TALK @ iit ISTITUTO ITALIANO DI TECNOLOGIA
iCUB FACILITY

Control schemes for safe physical Human-Robot Interaction

I will address basic control problems related to physical Human-Robot Interaction (pHRI), ranging from on-line collision avoidance to collision detection and fast reaction, up to the safe handling of intentional contacts for collaborative applications. The control solutions are obtained within a hierarchical architecture that generates consistent robot behaviors, organized in three layers for safety, co-existence, and active collaboration. Typical pHRI tasks involve dynamically varying and uncertain environments. Therefore, human-robot coexistence needs workspace monitoring and efficient collision avoidance methods, driven by exteroceptive sensors (e.g., one or more RGB-D). On the other hand, unavoidable physical contacts may occur anywhere on the robot body, and safety requires their reliable detection and a fast robot reaction, preferably based only on proprioceptive sensing (using model-based residuals or motor currents). Moreover, a robot should be able to distinguish (by suitable filtering of signals) between accidental collisions and intentional contacts, the latter being interpreted as a physical request for collaboration. When an active collaboration is engaged between human and robot, the exchanged forces and the common motion at the contact should be accurately regulated or used in a task-oriented way for the specific application. For this, the contact force at any generic location along the robot structure can also be estimated without using tactile or force sensors. The estimated forces are then used within generalized schemes of impedance, direct force or even hybrid force/motion control, all of them being designed so as to impose the requested behavior at the contact point. Experimental results obtained on two lightweight manipulators (a KUKA LWR4 and a Universal Robots UR10) within the EU projects SAPHARI and SYMPLEXITY illustrate the whole control architecture and the performance of the developed robot control methods. Furthermore, I will present also what pHRI capabilities can be achieved on a medium-size industrial robot (a KUKA KR5 Sixx) with a closed architecture, and having poor knowledge of its dynamics and of the embedded low-level control laws.

Leonardo Meeting Room – IIT Via Morego, 30 – 1st floor
Wednesday 23rd January 2019 @15:00 p.m.

PROF. ALESSANDRO DE LUCA

Dipartimento di Ingegneria Informatica, Automatica e gestionale (DIAG)
Sapienza Università di Roma

Hosted by Dr. Daniele Pucci and Prof. Giorgio Metta

Alessandro De Luca received the PhD in Systems Engineering in 1987 and is Full Professor of Robotics, Automation, and Automatic Control at DIAG, Sapienza University of Rome since 2000, where he is also Director of the Master of Science in Control Engineering, a program fully taught in English since 2013. He served as an Associate Editor (1994-98), an Editor (1998-2003), and the Editor-in-Chief (2003-04) of the IEEE Transactions on Robotics and Automation. He has been the Editor-in-Chief of the renamed IEEE Transactions on Robotics from its birth in 2004 until September 2008, and has served as RAS Vice-President for Publication Activities in 2012-13. He was General Chair of ICRA 2007 held in Rome and Program Chair of ICRA 2016 in Stockholm.He is an IEEE Fellow (class of 2007), received the German Helmholtz Humboldt Research Award for foreign scientists in 2005, and the IEEE-RAS Distinguished Service Award in 2009.

His research interests cover modeling, motion planning, and various control methods for robotic systems (in particular, for flexible manipulators, kinematically redundant manipulators, underactuated robots, wheeled mobile robots and mobile manipulators), as well as physical human-robot interaction and fault detection/isolation. He has published over 200 journal and conference papers and book chapters, receiving two best conference paper awards (ICRA 1998, BioRob 2012) and one best application paper award (IROS 2008). He is one of the authors of the PROSE-awarded Springer Handbook of Robotics (2008, 2016). With the DIAG Robotics group, he was/is principal investigator in five European research projects (PROMotion, PHRIDOM, FP6 CyberWalk, FP6 PHRIENDS, H2020 SYMPLEXITY) and in many national projects, and participates to H2020 COMANOID. He was national coordinator of the MIUR PRIN project SICURA (2008-10) and coordinator of the FP7 project SAPHARI – Safe and Autonomous Physical Human-Aware Robot Interaction (2011-15).