# REMPARK: Personal Health Device for the Remote and Autonomous Management of Parkinson's Disease

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# Outline of this presentation

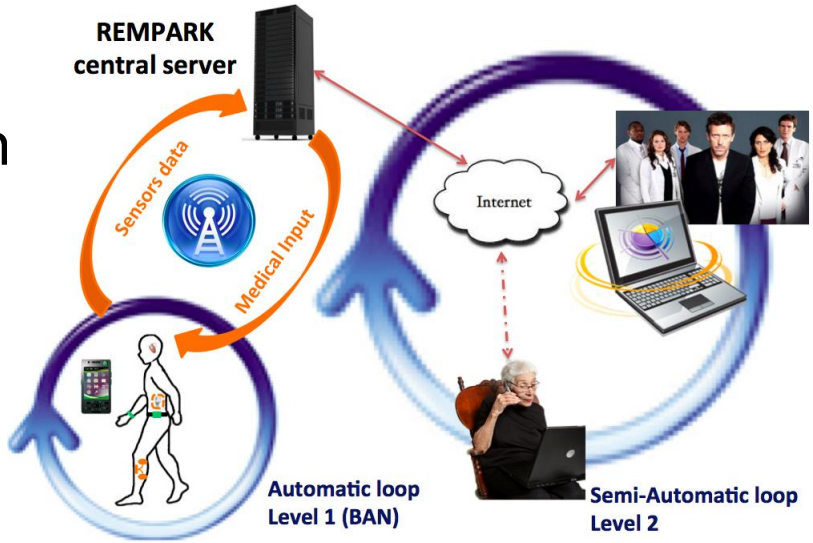
- Motivation and objectives.
- Architecture of the REMPARK system.
- Actual progress: Database construction and algorithmic development.
- Current state and forecasted works and results.
- Conclusions.

# Motivation and Objectives

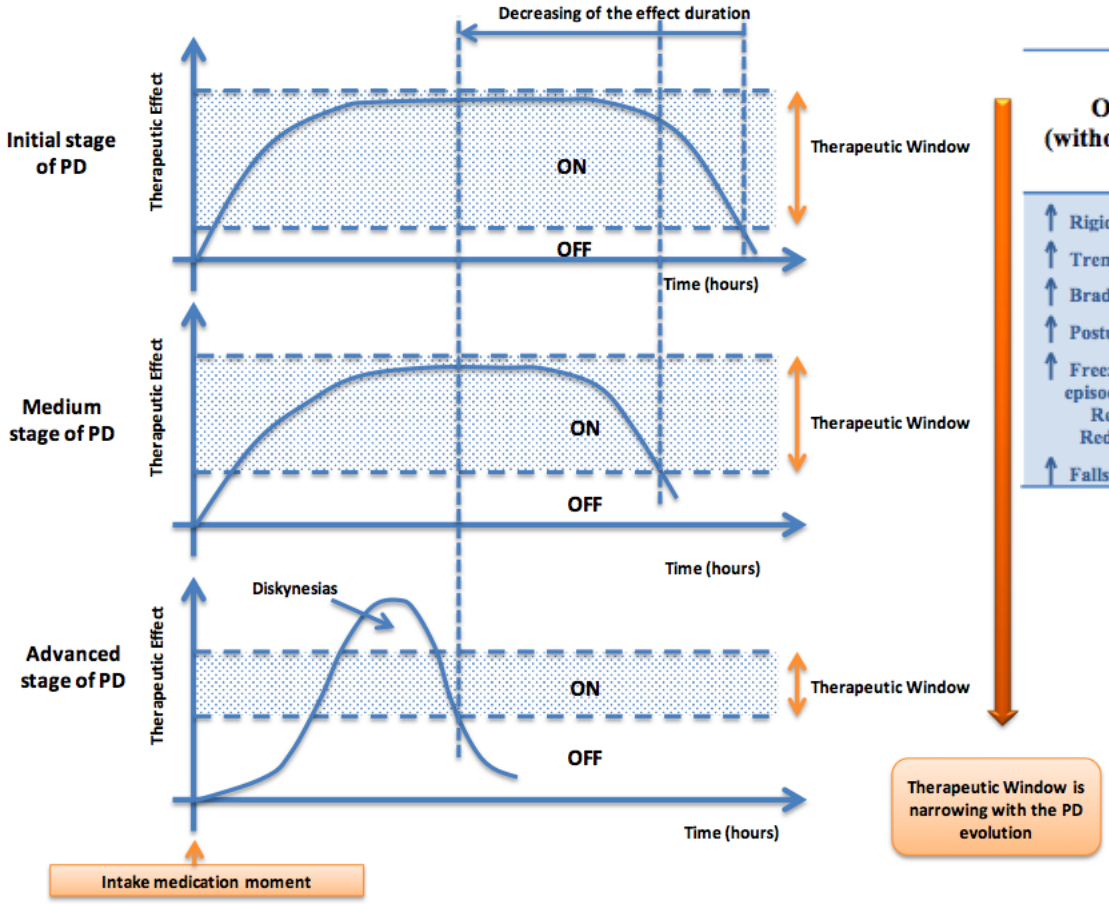
- Parkinson Disease (PD) is the second most common neurodegenerative disease after Alzheimer.
- In Europe, the annual incidence is around 20 cases/100.000 inhabitants per year. More than 2 million PD patients live in Europe.
- The prevalence is around the 1,6% of those people aged over 65 years.
- PD is becoming a public health problem of first magnitude (reduced capacity for self-care, reduced quality of life).

# Motivation and Objectives (2)

- Main objective of REMPARK is to develop a PHS (Personal Health System) with closed loop detection, response and treatment capabilities for PD management. The solution is at two levels:
- Immediate level:
  - Wearable system
  - Motor status identification in real time.
- Higher level
  - Intelligent analysis
  - Neurologist disease management

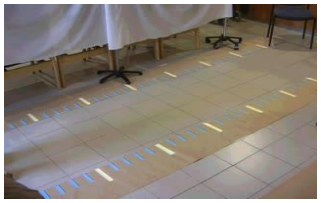


# Motivation and Objectives (and 3)

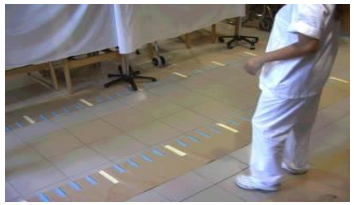



| OFF period (without medication effect) | ON period (under medication effect) | Dyskinesia status (Dopaminergic over-stimulation) |
|---|---|---|
| ↑ Rigidity | ↓ Rigidity | ON period symptoms + Dyskinesia |
| ↑ Tremor | ↓ Tremor | |
| ↑ Bradykinesia | ↓ Bradykinesia | |
| ↑ Postural alteration | ↓ Postural alteration | |
| ↑ Freezing of gait (FOG) episodes<br>Reduced gait speed<br>Reduced stride length | ↓ FOG episodes<br>Increased gait speed<br>Longer stride length | |
| ↑ Falls | ↓ Falls | |

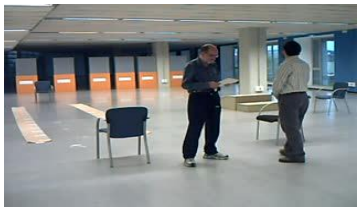
- Medication tries to compensate the needed level of dopamine.
- Fluctuation in the level of blood level of drug generates transitions between ON and OFF states.
- ON and OFF are related with a number of symptoms.



OFF State



ON State



Dyskinesia

# The REMPARK project

- FP7-ICTproject (2011 – 7 – 287677)
- Timeline: 1/11/2011 – 30/4/2015
- Development of a PHS for evaluation of ON/OFF/Dyskinesia status
    - In ambulatory conditions
    - With a sensitivity and specificity greater than 80%
- Identification of motor status in real time
- Development of a gait guidance system
- Development of a user interface (feedback from patient)
- Development of a server to allow interaction with doctors for tracking patient's condition.

# The REMPARK consortium

NUI Galway
OÉ Gaillimh

M&M QUALTECH

Nordforce
TECHNOLOGY AB

REM PARK


neusta
mobile solutions

Maccabi
Healthcare Services
Taking You Forward

EPDA
European Parkinson's Disease Association

Fraunhofer
PORTUGAL

CENTRO MEDICO TEKNON

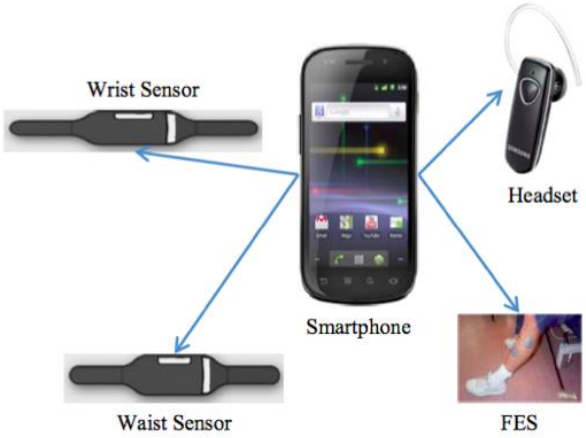
FONDAZIONE SANTA LUCIA
ISTITUTO DI RICOVERO E CURA A CARATTERE SCIENTIFICO
Ospedale di rilievo nazionale e di alta specializzazione per la riabilitazione neuromotoria

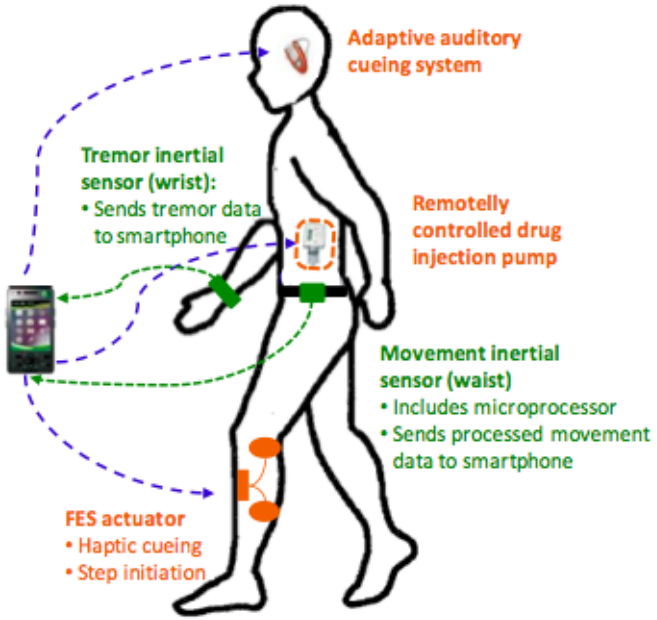
UPC

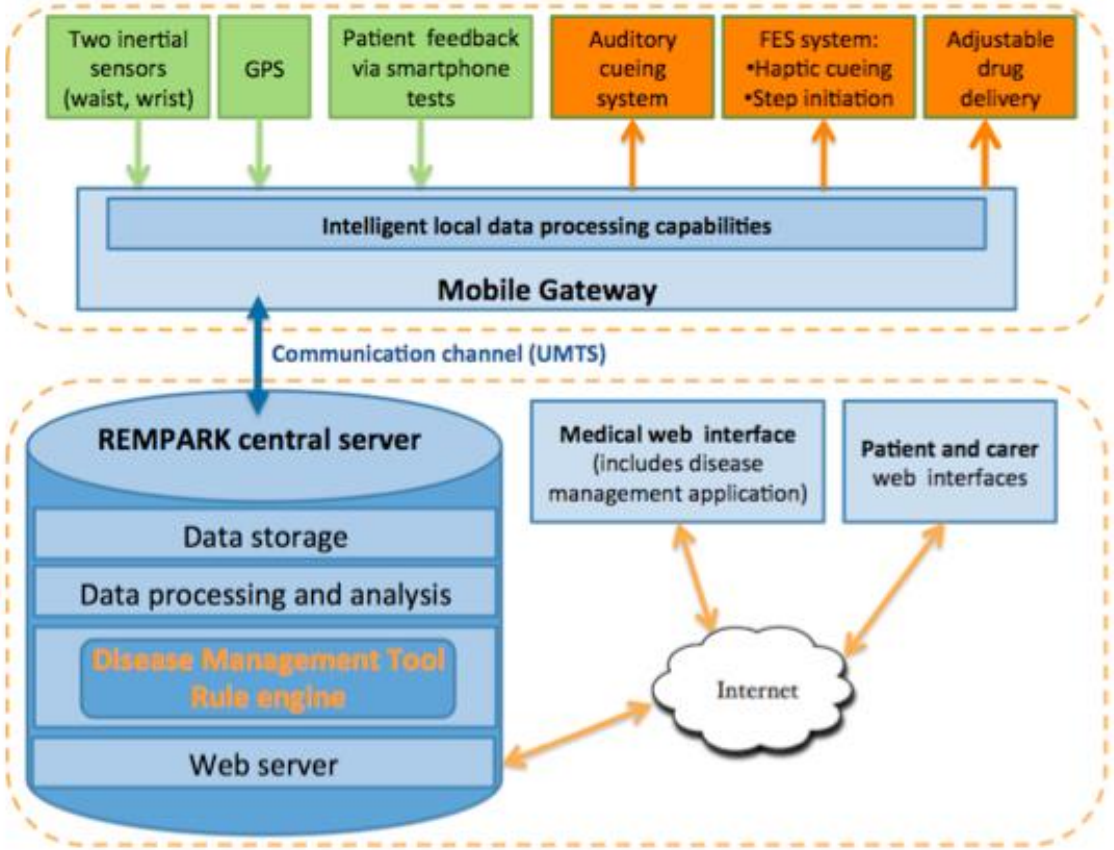
Telefónica
TELEFÓNICA I+D

- 11 partners
- Total cost: 4,8 M€
- Total funding: 3,3 M€

# Architecture of the REMPARK system

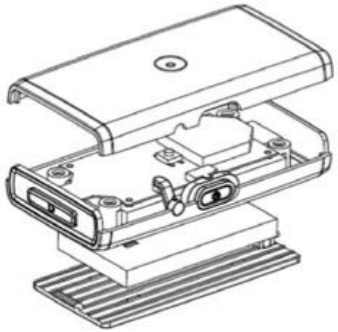


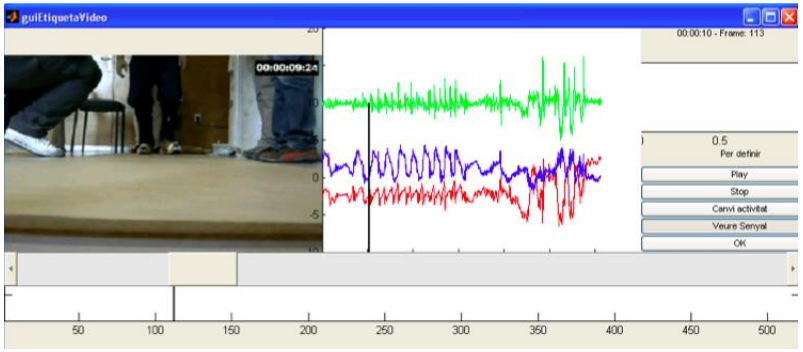



# REMPARK Database construction

- ✓ Adaptive REMPARK system needs a representative database for learning purposes.
- ✓ Enough data must be obtained
  - ✓ 90 PD patients in 4 countries
  - ✓ Ambulatory conditions
  - ✓ A specific protocol has been defined
- ✓ Embedded knowledge must be representative of the major movement disorders.
- ✓ Database is being constructed with labelled video, synchronized with wearable sensors signals

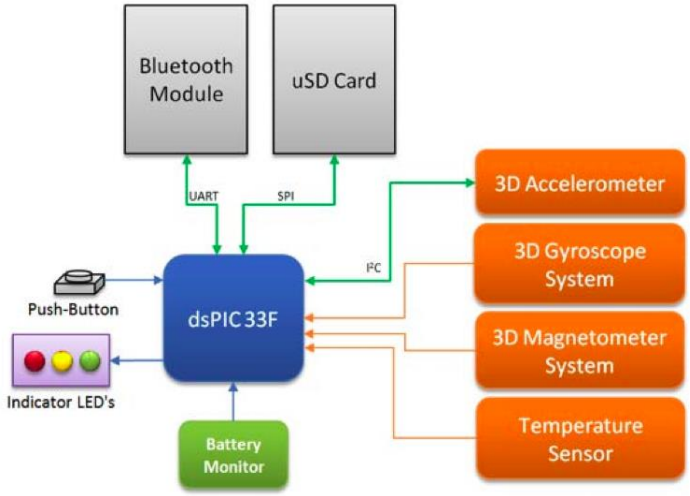




# REMPARK Database construction

Waist sensor

Wrist sensor (for tremor)



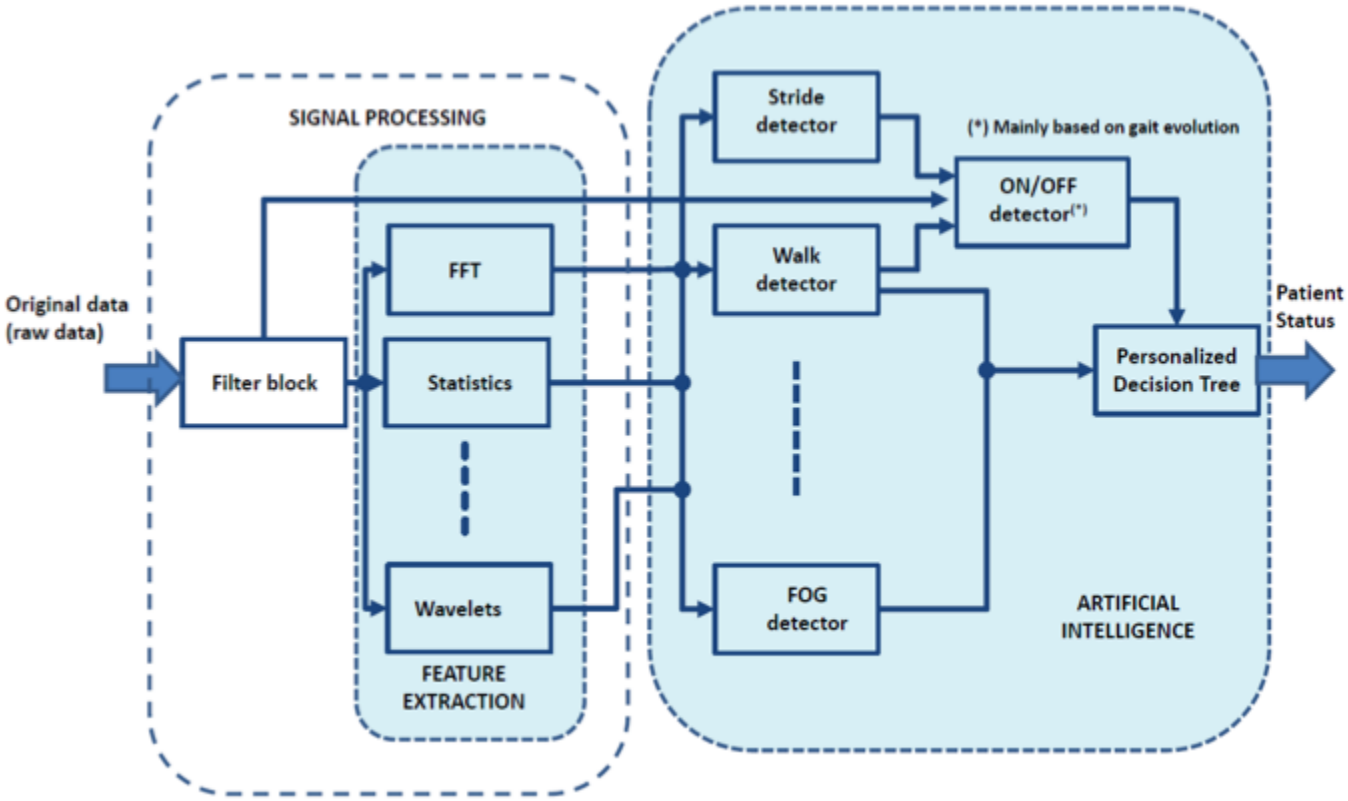

DATABASE construction and validation

Algorithmic development

Piloting experience and validation

# REMPARK Algorithmic development

- Main problems arise when patients are moving (**activity detection**)
- Previous to OFF, it appears alteration in stride or gait speed.
- FOG is characterized by shuffling gait or tremor without associated movement.
- Dyskinesia appears in ON or during state switching.



# REMPARK Algorithmic development (2)

- **Algorithms are developed in order to clearly identify:**
  - **Dyskinesia**
  - **Gait speed and stride length**
  - **Bradykinesia**
  - **Tremor**
  - **Freezing of Gait (FOG)**
  - **Falls**

**Dyskinesia**

- State of the Art algorithms identified and implemented
- Dyskinesias correctly detected in 6 PD patients
- Many activities provide false positives. **Current major effort!!**

**Gait speed and stride length**

- 9 State of the Art algorithms have been identified and tested.
- Tests were done in 3 healthy and 5 PD patients volunteers.
- Most promising ones will be kept for on-line implementation.

# REMPARK Algorithmic development (and 3)

## Bradykinesia

- Developed algorithm has been successfully tested with people with clear Bradykinesia.
- Algorithm is being tested with the rest of database.
- Actual algorithm exhibits a good sensitivity and specificity while patients do not present FOG

## Tremor

- Tremor detection just started
- Machine learning algorithm based on power spectra analysis of the accelerometers signals obtained from the wrist.

## Freezing of Gait (FOG)

- State of the Art method already identified.
- FOG detection is very difficult.

## Falls

- A fall detection algorithm have been already been developed by UPC
- It is applied in FATE project
- Commercialized by SENSE4CARE S.L.

# REMPARK project current status

- REMPARK system architecture is completely defined
- Database construction is already finished and its contents has been validated and organized.
- Algorithmic development is actually in progress and it will be probably finished next October 2013.
- Auditory cueing (actuation level) development is very advanced. Preliminary studies and usability trials have been already performed.

# REMPARK project current status (and 2)

- Communication protocols with the server have been defined and implemented.
- The Disease Management Tool is currently being defined.
- Medical Rule Engine will be completely defined and implemented very soon.
- The piloting activity will be organized and the required protocol will be worked on in the coming weeks.
- Interaction of the system with an apomorphine subcutaneous pump already defined and implemented
- FES (Functional Electrical Stimulation) activity in the project has been recently been re-defined and re-scheduled.

**Thank you for your attention !!**

**http://www.rempark.eu**