WIRELESS-PORTABLE SYSTEM FOR LONG-TERM MONITORING OF UPPER-LIMB ACTIVITY

Hernández-Delgado A. S.[1], García-Ugalde F.[1], Vega-Gonzalez A[2,*]

[1] Department of Electrical Engineering, Faculty of Engineering, [2] Department of Neurosciences, Instituto de Fisiología Celular, National Autonomous University of Mexico, Mexico 04510

[*]Current address Department of Chemical, Electronics and Biomedical Engineering, Universidad de Guanajuato, Leon, Gto. 37150, México

E-mail: mandigit9@yahoo.com.mx, a.vega@ieee.org

Introduction and Objectives

It has been pointed out that there is no optimal technique to measure upper-limb movements [1]. Furthermore the selection of the outcome measures has been debated. Therefore an "ideal" instrument should measure on the level of activity or role fulfilment that reflects function on a individual's normal day. If activities of the upper-limb are going to be studied, it is useful to study them in a free-living environment and the instrument should not interfere with the subject's activities. This paper describes the design and implementation of wireless-portable system, which is able to detect the posture and movement of the upper limb in a free-living environment

Methods

The system is composed of two parts, a storage unit and a set of acquisition units. The storage unit controls and receives all the information from the different acquisition units. This unit uses a PIC microcontroller (PIC18LF2550), a memory card (SD) and a wireless digital transmitter/receiver (nRF2401A). It commands all the acquisition units and stores the information. Each acquisition unit has a unique digital identifier and it is composed of a motion sensor, a microcontroller (PIC16F688), and a wireless transmitter/receiver (Figure 1). For sensing upper-limb activity, the motion sensor was based on the Strathclyde Upper-Limb Activity (SULAM)[2] which is able to measure the vertical position of the wrist relative to the shoulder.

Results

The proposed system can have several acquisition units associated to one storage unit, which creates a sensor network thanks to the ShockBurst® digital transceiver protocol. This sensor network is dedicated to assess the kinematics of a single subject (Figure 2) and it is possible to have more than two systems working in the same room without causing interference between each other. The system supports the use of other motion sensors, such as accelerometers or gyroscopes.

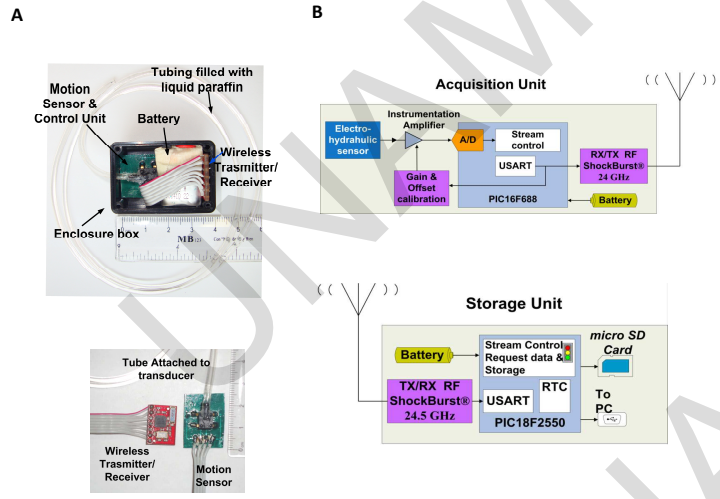

Figure 1. The wireless system. The figure shows the system developed, sensor and the wireless transmitter/receiver (A), which employs a small rechargeable 3.7 Volts Lithium Ion Battery. The different components can be observed in a block diagram (B).

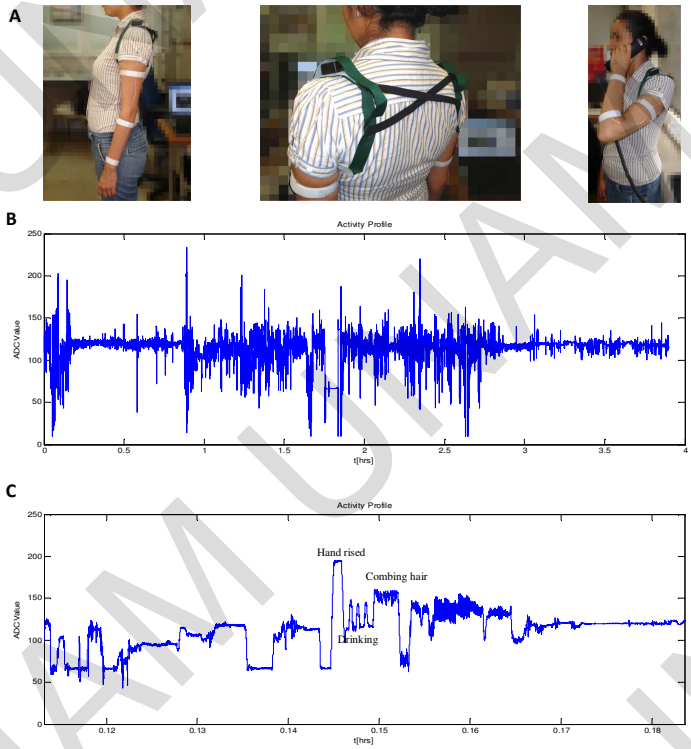

Figure 2. The wireless SULAM. The figures shows the system on a subject (A), and the signal from one upper limb (B). It also shows a segment of the activity profile (C). The data was stored on the SD card. The maximum sampling rate supported is 160 Hz.

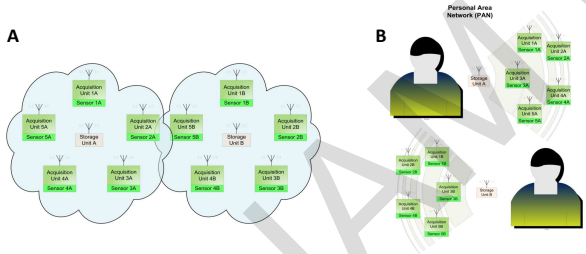

Figure 3. Interaction with other wireless SULAM systems. The wireless protocol is under the ISM band and it does not cause interference with other medical devices.

Discussion and Conclusions

A hardware technology consisting of an electro-hydraulic activity sensor (SULAM) and a digital wireless transmitter/receiver was implemented to transmit data from multiple motion sensors. The system is compact (3.8x2.6x1.8 cm each Sensor Unit) and light (16 gram) and it does not interfere with the subject's normal activities due the lack of annoying and/or bulky wires. The results represent and important first-step in the development of a wireless-portable system to assess upper-limb activity in free living environment, which could be used to evaluate and/or monitoring upper-limb rehabilitation. Also the wireless systems can be used with other types of sensor as accelerometers.

Referencias

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Acknowledgements

Supported by grants CONACyT 49740 and PAPIIT IN224407