CuPiD

Closed-loop system for personalized and at-home rehabilitation of people with Parkinson's disease.

CuPiD aims to develop and test a combination of technology-based services for at home rehabilitation and training of major motor impairments caused by Parkinson's disease.

Objectives of the project

Parkinson's disease (PD) is a neurological disorder with progressive disability over time. In the past two decades, there has been evidence demonstrating the ability of motor learning in PD and also improvements as a result of training. It has been shown that the brain affected by PD may be capable of plasticity and brain activity patterns may be altered by appropriate training.

CuPiD is a three year EU project whose aim is to provide technology-driven personalised rehabilitation exercises at home for people with Parkinson's disease. It is powered by an eight member consortium led by the University of Bologna.

CuPiD's objectives:

- Produce clinical guidelines for developing tailored therapy programs using technology
- Create a home-based rehabilitation system (wearable sensors and local processing)
- Build a telemedicine infrastructure for remote supervision of the rehabilitation

Project Description

CuPiD promotes patients' independence by providing home-based therapy. For this to be effective, CuPiD will monitor and record remotely a patient's activity in training and clinicians will be able to supervise their progression, change the training to fit an individual's needs and assess problems that occur using a computer interface.

CuPiD's three services:

1. Virtual Reality (VR) which will provide audio, visual and tactile feedback while the patients train using different simulations. This training requires integration of cognitive (attention, decision making) and motor function in a motivating and engaging environment.
2. Provision of external cues to avert freezing of gait (FOG) and training of its prevention (can include outdoor usage).
3. Biofeedback device for training of daily activities; the device will be portable and able to provide audio, visual and tactile feedback for the training of motor / cognitive functions (can be used outdoors).

CuPiD will develop and validate a personal health service with:

Virtual reality (VR). This is a powerful tool for repetitive practice for motor function, and provides feedback about performance and motivation for patients.

Wearable components. These will be connected to a VR simulation whose feedback will enhance training.

CuPiD will provide targeted care to improve motor function, reduce disability and social isolation of a wide variety of users with PD.

Freezing of gait (FOG) is a gait disturbance which is seriously debilitating. During FOG episodes the subject often perceives complete inability to continue walking. FOG episodes increase the risk of falls, and have a considerable negative impact on quality of life. CuPiD will offer a device which will realize FOG rehabilitation by predicting onset of a freezing episode and provide feedback shortly before the freeze. This can be used by a trained patient to

Case study

J has suffered from PD for 12 years. His major problem is freezing of gait occurring mainly in narrow spaces and when he is engaged in further activity other than walking (e.g. talking). The clinician recommends a training activity based on sensors placed on the legs. The system is worn for several hours during the day, when an episode of freezing occurs, biofeedback, is provided to the user, to help him recover the gait. This allows the user to learn new movement strategies to overcome the freezing episodes altogether, thereby providing a rehabilitation function.

consciously balance his / her body weight, thus providing assistance in case of freeze. Through repeated occurrences, the patients will internalize this feedback process, learning to overcome and manage freezing episodes.

In the first half of the project, configurations of sensors will be tested to increase knowledge of their specific applications. Tests will include wearable sensors, motor-task identification, efficacy of feedback restitution, real-time biofeedback, interface development and VR-based simulation.

The second half of the project consists of a large validation campaign to allow accurate evaluation of the services in terms of:
i) feasibility; ii) integration with healthcare institutions; iii) efficacy of intervention; iv) satisfaction of all users.

Expected Results & Impacts & Preliminary Results

The overall outcome will be the establishment of feasibility and efficacy of a closed-loop based rehabilitation protocol to be performed at home by subjects with Parkinson's disease. CuPiD will develop innovative rehabilitation based on new technology and the patient's needs.

Expected outcomes will include the following:

1. Provide an ICT-based tool to administer therapy in the home environment.
2. Demonstrate and quantify the influence of training on PD. There is still a huge matter of research and discussion in the scientific community, with clear evidences but already with enormous gaps to cover.
3. Provide evidence of efficacy of therapy by means of motor learning processes.
4. Allow research from the large amount of data gathered on the basic mechanisms of training in people with PD and the correlation between context (i.e. medication intake, stress, location, attention level) and motor performance.
5. Develop and validate new algorithms for feedback.
6. Provide an innovative Personal Health System with on-board processing enabling multi-modal feedback and multi-faceted training.
7. Guarantee usability and personalisation of rehabilitation, empowering the end-user to self manage her / his training at-home.
8. Contribute to the use of standardisation in health IT.

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- Tel-Aviv Sourasky Medical Center – Israel
- Eidgenössische Technische Hochschule Zürich - Switzerland
- Katholieke Universiteit Leuven - Belgium
- Oxford Computer Consultants - UK
- ST Microelectronics - Italy
- EXEL - Italy
- Fundació Illes Balears Innovació Tecnològia - Spain

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