Physiological Computing as a Facilitator for the Promotion of Physical Activity in People with Functional Diversity

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Introduction

Physical Activity (PA) helps reduce health risks and prevent a loss in motor skills. PA, as part of a rehabilitation program or as personal choice, produces enormous benefits to People with Disabilities (PwD), whatever its intensity and duration. Costless activities can be performed: walking, crawling depending on individual's motor skills.

Level	Activities
I	Crawling, running, shuttle-run game, dancing, martial arts, skating, playing table tennis.
II	Football, videogames (Nintendo's Wii controller and Wii-Fit Balance Board).
III	Sit-to-stand, step up-down, squatting, walking (free, gait, elliptical, treadmill), elastic bands for training upper limbs, swimming, playing videogames (Microsoft Kinect).
IV	Strengthening of knee extensor, hip flexor, and ankle dorsiflexors, physio-ball exercises, universal exercise unit, feet ergometer, cycling using adapted bikes, wheelchair hockey, gymnastics, animal therapy.
V	Virtual-reality games.

Table 1: PA according to GMFCS [1]

The proposal

The main idea is to combine Physiological Computing (PC) with measures of PA so that PwD can exercise longer. This multi-modal information will help people stay in 'optimal conditions' when working out.

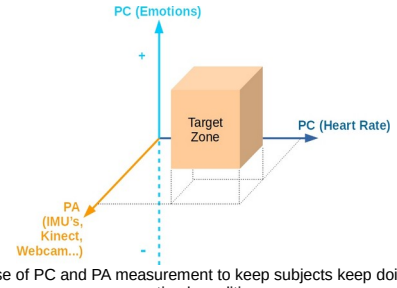

Fig 1: The use of PC and PA measurement to keep subjects keep doing exercise in optimal conditions

We have developed low-cost open-hardware elements for the measurement of physiological signals and PA based on well-known free hardware platforms such as Arduino nano IOT BLE. Several custom-made shields were designed to capture different physiological signals while the Arduino nano contains the inertial units needed for detecting PA.

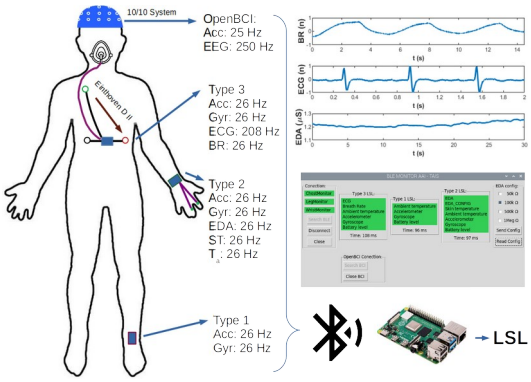

Fig 2: Set of wearables for measuring physiological signals and physical movements[2]

Alternatively, techniques based on computer vision can be also implemented for detecting and quantifying the PA. For example, Kinect provides the human joints coordinates but requires a specific hardware that may result expensive. A simple webcam camera along with a GNU software like OpenPose [4] can reduce costs.

Our first approach is based on the use of inertial units for PA. A computer receives signals from the wearables and determine the physiological state through the HR, EDA, … together with the rhythmic movement during the PA. A software application will guide user to do the exercise. It consists of a GUI that shows a piece of a keyboard moving from the right towards the left on the computer screen, with a speed that sets the exercise pace. The user's movement must be repeated every time the keyboard enters into a specific area.

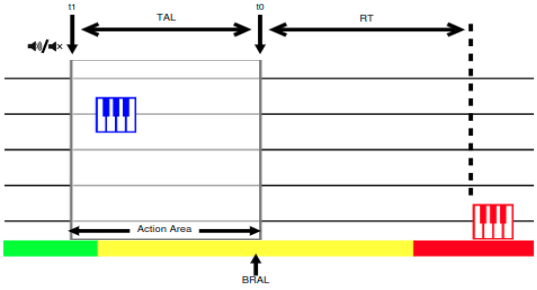

Fig 3: IRO screenshot. People have to make and action when the keyboard symbol reaches the action area.

The software adapts the rhythm to human internal state, reducing it when HR is greater than a recommended limit or when the detected internal state suggests that the person has an emotion with negative valence. The music is also turned on to encourage people to maintain the pace.

Fig 4: A person with disability interacting with IRO by raising his right arm periodically

Conclusions and future work

We have performed a previous research in determining the PA appropriate to PwD, developed a network of low-cost wearable devices that delivers both physiological and physical signals, and a software that allows adapting the exercise according to the received information. We will begin the experiment with final users after gathering their musical preferences and the type of exercise to do.

Acknowledgment

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