Assessing subject-specific dynamics for the better understanding of human motion

Keywords: Motion analysis, Identification, Inverse Optimal Control, Inertial Measurement unit.

Abstract:
The problematic of evaluating and understanding pathological human motion using tools inspired from robotics will be addressed in this talk. This talk will present a whole framework proposing to treat as the same time the motion quantification and its understanding.

Nowadays human motion can be analyzed using complex, expensive and non-portable stereophotogrammetric system and force plates. This exclude *de-facto* their use in real clinical or in-home rehabilitation applications or inside of the factories. Also, even if these systems are very accurate, the estimate of joint kinematics might be heavily jeopardized by the presence of soft-tissue artefacts. In this context, we will show that using (bio)mechanical models of the human and the knowledge of the physiological constraints of the investigated task it is possible to improve the accuracy of joint kinematics or to reduce the number of sensors required to quantify human motion. One of the objective here is to minimize the complexity of experimental setup while maximizing the relevance and the quality of the measured variables. Applications to different rehabilitation tasks (squat, knee rehabilitation, walking of parkinsonian, etc) will be presented. In order to have more representative and subject-specific models it is important to identify the body inertial parameters in human. To this purpose new methods allowing to determine the mass of each individual segment in the minimum amount of time will be presented. The method can also be used for humanoid robots.

Once the models are identified, inverse optimal control can be used to obtain a better understanding of the optimal behaviors and constraints acting on a subject during rehabilitation exercises or daily activities. Inverse optimal control consists in finding the cost-function(s) that govern(s) human motion. Cost functions derived from human observations could also be used to drive robots that are in close interaction with human such as exoskeletons.

These subject specific models together with the corresponding affordable measurement methodologies could spread among the clinicical and industrial ergonomics communities. This strong potential for future rehabilitation applications could contribute to a better general understanding of the relationships between biomechanics and disability and help controlling rehabilitation robots.

Biography:

Vincent Bonnet received the Ph.D. degree in automatics control and robotics, in 2009, both from the University of Montpellier 2. From 2010 to 2012, he was working as a post-doc in Biomechanics at Foro Italico University in Rome, Italy. From 2013 to 2016 is was working at the University of Tokyo Agriculture and Technology in Tokyo, Japan. He is now associate professor in Robotics at the University of Paris-Est-Créteil in Créteil, France. His research interests include various aspects of low-cost sensors, humanoid robotics, motion analysis, system identification and control.