precisión thermometer
- Breath and heart rate via PPG
- Modular design
- Wereable + flexible electronics
- Wireless communtication
- Low energy
- Mobile application
- Data storage
- Alert system (out-of-range values)

Thanks for your attention!

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