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SENSEmyHEART: A CLOUD SERVICE AND API FOR WEARABLE HEART MONITORS

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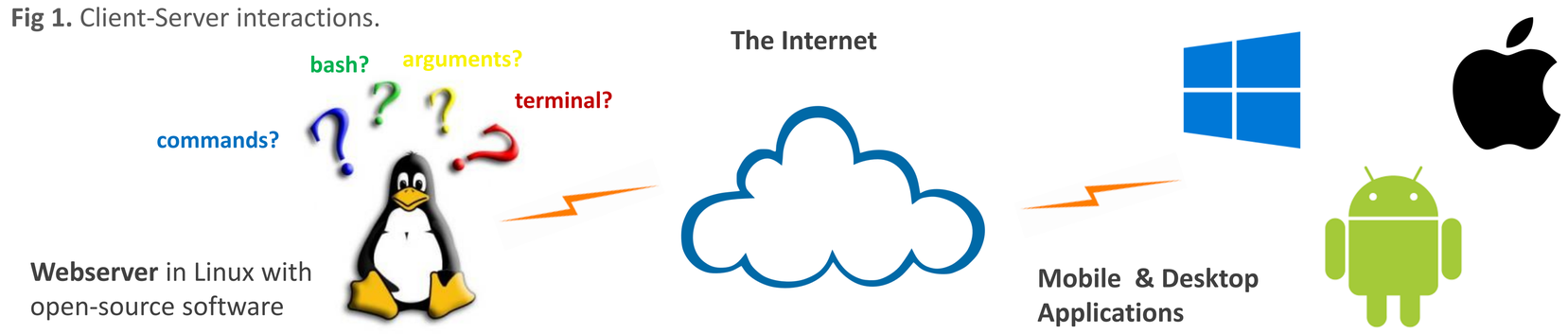
Motivation

Drawbacks of Physionet tools

PhysioNet provides the most reliable open-source software tools for ECG processing and analysis to date.
But it remains difficult to use in mobile settings and for Linux-unfamiliar users and researchers, such as clinicals and psychologists.

How to take advantage of these tools in wearable technology for cardiovascular monitoring?

Fig 1. Client-Server interactions.



Methodology

A Physionet-based pipeline

Purpose:
Integration of existing software-modules into a cohesive pipeline, including:

- Validated Qrs detectors
- Tested HRV computing function

Enhancements:

- **New feature**: cardiovascular intensity
- **Extended** the hrv function to obtain all sets of measures per analysis time window.
- **Support** for VitalJacket® ECG recordings.

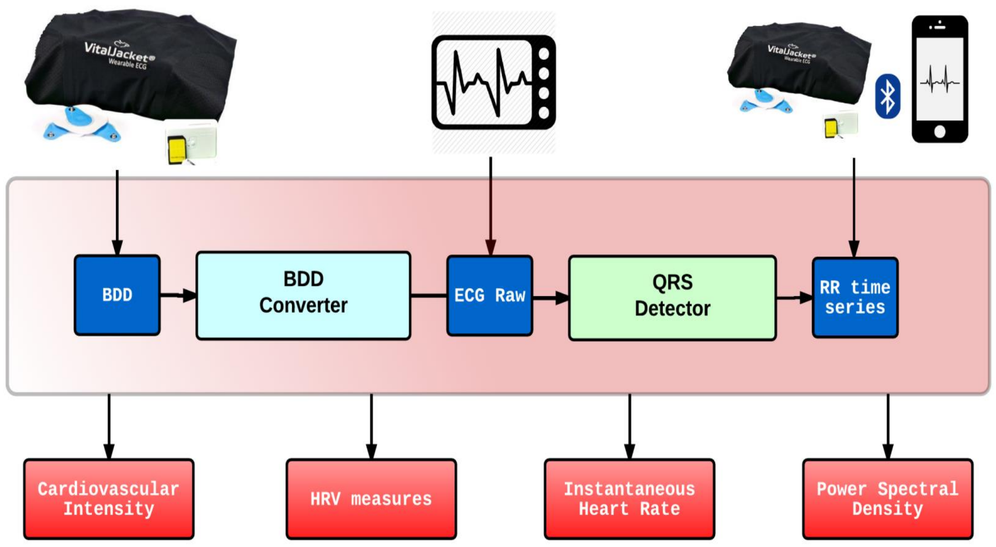


Fig 2. Overview of I/O in SenseMyHeart's processing pipeline

Peak Heart Rate

$$HR_{max} = 208 - 0.7 \times age$$

Cardiovascular Intensity

$$CI_i = \frac{(HR_i - HR_{rest})}{(HR_{max} - HR_{rest})} \times 100\%$$

Webserver and Application Programmatic Interface (API)

The **SenseMyHeart pipeline** is exposed to remote clients through a **webserver**, which provides an interface (API) over HTTP, using the Simple Object Access Protocol (SOAP).

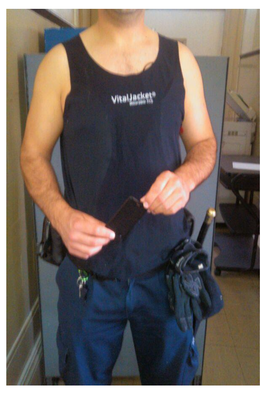
Name: submitExam
Mandatory Inputs: Session-Token, ExamType, ExamData
Outputs: Operation status

Name: getHrvSeries
Mandatory Inputs: Session-Token
Optional Inputs: Time Interval, Window Size, Window Overlap, Qrs Detector
Outputs: Hrv Measurements per Time Frame

Results

Real Use Cases

The **SCOPE project** investigates the psychophysiological impact of stress among police officers originating from on-duty tasks, such as patrolling and on-site interventions.



Policeman with wearable device and smartphone

on-duty tasks

- Compute **HRV measures** using SMH
- Extract **geo-referenced** data using phone
- Use **accelerometer** to estimate activity

Generate stress-events based on recommendation system

Proof-of-concept client applications – available to serve a variety of research profiles

Data analysis returns measurements of HRV in time and frequency domains, computed over 5 minute time windows (customizable), which reflect activity of the Autonomic Nervous System (ANS).

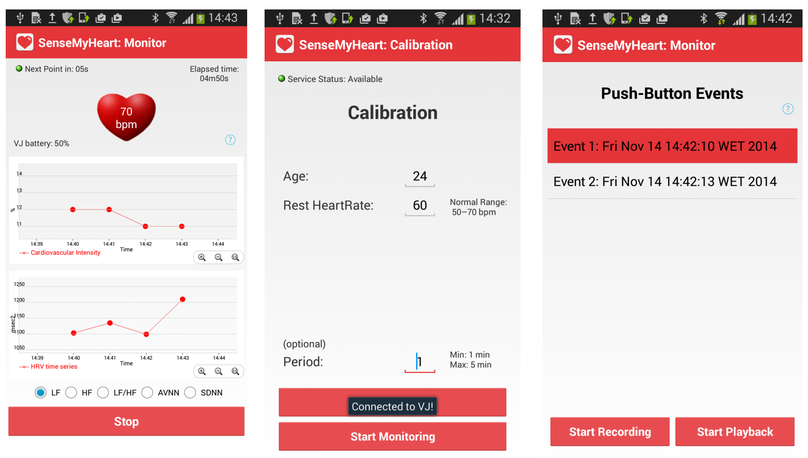


Fig 3. Android application with bluetooth connectivity to a wearable device VitalJacket®, showing online analysis.

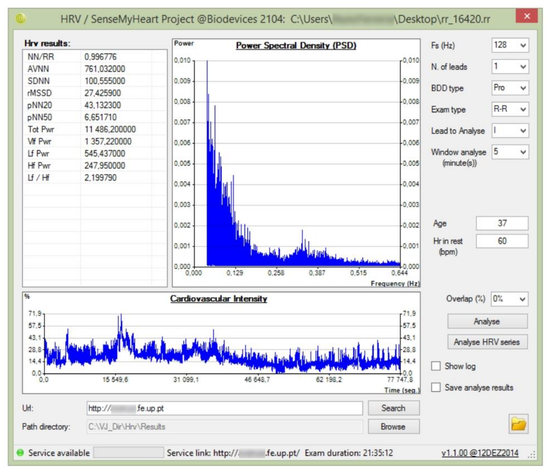


Fig 4. Desktop application for Windows users, depicting off-line analysis of ECG exams.

Discussion

We developed a novel **computing infrastructure** built on top of existing and recognized open-source software in ECG processing and HRV measurement. This has **enabled research projects to study cardiovascular stress** under very different work conditions, making use of wearable technology.

Pros:

- Well suited for mobile environments.
- Developers can build their applications seamlessly across platforms.
- Scalable to include other algorithms and relevant sensor data.

Although, this requires:
A **stable** network connection!

Acknowledgments

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