AUTOMATIC IDENTIFICATION AND LOCALIZATION OF INERTIAL SENSORS ON THE HUMAN BODY

Dirk Weenk*, Bert-Jan van Beijnum, and Peter Veltink

University of Twente, Faculty of EEMCS, Biomedical Signals and Systems
P.O. Box 217, 7500 AE Enschede, The Netherlands.
Web page: http://www.utwente.nl/ewi/bss/
e-mail: d.weenk@student.utwente.nl

ABSTRACT

Human motion capture is used for many purposes like sports training and rehabilitation. In the last few years, inertial sensors (accelerometers and gyroscopes) in combination with magnetic sensors was proven to be a suitable ambulatory alternative to traditional human motion tracking systems based on optical position measurements, which are restricted to a bounded area. While accurate full 6 degrees of freedom information is available, these inertial sensor systems still have some drawbacks [1, 2]. All sensors have a unique location ID, i.e. each sensor has to be attached to a certain predefined body segment, and they have to be connected by wires. Another disadvantage is the fact that the relative positions and orientations of the sensors with respect to the segments are unknown, which has to be resolved by a sensor-segment calibration procedure. These drawbacks cause the set-up time of the current systems to be relatively large.

The goal of this project is to develop a 'Click-On-and-Play' ambulatory 3D human motion capture system, containing a set of wireless inertial sensors which can be placed on the human body at random positions, because they will be identified and localized automatically.

In this first study the automatic identification of the inertial sensors is investigated, i.e. the automatic assessment of the body segment to which each inertial sensor is attached. This is done during normal walking and under the assumption that all sensors are present and attached to the body segments correctly. This problem is considered a classification problem, i.e. the sensors are divided into several classes (the body segments). A typical classification system consists of a feature extractor followed by a classifier.

Walking data was recorded from eleven healthy subjects using an Xsens MVN motion capture suit with full body configuration (17 inertial sensors). Subjects were asked to walk for about 5-8 seconds at normal speed. The magnitudes of the 3D acceleration and 3D angular velocity were calculated. Features as variance, mean, correlations between sensors and power spectra were investigated. As a classifier a decision tree was developed. For all sensors it could be determined whether or not they are on the same lateral side, but the absolute left and right identification is not possible based on merely the magnitudes of the 3D accelerations and 3D angular velocities. For eight of the eleven subjects all sensors were identified correctly and totally 90.4% of all the sensors were identified correctly (no left and right, but only ipsi-/contralateral identification).

The next step is to look into the left and right identification, the identification during other daily-life activities, and the identification of a subset of the 17 sensors. Also automatic classification algorithms like Weka (Waikato Environment for Knowledge Analysis) will be used and compared with these first results. After the identification, the in-use estimation of orientation and position of the sensor with respect to the segment will be investigated.

REFERENCES

[1] D. Roetenberg, H. Luinge, and P. Slycke. 6 DOF Motion Analysis Using Inertial Sensors. In *Proceedings of Measuring Behavior 2008 (6th International Conference on Methods and Techniques in Behavioral Research)*, pages 14–15, Maastricht, The Netherlands, August 2008.

[2] H.M. Schepers, D. Roetenberg, and P.H. Veltink. Ambulatory human motion tracking by fusion of inertial and magnetic sensing with adaptive actuation. *Medical and Biological Engineering and Computing*, 48(1):27–37, 2010.