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APPLICATIONS OF TEXTILE BASED ELECTRODES IN GAIT ANALYSIS - PROLIMB PROJECT

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ABSTRACT

This paper presents the application of textile based electrodes for surface electromyography embedded in a wearable locomotion data capture system for gait analysis. The system that is under development will allow the measurement of several locomotion-related parameters in a practical and non-invasive way, comfortable to the user, reusable which can be used by patients from light to severe impairments or disabilities. The present paper gives an overview of the research, regarding the design of the textile electrodes, the textile support, and communications.

Keywords: gait, rehabilitation, textile sensor, body network.

INTRODUCTION

Human motion capture systems are used by medical staff to detect and identify mobility impairments, early stages of certain pathologies. These systems may also play an important role on the evaluation of surgical or rehabilitation intervention effectiveness. Different techniques have been used in the recent past to capture and analyze locomotion, in order to characterize and improve body postures, and detect early stages of pathologies that cause mobility difficulties (Z. Yuting et al, 2011). Vision is probably the most popular technology. It uses cameras to capture the spatial location of special labels attached to specific places such as joints. There exist other approaches, such as recording kinematic variables through accelerometers and gyroscopes. Surface electromyography (sEMG) is also used to monitor the muscle activity in limbs. The combination of these different technologies can give very important information to the professionals. However the present solutions present several disadvantages: the systems are expensive and complex, difficult to apply by healthcare staff, difficult to use and uncomfortable for the patient. In the particular case of sEMG, the conventional electrodes use adhesive electroconductive gel to reduce skin-electrode impedance, which can develop skin irritation when used for prolonged periods of time. An alternative to these sensors could be embedding sensing equipment in a comfortable piece of garment, which is presently possible.

PROJECT OVERVIEW

ProLimb is a project under development with the purpose of proposing a wearable system capable of simplifying the assembling work and the comfort of the user. This system should be autonomous and allow a real time monitoring for human locomotion data capture. The proposed system is intended to be dressed by the patient itself or with aid if needed. This is

accomplished by means of an instrumented legging, capable of acquiring several human locomotion parameters in a non-invasive way, even for people with strong impairments or disabilities. The system includes the capture of the following parameters:

- Spatial position of the lower limbs, speed and accelerations, by using 3D accelerometers and gyroscopes;
- Electromyographic signals of specific muscles located in the lower limbs.

The system uses as support a legging with elastic properties, which allows the correct positioning of the sensors and electronics. This legging is equipped with different sensors that involve the measurement of kinematic quantities, and surface electromyogra-phy (sEMG) of several muscles. The sensors communicate by means of sensor nodes (SN) to the central processing module (CPM), which on its turn sends the information by wireless communication, in this case with Bluetooth®.

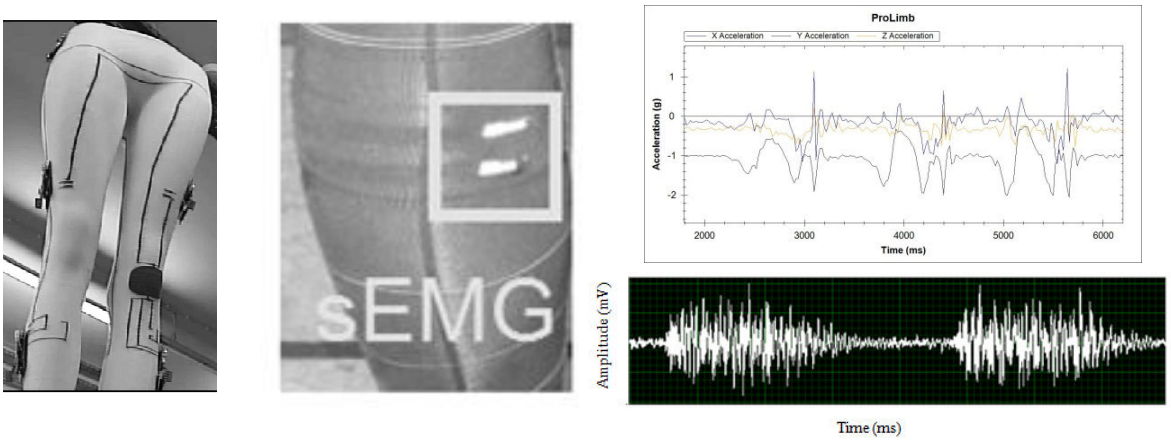

Fig. 1 - First version of the legging with the sEMG electrodes and inertial modules (left), sEMG electrodes placed on gastrocnemius medialis muscle (center left), sEMG waveform obtained with textile electrodes (center right), 3D Accelerometer waveform during an experiment involving three consecutive step (center top right).

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