Doctoral Course

"Physical Human Robot Interaction"

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Short Abstract:

One of the most revolutionary and challenging features of the next generation of robots will be physical human-robot interaction (pHRI). pHRI robots will be designed to coexist and cooperate with humans in applications such as assisted industrial manipulation, collaborative assembly, domestic work, teleoperation, rehabilitation or medical applications. Clearly, such robots must fulfill different requirements from those typically met in conventional industrial applications. This course aims at introducing the underlying concepts and necessary tools for the realization of an effective human-robot interaction.

Course Contents in brief:

- Versatility and stability in human motor behavior
    I. Human musculoskeletal structure
    II. Dynamic modeling of the contact stability in humans
    III. Human intention estimation: real-time applications
- Impedance and force control
- Human-in-the-loop control of adaptive robots
    I. Teleimpedance
    II. Rehabilitation robotics
    III. Prosthetics: softness by control.
- Robot learning for physical human-robot interaction
    I. Introduction to robot learning
    II. Learning from demonstration – A probabilistic approach
    III. Robot learning for human-robot collaboration

Total # of hours: 16

References:

[1] Zatsiorsky, Vladimir M. Kinetics of human motion. Human Kinetics, 2002.
[2] Ott, Christian. Cartesian impedance control of redundant and flexible-joint robots. Springer, 2008.
[3] Ajoudani, Arash. Transferring human impedance regulation skills to robots. Springer 2016.
[4] Siciliano, Bruno, and Oussama Khatib, eds. Handbook of robotics. Springer Science & Business Media, 2008.
[5] Billard, A., Calinon, S., Dillmann, R., and Schaal, S. "Robot Programming by Demonstration" Siciliano B. and Khatib, O. (eds.). Handbook of Robotics, pp. 1371-1394. Springer.
[6] Rozo, L., Calinon, S., Caldwell, D.G., Jimenez, P. and Torras, C. "Learning Collaborative Impedance-based Robot Behaviors". In Proc. of the AAAI Conference on Artificial Intelligence. Bellevue, WA, USA. pp. 1422-1428.

CV of the Teachers

Arash Ajoudani received his PhD degree in Robotics and Automation from Centro "E Piaggio", University of Pisa, and Humanoids and Human Centred Mechatronics Lab, Advanced Robotics Department (ADVR), Italian Institute of Technology (IIT), Italy. His PhD thesis was a finalist for the Georges Giralt PhD award 2015 - best European PhD thesis award in robotics. He is currently a tenure-track scientist in Human-Robot Interfaces and physical Interaction (HRI[2]) lab of the ADVR. He was a finalist for the best manipulation paper award at ICRA 2012, a winner of the best student paper award at ROBIO 2013, and a finalist for the best oral presentation award at Automatica.it (SIDRA) 2014. He is the author or co-author of several publications in international conferences and journals. He is currently serving as a Co-Chair for the Student Activities Committee (SAC) of the IEEE Robotics and Automation Society (RAS), as a scientific advisory committee for the IEEE Biorob, ICORR, and IEEE-RAS Young Reviewers Program (YRP), and as a reviewer for high ranked robotics journals such as IEEE Transactions on Mechatronics and Robotics, and international robotic conferences such as ICRA and IROS. His main research interests are in physical human-robot interaction, impedance control, robust and adaptive control, rehabilitation robotics, and tele-robotics.

Leonel Rozo is a postdoctoral researcher at the Department of Advanced Robotics (ADVR), Istituto Italiano di Tecnologia (http://iit.it). He received his B.Sc on Mechatronics Engineering from the "Nueva Granada" Military University (Colombia, 2005), his M.Sc in Automatic Control and Robotics (2007), and Ph.D in Robotics (2013) from the Polytechnical University of Catalonia (Barcelona, Spain). From 2007 to 2012 he carried out his research on force-based manipulation tasks learning at the Institut de Robotica i Informatica Industrial (CSIC-UPC). He is author or co-author of several publications in international conferences and journals in the fields of robot learning and human-robot collaboration. Dr. Rozo is also a reviewer for top-tier journals (T-RO, RAS, IJRR) and international conferences (ICRA, IROS, Humanoids). His research interests cover robot programming by demonstration, physical human-robot interaction, machine learning and optimal control for robotics.

Room and Schedule

Room: *Aula Riunioni del Dipartimento di Ingegneria dell'Informazione, Via G. Caruso 16, Pisa – Ground Floor*

Schedule:

Session 1: 18/4/2016   --- time: 10-13 (Arash Ajoudani)

Session 2: 19/4/2016 --- time: 10-13 (Arash Ajoudani)

Session 3: 21/4/2016 --- time: 10-13 (Arash Ajoudani)

Session 4: 22/4/2016 --- time: 10-12 (Arash Ajoudani)

Session 5: 26/4/2016 --- time: 10-12 (Leonel Rozo)

Session 6: 27/4/2016 --- time: 10-12 (Leonel Rozo)

Session 7: 28/4/2016 --- time: 10-12 (Leonel Rozo)