Whole-Body Control for Robots in the Real World

Sept 18th, 2014
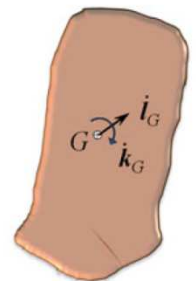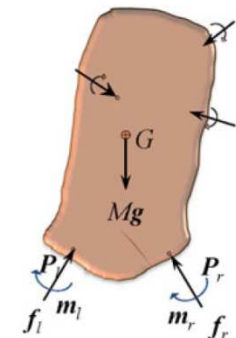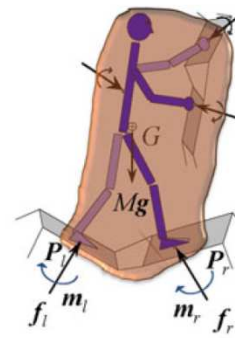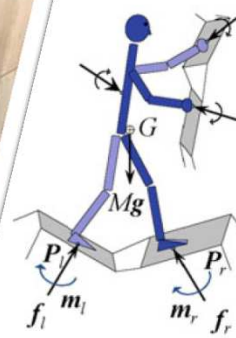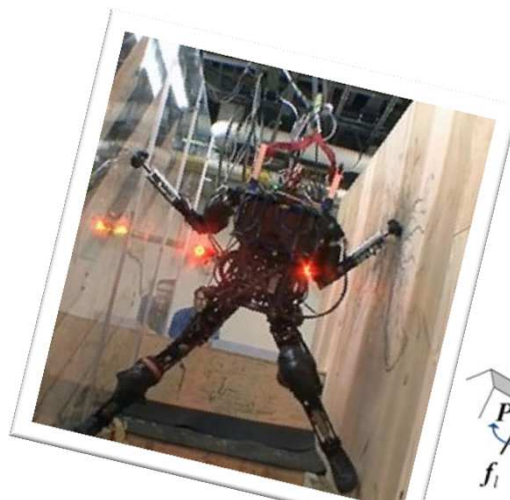
Organizers:

Federico L. Moro

Michael Gienger

Oussama Khatib

Eiichi Yoshida

WBC

The class of Whole-Body Control (WBC) Systems represent a wide range of complex movement skills in the form of low dimensional task descriptors which are projected on to the robot's actuators, such exploiting the full capabilities of the entire body of redundant, floating-based robots in compliant multi-contact interaction with the environment, to execute any single task, when feasible, and simultaneous multiple tasks.
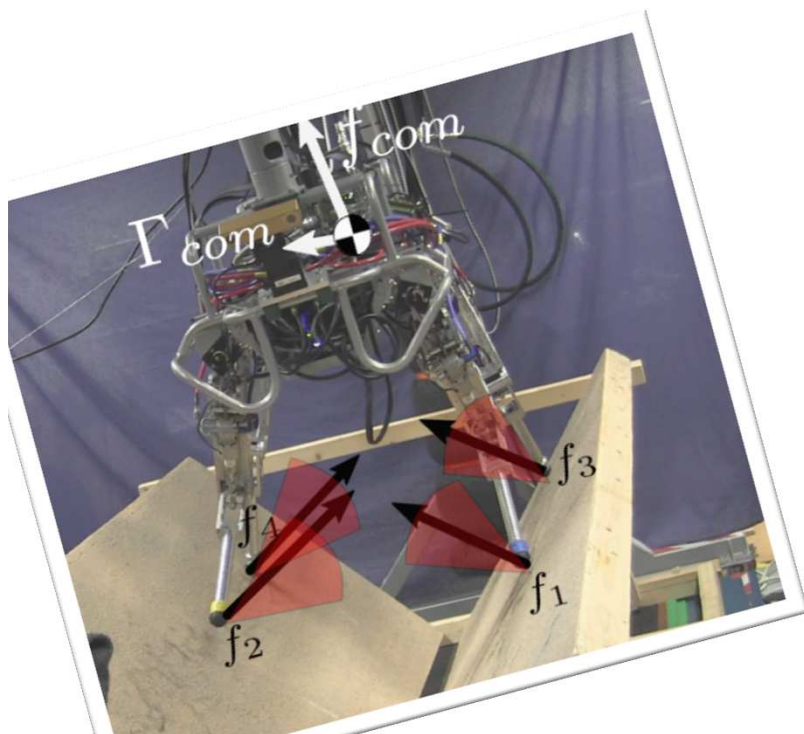
- Whole-body position/force control
- Model-based robot dynamics
- Centroidal momentum
- Contacts planning and control
- Torque-control
- Compliant body behavior
- Practical tips on whole-body control with real robots
- Whole-body agile locomotion and dexterous manipulation

SCHEDULE

[08.45 - 09.00] Introduction
[09.00 - 09.30] Christian Ott (DLR)
 "Practical Experiences with the Torque-Controlled Humanoid Robot TORO"
[09.30 - 10.00] Yoshihiko Nakamura (Univ. of Tokyo)
 "On Reuse of Human Motion for Robot Control"
[10.00 - 10.30] Patrick M. Wensing and David E. Orin (OSU)
 "Centroidal Dynamics for Whole-Body Humanoid Control"
[10.30 - 11.00] Coffee Break
[11.00 - 11.30] Siyuan Feng (CMU)
 "Full-Body Control for the Atlas Robot"
[11.30 - 12.00] Federico L. Moro (IIT)
 "An Attractor-based Whole-Body Motion Control (WBMC) System – Tests with the COMAN Robot"
[12.00 - 12.30] Andres Valenzuela (MIT)
 "Optimization-based estimation, planning, and control"
[12.30 - 13.30] Lunch Break
[13.30 - 14.15] Interactive Session
[14.15 - 14.45] Andrea Del Prete (LAAS-CNRS)
 "Joint-Torque Control with Electric Motors and Harmonic Drives"
[14.45 - 15.15] Silvio Traversaro (IIT)
 "Whole-body Dynamic Computations on the iCub Humanoid"
[15.15 - 15.45] Coffee Break
[15.45 - 16.15] Luis Sentis (UT Austin)
 "Middleware for Rapid Application Programming"
[16.15 - 16.45] Mitsuharu Morisawa (AIST)
 "Locomotion and Manipulation in Unknown Environment by HRP-2"
[16.45 - 17.15] Ludovic Righetti (MPI)
 "Experiments with Hierarchical Inverse Dynamics Control on a Torque-Controlled Humanoid"
[17.15 - 18.00] Round Table

Interactive Session:

Hongkai Dai (MIT), Andres Valenzuela (MIT), Russ Tedrake (MIT)
 "Whole-body Motion Planning with Simple Dynamics and Full Kinematics"
Michele Focchi (IIT), Andrea Del Prete (LAAS-CNRS), Ioannis Havoutis (IIT), Claudio Semini (IIT), Roy Featherstone (IIT), Darwin G. Caldwell (IIT)
 "High-slope Terrain Locomotion for Torque-Controlled Quadruped Robots"
Gerardo Jarquin (IPN), Gustavo Arechavaleta (IPN), Adrien Escande (AIST), Eiichi Yoshida (AIST)
 "Time-Constrained Whole Body Control With Smooth Task Transitions"
Yisoo Lee (SNU), Hyeonjun Park (SNU), Ji-Hun Bae (SNU), Moon-Hong Baeg (SNU), Jaeheung Park (SNU)
 "Experimental Results of Whole-body Control Framework on Torque Controlled Humanoid Legged Robot and Dual Arm-Hand Manipulator"
Alessio Rocchi (IIT), Enrico Mingo Hoffman (IIT), Edoardo Farnioli (IIT), Nikos G. Tsagarakis (IIT)
 "A Whole-Body Stack-of-Tasks compliant control for the Humanoid Robot COMAN"
Jesper Smith (IHMC), Sylvain Bertrand (IHMC), Peter Neuhaus (IHMC), Matthew Johnson (IHMC), Jerry Pratt (IHMC), and the IHMC team
 "Momentum-based whole-body control framework – Application to the humanoid robots Atlas and Valkyrie"
Wael Suleiman (Univ. of Sherbrooke Quebec)
 "Inverse Kinematics: New Method for Minimum Jerk Trajectory generation"
Hilario Tome (PAL), Luca Marchionni (PAL), Adolfo Rodriguez Tsouroukdissian (PAL)
 "Whole body control using Robust & Online hierarchical quadratic optimization"

International Journal of Humanoid Robotics
Special Issue on
Whole-Body Control for Robots in the Real World

International Journal of Humanoid Robotics (IJHR)
Special Issue on the theme **"Whole-Body Control for Robots in the Real World"**

IJHR Website: http://www.worldscientific.com/page/ijhr/callforpapers-details#Whole-Body%20Control
WBC-SI Website: http://www.walk-man.eu/news/events/item/iros14-ws-ijhr-si-on-whole-body-control-for-robots-in-the-real-world.html

GUEST EDITORS:
Federico L. Moro *(Istituto Italiano di Tecnologia (IIT), Italy)*
Michael Gienger *(Honda Research Institute (HRI) Europe, Germany)*
Ambarish Goswami *(Honda Research Institute (HRI) USA, USA)*
Oussama Khatib *(Stanford University, USA)*
Eiichi Yoshida *(CNRS-AIST JRL, Japan)*

IMPORTANT DATES:
Submission deadline: 20th Oct 2014
Notification of acceptance: 16th Jan 2015
Final version due: 1st Mar 2015
To appear in the issue of June 2015

CALL FOR PAPERS:
Following on the Full-day Workshop at the *IEEE/RSJ International Conference on Intelligent Robots and Systems* (IROS 2014), a Special Issue on the *International Journal of Humanoid Robotics* (IJHR) has been organized for the Issue of June 2015. Perspective contributors are invited to submit a full paper on their related research. All papers will undergo the regular IJHR review process.

Authors should follow the guidelines of the International Journal of Humanoid Robotics (IJHR). The format is described at:
http://www.worldscientific.com/page/ijhr/submission-guidelines

Prospective authors should submit an electronic copy of their completed manuscripts through the on-line submission system at:
http://www.editorialmanager.com/ijhr/default.asp?pg=login.asp with the note "This paper is submitted to the Special Issue on Whole-Body Control for Robots in the Real World" according to the submission schedule.

CONTENT:
With growing research interest in humanoid robotics, robots have become increasingly proficient in performing many different, non-trivial tasks, such as running, jumping, climbing stairs, and manipulating objects. In most cases, however, each of these tasks is addressed individually, and this imposes a fundamental limitation on the use of robots in the real world. While humans may occasionally be outperformed by robots in a single task, they are vastly more capable of adapting and combining behaviors to solve multiple different tasks. This flexibility allows humans to generalize their knowledge, and to successfully perform tasks that they have never explicitly faced before. This also opens the door for simultaneous execution of multiple tasks. To address these constraints, Whole-Body Control Systems have been proposed as a promising research direction. They represent a wide range of complex movement skills in the form of low-dimensional task descriptors which are projected on to the robot's actuators, thereby exploiting the full capabilities of the entire body.

Until recent years, limitations on hardware relegated Whole-Body Control to almost purely theoretical research. Recently a growing number of experimental platforms have become available (in particular torque-controlled humanoids). This new opportunity has triggered the deployment on real robots of the theoretical outcomes of research in the field. This is backed up by a number of new research projects addressing issues in this domain, including WALK-MAN, CoDyCo, KoroiBot, and the Darpa Robotic Challenge (DRC) which presents a more application-oriented development of these methods.

This Special Issue aims to bring together the main actors in the field to disseminate knowledge of the rapidly evolving state-of-the-art in Whole-Body Control, with dual goals of understanding the new theoretical studies and applying this experience to real robots, with particular emphasis on the latter.

LIST OF TOPICS:
The focus will be on real experiences in Whole-Body Control with real robots. The SI will cover, but not be limited to, the following topics:

- Whole-body position/force control
- Model-based robot dynamics
- Centroidal momentum
- Contacts planning and control
- Torque-control
- Compliant body behavior
- Practical tips on whole-body control with real robots
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WBC-SI

INTERACTIVE SESSION

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