ComInLabs

SHERPAM

Sensors for **HE**alth **R**ecording and **P**hysical **A**ctivity **M**onitoring

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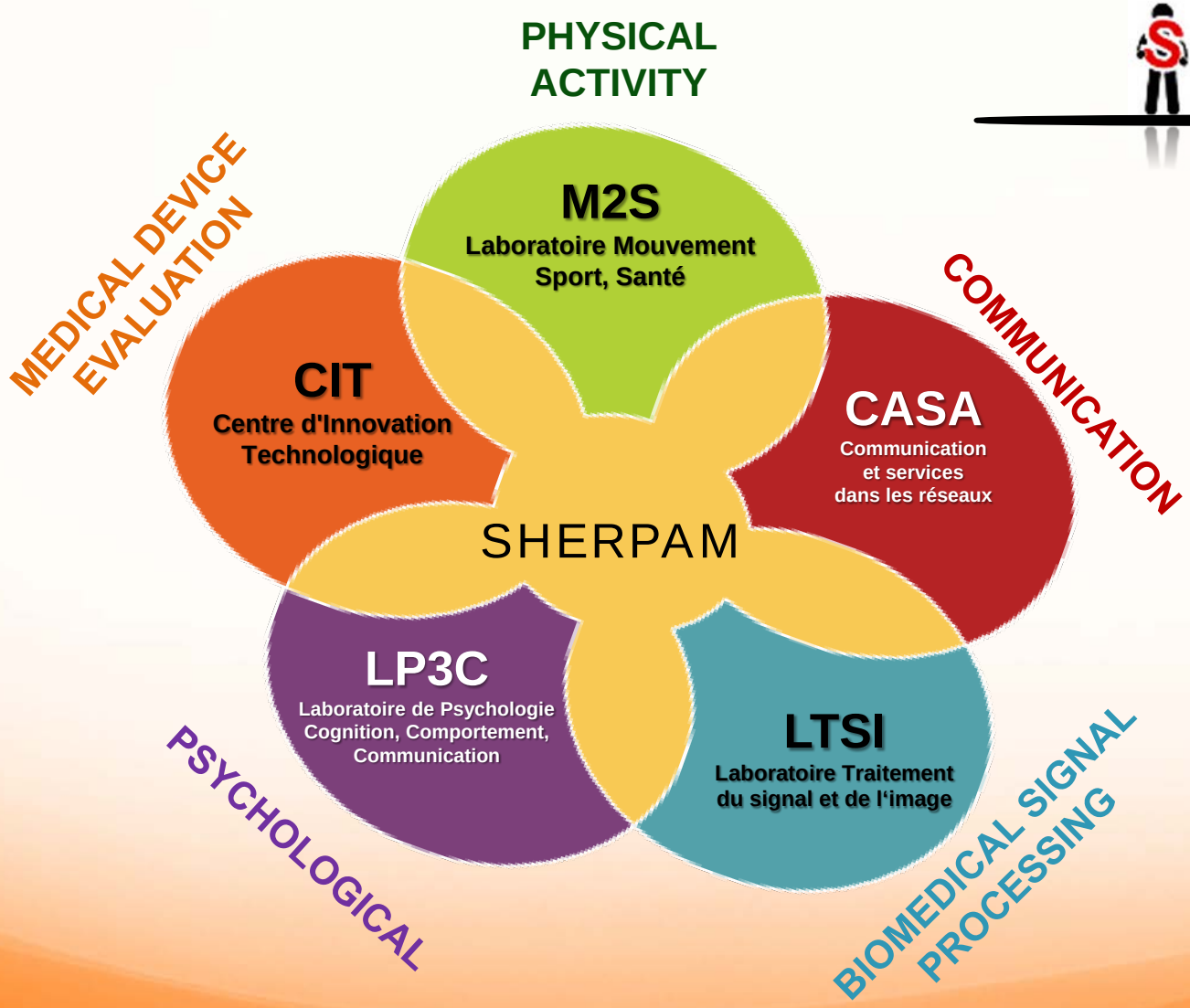
COMPOSITION OF A CONSORTIUM WITH DIFFERENT EXPERTISE



Objectives

- Propose a monitoring **system** able to **acquire, transmit and process data**
- Validate the device on pilot trial around **physical activity**
  - **Cyclo-tourism, lower extremity Peripheral Artery Disease Patient, Patient suffering from cardiac disease, Activity recognition**
- Study **acceptability, acceptance and adoption** of the medical device
  - **Co-design process** users-oriented
  - **Measure of user's acceptability** during the clinical trial

Sherpam project design with respect to human factors

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Acceptability | Acceptance | Adoption

Planification | Conception | Prototyping | Development | Implantation | Evaluation | Deployment

2015-2016 | 2016-2017 | 2017-2018 | 2019

Usage Specification

- Risk factors
- Organizational settings
- Activity goals & Tasks
- Users profiles & Needs

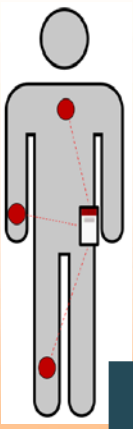
Context Understanding

Risk Management: Dangers, abnormal use, pretest

Contribution to the CPP

Pre-test of the acceptance survey

Co-conception and test of the user's manuel



Sensors, gateway, mobile app. & web site

Usability & Acceptance Testing
(clinical trial Experiment on 3 weeks)

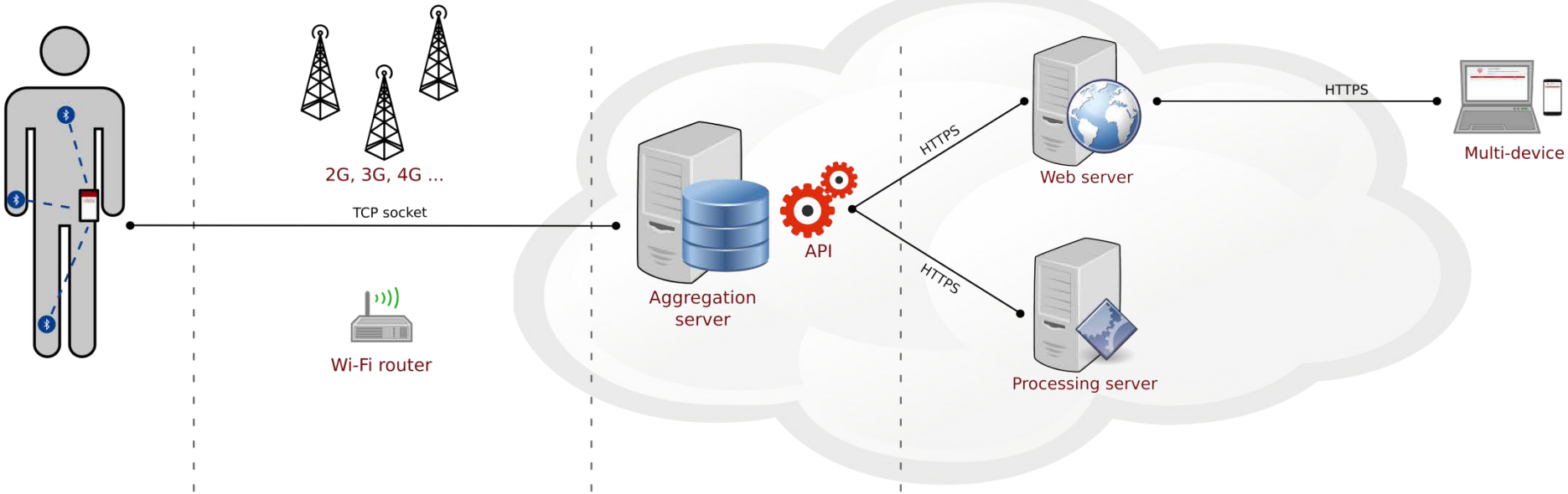
Methodology
(3 groups of users)
G1 (n=10) : Cardiac deseases patients
G2 (n=10) : Healthy users (cyclotourists)
G3 (n=10) : PAD patients

Methodology
(face to face survey and repeated Measurements)
T0: Acceptability *a priori*
T7: Middle acceptance
T21: Final acceptance

OVERVIEW OF SHERPAM

Extensibility, Self-Sufficiency

Interference tolerance



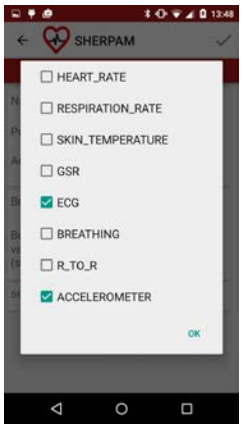
Segment 1:
BAN
Sensors and gateway

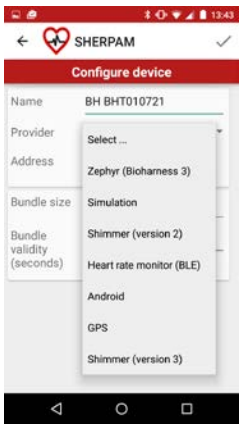
Segment 2:
Mobile transmission
Cellular networks, corporate/community/personnal Wi-Fi

Segment 3:
Aggregation server
Decrypt, pre-process and store

Segment 4:
Data processing
Processing unit, data visualization etc.

Agility



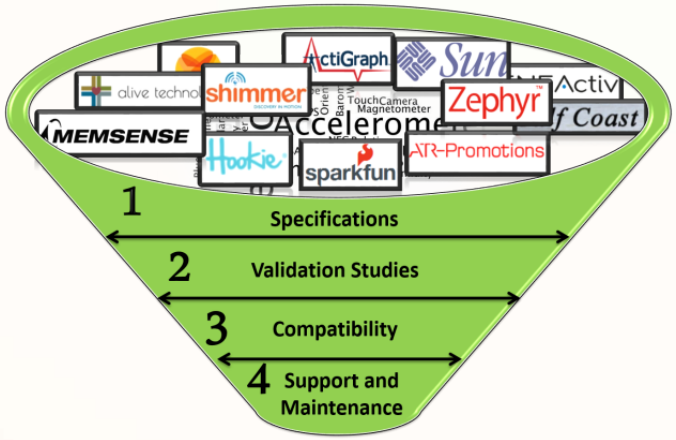


Agregation server

- RACHA application
- AOMI application

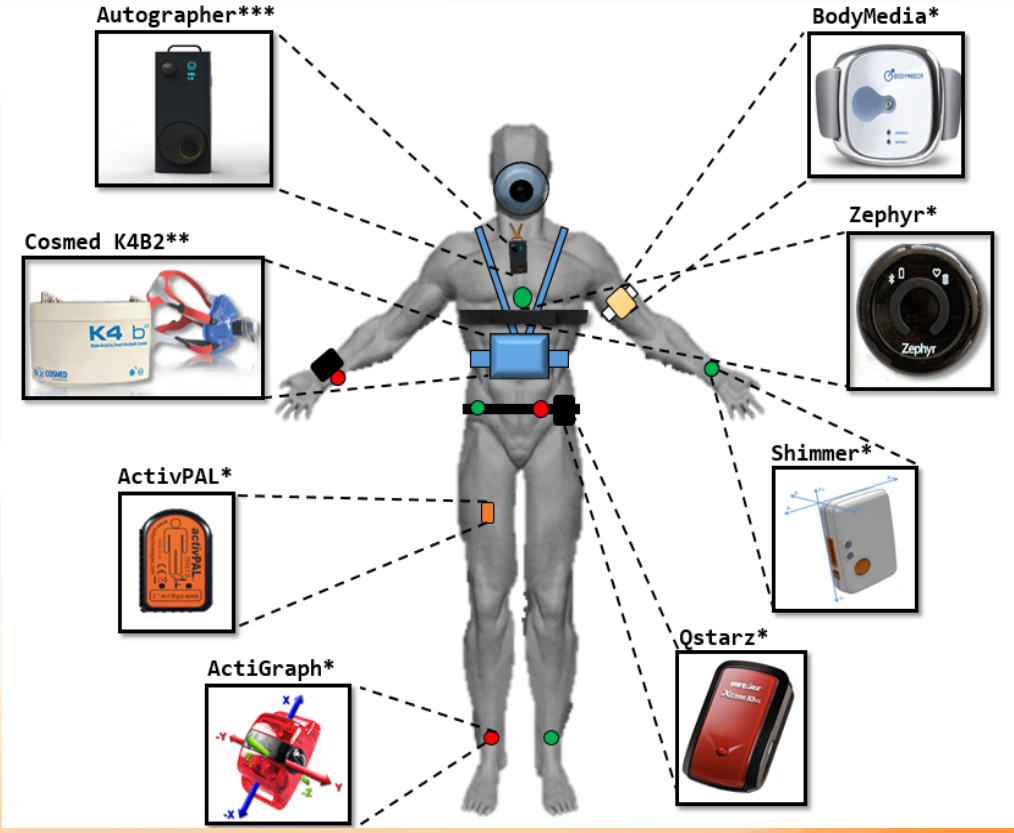
Set of the sensors

A large number of sensors are available to quantify the physical activity and cardiovascular state



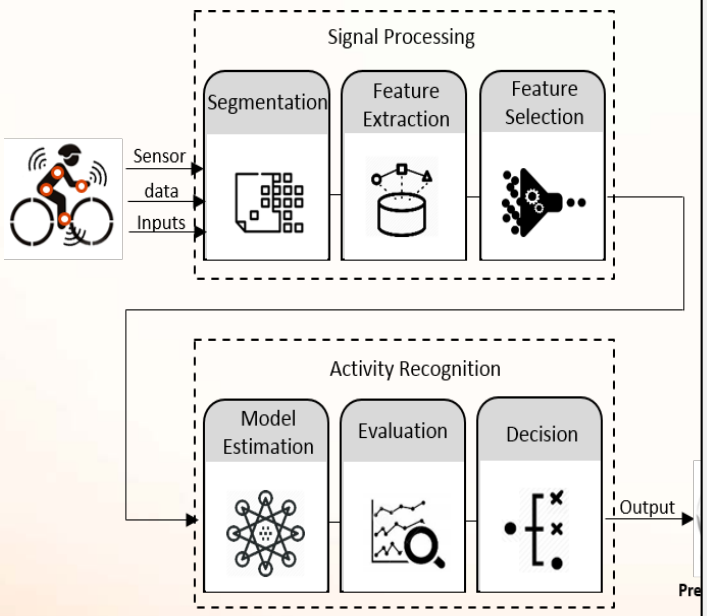
Cardiac sensor & accelerometer

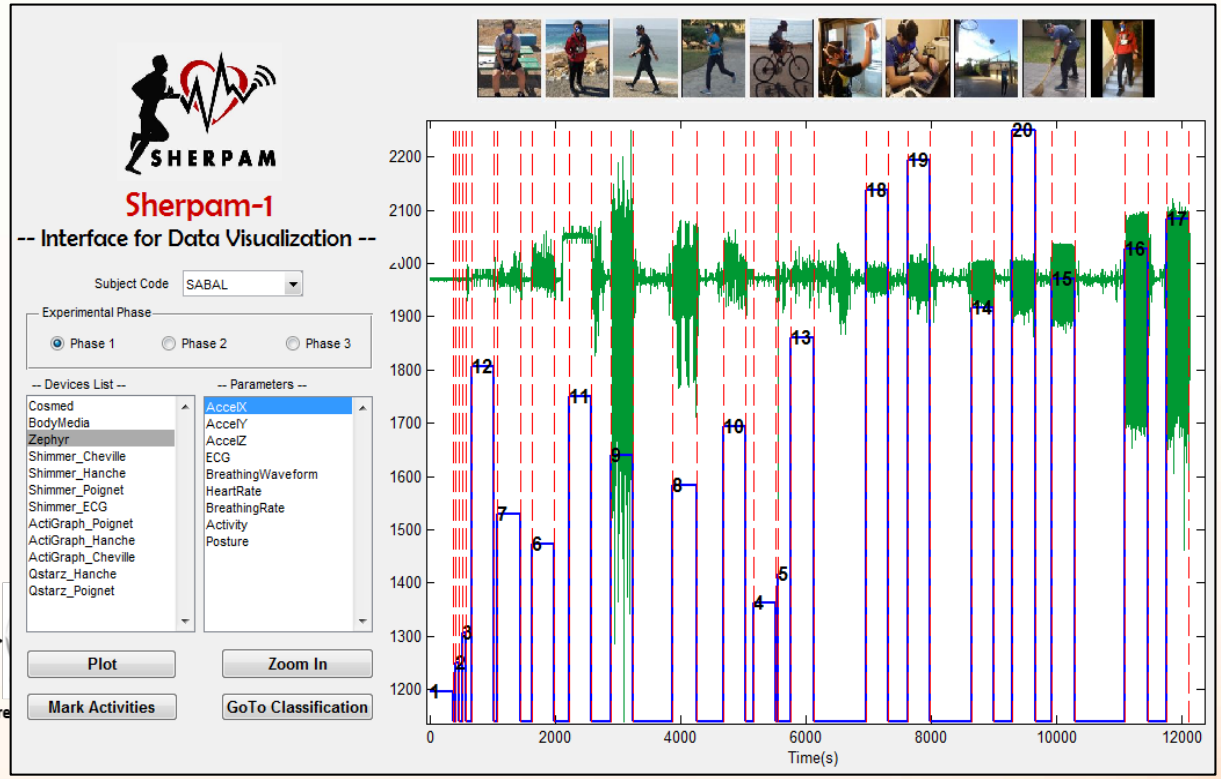
GPS



Develop SP tools on the server : Physical activity and Energy Expenditure estimation

Activity Recognition



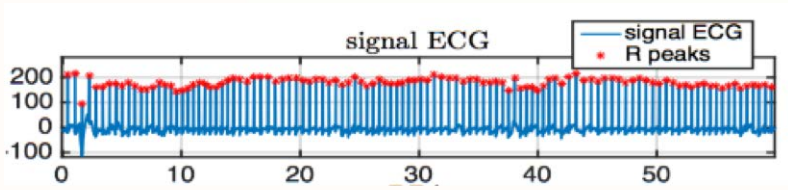


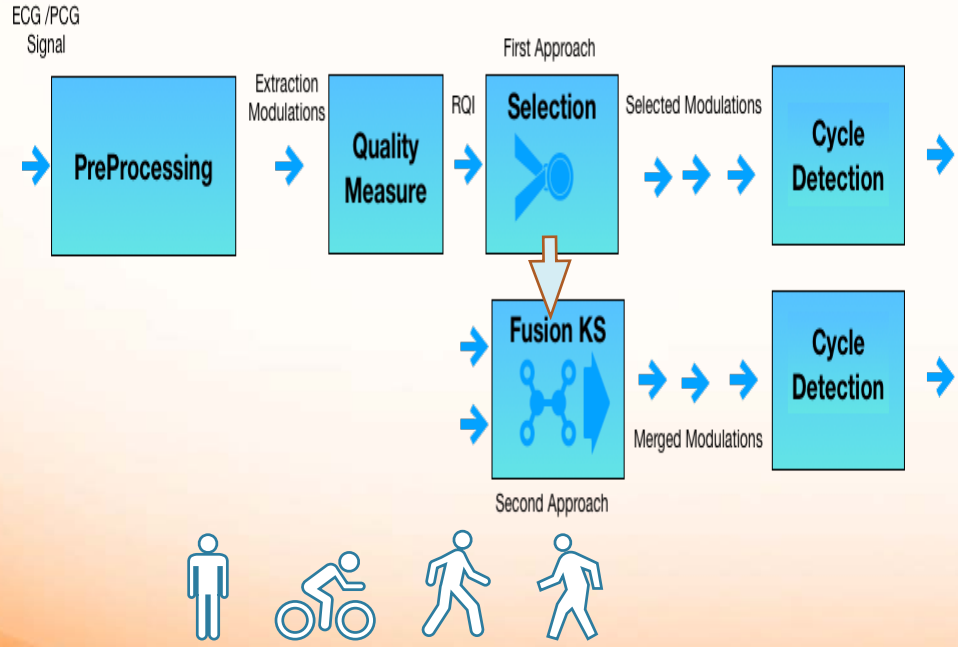
An original and Unique Free Living Database

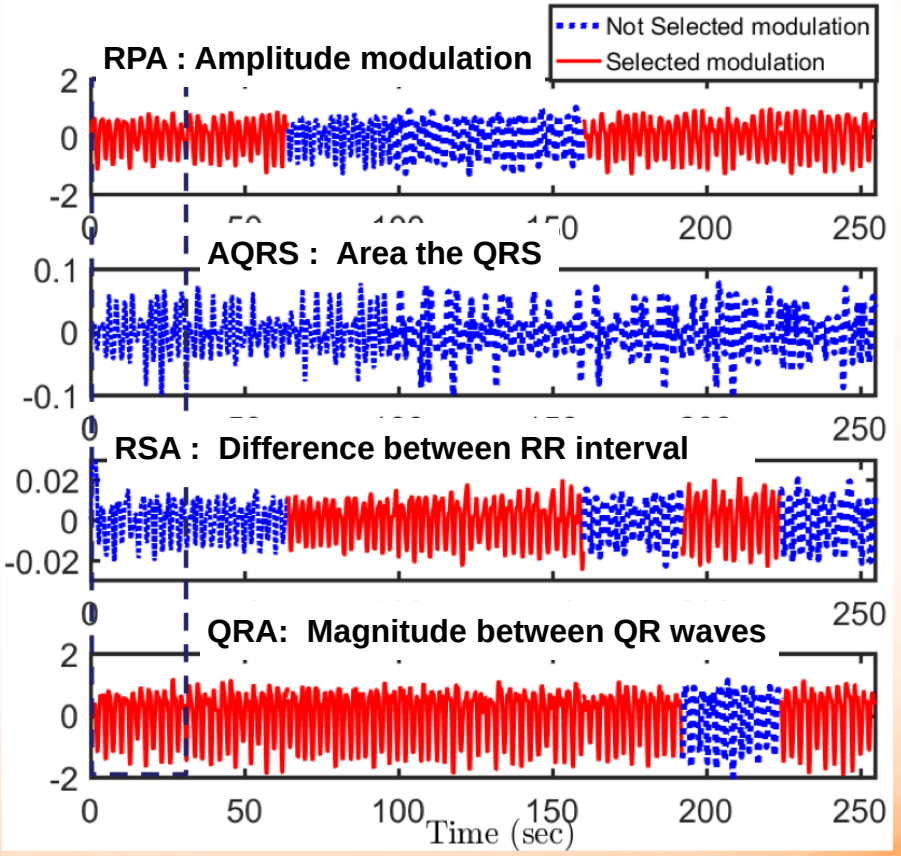
A set of classification approaches compared and objectively evaluated (IEEE-JBHI)

Develop SP tools on the server: Ventilation for Energy Expenditure estimation

Minimization of the sensors
Estimation of Respiratory Frequency from ECG







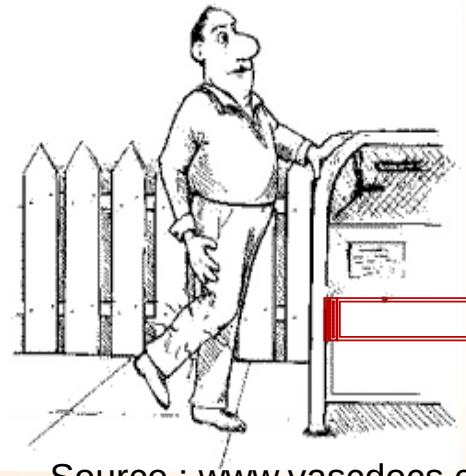
An original and Unique Free Living Database

Under submission APP , IEEE-TBME July 2019, Cinc 2018, Cinc 2019

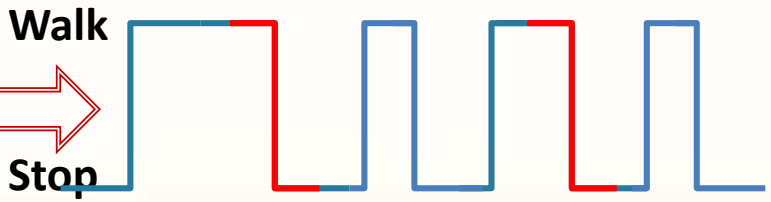
An example of use: application for PAD

OBJECTIVE EVALUATION OF THE OUTDOOR WALKING CAPACITY OF LOWER EXTREMITY PERIPHERAL ARTERY DISEASE PATIENT
CARDIO-VASCULAR MORTALITY AT 5 YEAR ESTIMATED BETWEEN 18% TO 30%

1/ CARACTERISATION OF THE WALK/STOP PATTERN



Source : www.vascdocs.com



NO PAIN | PAIN

- **Activity recognition**
- **Heart rate estimation**
- **Respiratory rate estimation**
- Energy expenditure estimation
- ….

2/ IDENTIFY STOPPING PERIODS DUE TO ISCHEMIC PAIN DURING THE WALKING SESSION

An example of use : application for PAD

All GPS data are stored on the distant server

The physician can access to the raw GPS data

Stop walking is automatically detected and a message box allow the patient to determine the pain level causing the stop

The physician directly receive by e-mail, at the end, a resume of the activity

The Walk begin is automatically detected

Walk upturn is automatically detected

The walk duration is real time screened

Stop walk duration is real time screened

At the end, a resume of the walk session is screened to the patient

Automatically prepare the GPS

START

Begin to walk

Stop walking due to pain

Can walk again

END

Industrial Transfert Ongoing discussion for potential deployment at the University Hospital of Rennes are underway, APP AMWalC IDDN.FR.001.450027.000.S.A.2018.00031230Di

Usability & Acceptance Testing

At T0, Motivations to use the device

Why they will use the device?

1. Help medical research / participate to the clinical trial
2. Have a diagnostic / abnormalities detection
3. Have a medical monitoring

What are the health benefits?

1. Abnormalities detection : rescue and treat
2. Medical monitoring : feel secure
3. Cardiovascular prevention

First results of the acceptability

Measure	Group*	T0 **	T0 + 7 jours	T0 + 21 jours
Utility (12 items)	G1	5,2	4,8	4,3
	G2	3,9	3,4	2,8
	G3	5	5,2	5,1
Sherpam device's utility **decreases with use for the cardiac patients (G1) and cyclotourists (G2)**). For the **PAD group, utility is evaluate as acceptable and stable** throughout the use.				
Usability (10 items)	G1	5,6	5,7	6
	G2	5,4	5,7	5,7
	G3	6	6,3	6,5
Sherpam device is **easy to use** for the 3 groups.				
Intention of use (1 item)	G1	4,8	3,8	3,6
	G2	2,5	2,2	2,8
	G3	3,6	4,9	4,5
Only the PAD group (G3) have a favorable intention at the end of the test. **The intention of use decreases throughout the use for the cardiac group (G1)** For the cyclotourists, the intention of use **remains stable but relatively weak**.				

*G1 = cardiac patients; G2 = healthy cyclotourists ; G3 = AOMI patients

** Average of a score (scale to 1 to 7)

Different uses for different users





Cardiac patients (G1)	Healthy cyclotourists (G2)	PAD patients (G3)
• Data transmission to the CHU • Activity tracking • Application easy to use		
• Control of the activity : sense of safety • Precise heart rate measure	• Assessment of performances	• Motivation to realize physical activities • Assessment of capacities
• Too much equipment to carry / long installation • Difficult to read the data in real time • Missing maximum heart rate alert • Need clinical feed-back • Missing a history		• Not easy to keep the phone in the hands during the walking • Missing a history to note the evolution

On line Visualisation

Historic

Clinical evaluation

Why they will use the device?

1. Help medical research / participate to the clinical trial
2. Have a diagnostic / abnormalities detection
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What are the health benefits?

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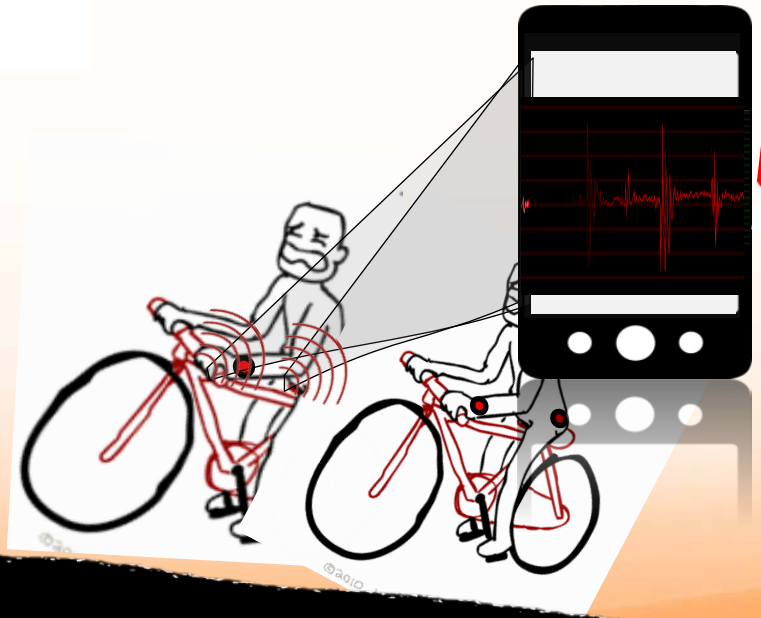


Sherpam in brief

- **Publications**
  - 5 per-review
  - 12 conferences communication
  - 4 Softwares App (Sherpam, AMWalC, RACHA, RESPIR)
- **Important results**
  - 4 innovative databases (free living activity, PAD patient, Cardiac and Cyclotourism)
- **Industrial Transfert**
  - Running discussion for potential deployment of the SHERPAM AMWalC App at the University Hospital of Rennes,
- **Research formation** 2 PHD defense
- **Training**
  - Serve as a pilier in the implementation of an EUR project (“Ecole Universitaire de Recherche”) in Digital Sport Sciences.

Thank you for your attention

SHERPAM

- Privacy protection
- Interoperability with different sensors
- Medical application
- AOMI

Others projects

- Data can be sold to other parties
- Enclosion into manufacturers' ecosystem
- Wellness
- -

THE LANCET

Lee *et al.*, 2012

Physical inactivity causes:

- ☞ **6%** of the burden of disease from coronary heart disease,
- ☞ **7%** percent of type 2 diabetes,
- ☞ **10%** percent of breast cancer, and **10%** of colon cancer.

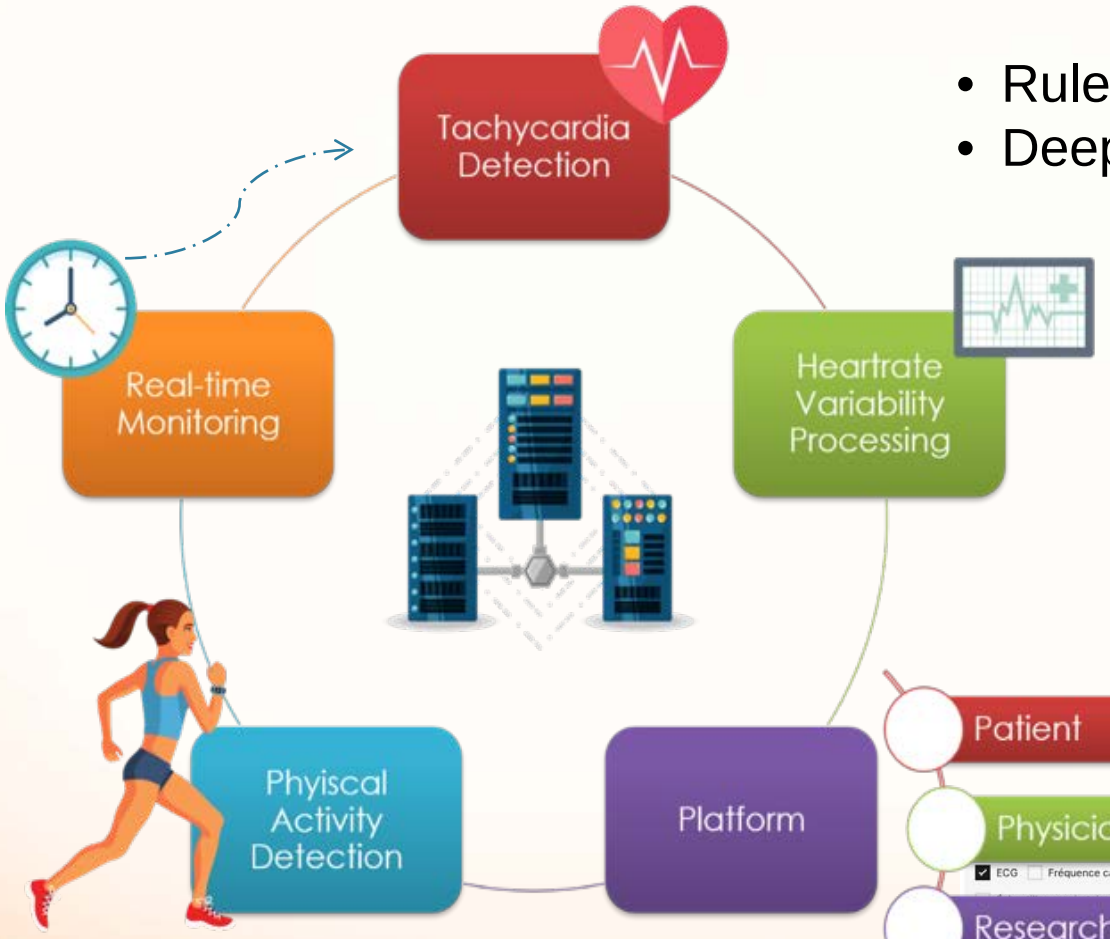
Inactivity causes 9% of premature mortality, or more than 5.3 million of the 57 million deaths that occurred worldwide in 2008.

Table 3 Sports practiced during the cardiovascular events

Sport	*n*	%
Running	51	40.4
Swimming	25	19.8
Cycling	17	13.4
Soccer	6	5.6
Diving	5	4.8
Walking	4	3.2
Table tennis	2	1.6
Rugby	2	1.6
Bodybuilding	2	1.6
Gymnastic	1	0.8
Pelota	1	0.8
Tennis	1	0.8
Full contact	1	0.8
Jet ski	1	0.8
Basketball	1	0.8
Golf	1	0.8
Handball	1	0.8
Alpine skiing	1	0.8
Rock climbing	1	0.8

Only 124 cases are reported (three cases without information about the sport).

Sports-related acute cardiovascular events in a general population: a French prospective study
Chevalier L. et al., Eur J Cardiovasc Prev Rehabil, 2009, 16: 365-370



- Rules-based algorithm
- Deep learning

- RACHA application
- AOMI application