



UNIVERSITÀ DI PISA  
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE  
Dottorato di Ricerca in Ingegneria dell'Informazione

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Doctoral Course

**“Modelling human somatosensory and motor system: design principles and applications in robotics and advanced human-machine interaction”**

Prof. Matteo Bianchi

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**Short Abstract:** In our daily lives, we often perform actions requiring fast and precise sequences of swiping and tapping movements, for example to operate with our phone. To perform this efficiently, our nervous system combines the sliding movement between the skin and the screen of the phone, the short pulse of vibrations when we click on a virtual button or swipe over a rendered texture, kinesthetic information from muscles and tendons, and efference copy of our motor command. Accessing the mechanisms underpinning the functions of the human somatosensory and motor system – which are tightly intertwined each other, can suggest useful guidelines for the design of haptic systems (interfaces and sensors) in a wide range of applications (telerobotics, rehabilitation, assistive robotics and advanced human machine interaction in Augmented and Virtual Reality) as well as for the planning and control of autonomous robots. This course will introduce the main foundations of haptics, the multi-disciplinary science that studies touch perception and the artificial sensing and delivering of tactile information through mechatronic systems, moving from the biological bases of the sense of touch and human motor system to the applications in different fields of robotics and advanced human machine interaction.

**Course Contents in brief:**

- Introduction to haptics
- Biological bases of human touch and its relationship with human motor system
- Modelling and Psychophysics
- Interfaces and Sensors
- Telerobotics and virtual reality
- Advanced human machine interaction and autonomous robotics

**Total # of hours of lecture:** 30

## References:

- [1] Hannaford, Blake, and Allison M. Okamura. "Haptics." Springer Handbook of Robotics. Springer, Cham, 2016. 1063-1084.
- [2] Niemeyer, Günter, et al. "Telerobotics." Springer handbook of robotics. Springer, Cham, 2016. 1085-1108.
- [3] Webster, J.G. and Bianchi, M. (2016). Haptic Devices. In Wiley Encyclopedia of Electrical and Electronics Engineering, J.G. Webster (Ed.). <https://doi.org/10.1002/047134608X.W8326>
- [4] Averta G, Della Santina C, Battaglia E, Felici F, Bianchi M and Bicchi A (2017) Unveiling the Principal Modes of Human Upper Limb Movements through Functional Analysis. *Front. Robot. AI* 4:37. doi: 10.3389/frobt.2017.00037
- [5] Moscatelli, A., Bianchi, M., Ciotti, S., Bettelani, G. C., Parise, C. V., Lacquaniti, F., & Bicchi, A. (2019). Touch as an auxiliary proprioceptive cue for movement control. *Science advances*, 5(6), eaaw3121.
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## CV of the Teacher

Matteo Bianchi is currently an Associate Professor of Robotics and Control Theory at the Università di Pisa, and a Clinical Research Affiliate at Mayo Clinic (Rochester, US). His research interests include haptic interface and sensor design, with applications to advanced human-machine interaction (including prosthetics); human and robotic hands. He is the author of more than 100 peer-reviewed contributions, and he is the recipient of multiple awards, including the Best Paper Award at the 2016 Haptics Symposium. He actually serves as a co-Chair of the RAS Technical Committee on Robot Hands, Grasping and Manipulation.

## Room

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

## Schedule

23, 24, 27, 28, 29 June 2022

h. 9.30-12-30

h. 14.30-17.30