INTERACTION

Training and monitoring of daily-life physical interaction with the environment after stroke

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The objective of the recently started EU project INTERACTION is to develop an unobtrusive and modular system for monitoring the quality of daily-life activities of stroke subjects involving the upper and lower limbs.

Keywords – Daily-life activity, stroke survivors, rehabilitation, ambulatory monitoring, unobtrusive monitoring, textile-based and micromechanical integrated sensing, distributed sensing, telemonitoring, on-body feedback.

1. INTRODUCTION

Persons who suffered a stroke are trained to improve adequate control over their movements with the objective to optimize their daily-life functional performance. Critical is how good they are able to interact physically with the daily-life environment, including handling objects, controlling body balance during functional ambulation and while interacting with the environment.

Continuous daily-life monitoring of the functional activities of stroke survivors, in their physical interaction with the environment, is essential for optimal guidance of rehabilitation therapy by medical professionals and coaching of the patient. Such information cannot be obtained with present monitoring systems.

It is the objective of the INTERACTION project to develop and validate an unobtrusive and modular system that enables monitoring the quality of daily-life activities and physical interactions with the environment (Fig. 1). Data can be used to guide specific training interventions to regain upper and lower limb motor function after stroke.

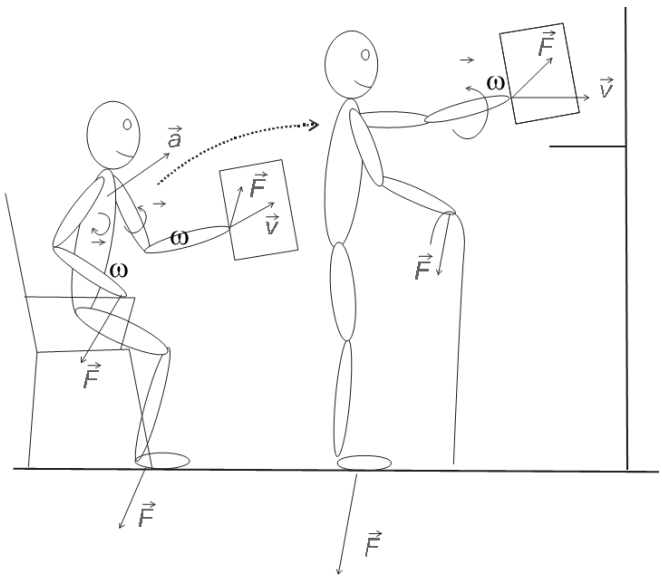


Figure 1. The INTERACTION concept: monitoring the quality of daily-life physical interaction with the environment for control of body balance and upper-extremity function during daily life. The interaction quality is derived from muscle activation (EMG), and movement and interaction force sensed at the interface with the environment.

2. METHODS

In order to realise the INTERACTION concept, the following methods are used:

- Instrumented textiles (shoes, trousers, shirt and gloves) with integrated textile-based and micromechanical sensors, to unobtrusively sense muscle activation (EMG), interaction forces and body movements
- Methods for qualitative and quantitative assessment of the dynamic interaction of a person with the environment, identifying activity tasks during daily-life and evaluating the quality of performance of these tasks, applying task-dependent performance criteria
- Telesupervision and intelligent on-body feedback, well integrated in clinical training concepts

The INTERACTION system will be evaluated in an experimental clinical setting, simulating daily-life conditions and demonstrated under daily-life conditions in stroke survivors.

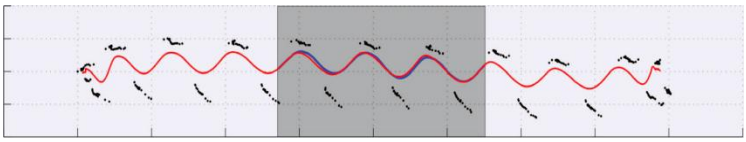
3. PAST RESULTS

The project builds on the results of former research [1]:

- Instrumented textiles developed at the University of Pisa [2,5] (Fig. 2)
- Method to assess human body balance using instrumented shoes, measuring foot movement and ground reaction forces [3] (Fig. 3)
- Method to assess power exchange with the environment from inertial movement sensing and interaction forces [4]

(a) (b) (c)

Figure 2. Fabric-based human motion monitoring devices using screen printed piezoresistive rubber sensors and sensor track (black stripes in the garments), developed by the University of Pisa and Smartex [5]: a) upper-limb monitoring device developed for post stroke telerehabilitation. b) instrumented glove. c) fabric-based motion classification garments for monitoring leg kinematics.



(a)

(b)

Figure 3. Assessment of human balance performance by estimating body center of mass movement relative to foot placement (a) from instrumented shoes (b) as developed and evaluated by the University of Twente, Xsens and Roessingh Research and Development [3].

4. ACKNOWLEDGMENT

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REFERENCES

[1] De Rossi D., Veltink P.H., Wearable technology for biomechanics: e-textile or micromechanical sensors?, IEEE Engineering in Medicine and Biology Magazine, vol. 29, issue 3, 2010, pp. 37-43.

[2] Lorussi F., Rocchia W., Scilingo E.P., Tognetti A., De Rossi D., Wearable, Redundant Fabric-Based Sensor Arrays for Reconstruction of Body Segment Posture, IEEE Sensors Journal, vol.4, no. 6, 2004 pp.807-818.

[3] Schepers H.M., van Asseldonk E.H.F., Buurke J.H., Veltink P.H., Ambulatory Estimation of Center of Mass Displacement during Walking, IEEE transactions on Biomedical Engineering, vol. 56, 2009, pp. 1189-1195.

[4] Veltink P.H., Kortier H.G., Schepers H.M., Sensing power transfer between the human body and the environment, IEEE Transactions on Biomedical Engineering, vol. 56, 2009, pp. 1711-1718.

[5] Pacelli M., Loriga G., Taccini N., Paradiso R., Sensing Fabrics for Monitoring Physiological and Biomechanical Variables: e-textile solutions, Proceedings of the 3rd Summer School and Symposium on Medical Devices and Biosensors, MIT, Boston, USA. Sept. 4-6, 2006.