



PhD Proposal 2017

School: Ecole Centrale de Nantes	
Laboratory: LS2N (currently IRCCyN)	Web site: http://www.irccyn.ec-nantes.fr/en/
Team: REV (Robotics)	Head of the team: D. Chablat
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Collaboration with other partner during this PhD:	
In France:	In China:

Title: Realtime imitation of human dynamics by humanoid robots
Scientific field: Robotics / Mechanics
Key words: motion imitation, dynamics, human, humanoid, balance, realtime

Details for the subject:

(Maximal length of 2 pages, including images, list of reference, ...The pdf file should not exceed 1Mo)

Background, Context:

Motion imitation brings a lot of promises in terms of prosthetics, robot easy-programming and human extended capabilities. When applied in kinematics, realtime motion imitation mainly faces experimental difficulties, as the mechanical kinematic model is linear and easy to pseudo-inverse. Then the specific constraints, such as balance, can be included using tasks priorities. In terms of dynamics, the mechanical models of both human and humanoid are far from linear. Their inverse requires long calculation times, and realtime becomes hazardous. Some attempts were performed numerically, but taking the balance constraint into consideration is still an open issue (in realtime), and experimental validation still undone.

Research subject, work plan:

The candidate will focus on realtime imitation of human motions by humanoid robots, with dynamics applications. An experimental validation of the proposed approach is also expected with the humanoid robots available in the research group: NAO (58cm, 6kg) and ROMEO (140cm, 39kg). The approach will be based on task prioritization in dynamics situations; the kinematics was already performed and is available.

The thesis progression will be as follows:

- **Year 1: Understanding the problems involved. 1) Bibliographic study and positioning (6 months), leading to a research report and a presentation to the research group; 2) Numerical development of relevant approach(es) detected in the bibliography (6 months, report, presentation), development of experimental abilities.**
- **Year 2: Making research. From year 1, choose three points to be developed as research. 1) Realize point 1 (6 months) up to publication; 2) Realize points 2 and 3.**
- **Year 3: Concluding Ph.D. Publications, finish experiments, thesis writing and defence.**

References:

- [1] Tasks prioritization for whole-body realtime imitation of human motion by humanoid robots. S Sakka, LP Poubel, D Cehajic. Digital Intelligence (DI2014), 2014
- [2] Support Changes during Online Human Motion Imitation by a Humanoid Robot using Task Specification. LP Poubel, S Sakka, D Cehajic, D Creusot (2014). IEEE International Conference on Robotics and Automation (ICRA).
- [3] Robotics-based reconstruction and synthesis of human motion. E Demircan (2012). Stanford University.
- [4] Enabling real-time full-body imitation: a natural way of transferring human movement to humanoids. M Riley, A Ude, K Wade (2003). IEEE International Conference on Robotics and Automation (ICRA).
- [5] Towards a Real-Time Bayesian Imitation System for a Humanoid Robot. AP Shon, JJ Storz, RPN Rao (2007). IEEE International Conference on Robotics and Automation