

# System designed for monitoring the motion activity of human lower limbs and related method.

## KEYWORDS

- ❑ DIGITAL TECHNOLOGIES FOR MEDICAL APPLICATIONS
- ❑ WEARABLE SENSING SYSTEM
- ❑ COOPERATING DEVICES IN MASTER-SLAVE CONFIGURATION
- ❑ DETECTION OF FREEZING-OF-GAIT IN PARKINSON'S DISEASE
- ❑ ENERGY HARVESTING IN WEARABLE SYSTEMS.

## AREA

- ❑ BIOMEDICAL

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### Priority Number

n. 102018000006405 \_ 18.06.2018.

### Patent Type

Patent for invention.

### Ownership

Sapienza University of Rome 100%.

### Inventors

Fernanda Irrera.

### Industrial & Commercial Reference

ICT for health and wellness, wearable sensors, technologies for Internet of Things, data sharing in cloud.

### Time to Market

Master-Slave operation verified, algorithms robust.

Performances validated on 48 patients.  
Power Consumption: to be engineered.  
Estimated Time-to-market < 1 year/man.

### Availability

Cession, Licensing, Research, Development, Experimentation and Collaboration.



### Abstract

The patent is placed in the context of ICT for health application. It consists in a system of wearable sensors for home monitoring of involuntary gait blocks of neurophysiological patients (as in the case of the Parkinson's Disease).

The devices cooperates in the Master-Slave configuration for recording and processing the information in real-time, reporting an eventual oncoming block potentially causing a fall.

All the data related to motion symptoms are stored in a memory integrated in the board, thus realizing an electronic agenda. To improve the battery duration, it is implemented an algorithm which recognizes the sitting and lying positions, and set components in the stand-by condition.

Fig. 1 **Hardware System**. **A** indicates the two hard devices **Master and Slave** containing the sensors, the microprocessor, the memory, the wireless communication unit, the rechargeable battery. **B** is a wireless transducer which receives the information from the Master that an involuntary block has been recognized and actuates a sensorial stimulation (in the picture it is a microphone, but it can be another type of stimulus, not auditive). **A** can transmit data to an external station (Smartphone or PC) using the home wi-fi. The external station makes an off-line elaboration realizing an electronic agenda with statistical data on the patient symptoms, graphs, tables, pictures and shares this information in the cloud to which authorized person have free access (doctors, relatives, care-givers).

### Publications

- ❖ Wearable sensing system for an improved analysis of the freezing of gait in Parkinson's Disease using electromyography and inertial sensors DOI: 10.3390/s19040948, Sensors 2019, 19(4), 948.



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# System designed for monitoring the motion activity of human lower limbs and related method.

## Technical Description

The hard system is made of two wearable devices to be fixed on the lower limbs.

They include sensors, memory, microprocessor, wireless communication unit, battery. One of the two devices is the Master, the other is a Slave.

The data acquisition is made in parallel, but processing is all in charge of the Master. It receives wireless the Slave data, elaborates and stores them together with the Master's ones, and eventually transmits wireless to a PC for the off-line processing and data sharing in a cloud.

The algorithms recognize in real-time and in a very reliable and robust way specific motion symptoms as the involuntary gait block.

This guarantees that a sensorial feedback can be given to the patient, since validated clinic studies demonstrated that involuntary blocks can be released and falls prevented with proper sensorial stimulations.

## Technologies & Advantages

The possibility of integrating inertial sensors in electronic circuits allows developing wearable systems for home monitoring and assistance with long autonomy.

Patients affected by neurodegenerative diseases would mostly benefit of such systems, showing symptoms of the motion sphere which often imply injuries and falls catastrophic for their life quality. With population aging, such pathologies become more diffused raising a consequent social issue and the costs supported by the National Sanitary Service.

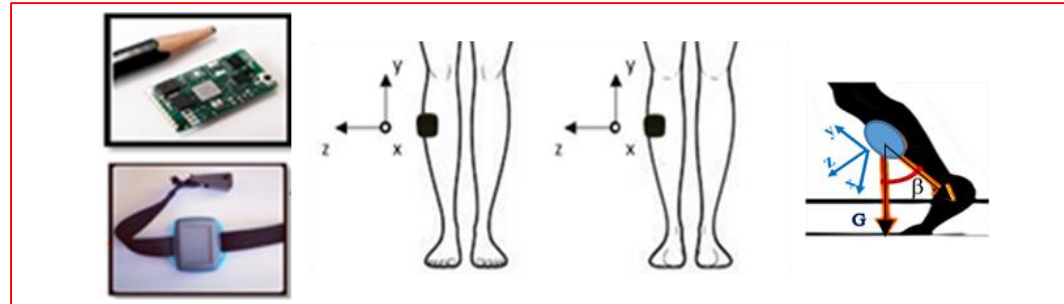


Fig. 2 **Donning.** The devices can be put on the lower limbs, very comfortably and easily, because their size is of a few square centimeters and their weight is of a few grams, including the battery. They can be allocated into proper tight pockets in the socks, guaranteeing a fixed position. In the figure, the angle  $\beta$  between the gravity vector and the shin is outlined, since it is used for the algorithm of gait disorder recognition.

## Advantages Clinical

- Controlling motion symptoms through home monitoring along the daily in free living, improved assessment of the clinical condition.
- Optimization of the therapy, in order to maximize the drug effects reducing their side effects in the motion sphere.

## Advantages Social

- Reduction of the hospitalizations due to injuries and falls, reduction of the hospital commuting, less inconveniences for patients and assisting families and caregivers.

## Advantages Economic

- Reduction of the expenses in charge to the National Sanitary Service for diagnostic scopes or consequent to indirect causes as injuries and falls.
- Expenses optimization related to the best use of doctors and medicines.

## Applications

1. The main application of this wearable system is the collection of objective and quantitative information about motion, along the day and in free-living condition
2. The National Sanitary Service can use it to reduce direct and indirect costs related to a specific disease and to make its management more efficient
3. A Drug Company can use it in conjunction with their commercial product, to publicize its efficacy respect to products put on the market by other companies
4. Monitoring patients on a wide territorial, social, environmental scale can find application in a statistical tool for epidemiological studies relatively to specific diseases
5. This system is thought for remote sharing in cloud of specific clinical information related to a patient, thus finding application in Smart Health technologies in an Internet of Things framework.

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