3D Analysis of Normal and Pathological Gait Based on Low-Cost Wireless Accelerometers

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Abstract

We describe the principle and use of a new low-cost, wireless, 3-axis accelerometer-based device that records acceleration signals and automatically analyses them to characterize normal and pathological gait.

This work is part of a project that deals with the three-dimensional (3D) analysis of normal and pathological human motion based on a newly developed system for clinical applications, using low-cost wireless accelerometers and signal processing. Neurologists specialized in human motion disorders are indeed very interested in the development of innovative, quantitative techniques, and their possible use in clinical practice, e.g. in the diagnostic and analysis of Parkinson disease.

Our research aims at the extraction of gait parameters to contribute to the understanding of these motion disorders as well as to the critical analysis and development of new therapeutic strategies. For this purpose, we have successfully developed and used a low-cost, wireless, 3-axis accelerometer-based hardware system to record gait acceleration signals (Figures 1 and 2). We have also developed a signal-processing algorithm capable of automatically extracting, from these signals, on a stride-by-stride basis, gait events such as the heel strikes, toe strikes, heel-offs, and toe-offs, which characterize the stance and the swing phases of walking. Our hardware and algorithm have been validated by comparing the times of occurrence of each of these gait events with those obtained both by another kinematic 3D analysis system based on active markers and by a force platform. The comparison demonstrates that our new wireless accelerometer hardware and related algorithm constitute an effective low-cost gait and walking analysis system, which could thus be used for the assessment of mobility in routine clinical practice.

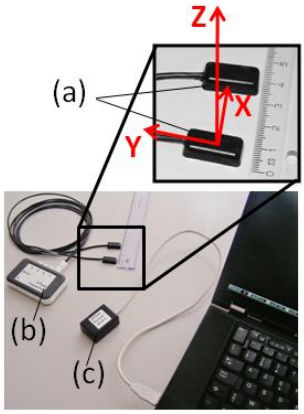

Figure 1: Wireless, 3-axis accelerometer-based hardware system: (a) 3-axis accelerometers, (b) transmitter module, (c) receiver module.

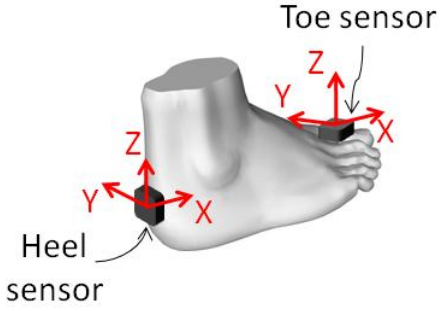

Figure 2: Position of the sensors (the 3-axis accelerometers and the active markers).