Manipulation and Haptics

[how ADL influenced my research]

Domenico Prattichizzo

UNIVERSITÀ DI SIENA 1240

SIRSLAB SIENA ROBOTICS AND SYSTEMS LAB

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ADL Festschrift: a workshop in honor of Alessandro De Luca for his 60th birthday, Rome Jan. 9, 2017.


Manipulate
Touch
- Learning by ADL

Flexible robots by ADL

De Luca, A., and Siciliano, B. (1989). Trajectory control of a non-linear one-link flexible arm. International Journal of Control, 50(5), 1699-1715.

De Luca, A., and Lucibello, P. (1989). Inversion techniques for trajectory control of flexible robot arms. Journal of Field Robotics, 6(4), 325-344.

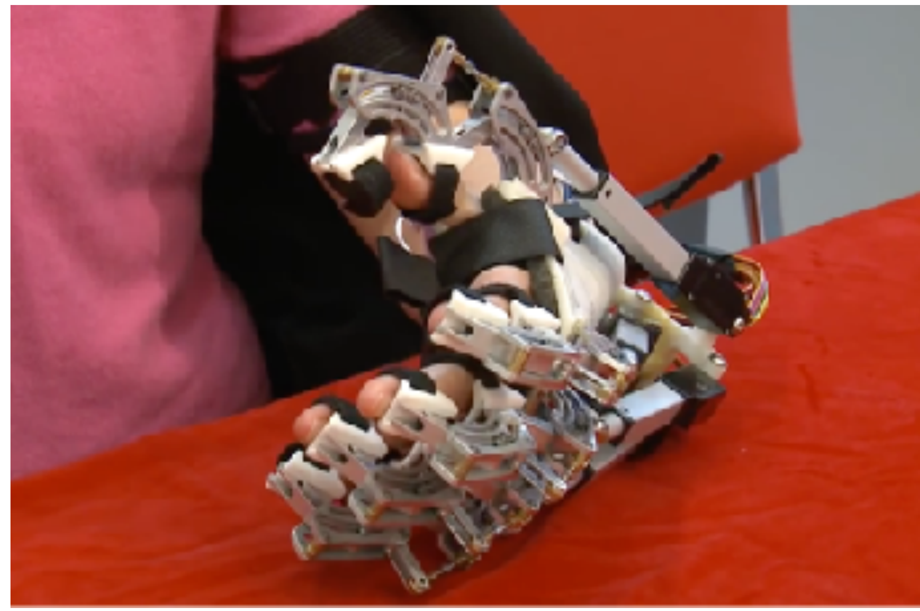
Chicago

De Luca, A. (2000). Feedforward/feedback laws for the control of flexible robots. In Robotics and Automation, 2000. Proceedings. ICRA'00. IEEE International Conference on (Vol. 1, pp. 233-240). IEEE.

De Luca, A., and Book, W. J. (2016). Robots with flexible elements. In Springer Handbook of Robotics (pp. 243-282). Springer International Publishing.


AQUAFINA


beyond exoskeleton and prosthesis

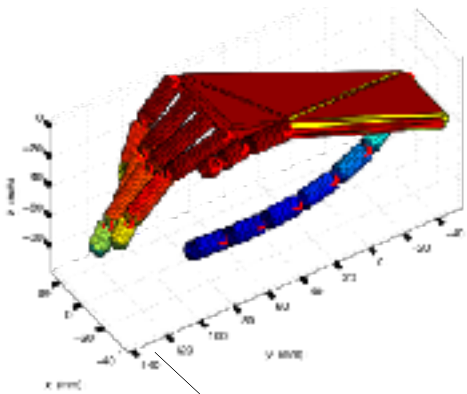


The robotic sixth finger

prattichizzo@ing.unisi.it

Cutting the apple

Design stiffness to design finger trajectories



Design a reference fingertip trajectory

$$\mathbf{k}_{q_k} = \mathbf{Q}_k^{-1}\mathbf{T}_k^{\mathrm{T}}\delta\mathbf{f}_k$$

Compute relative joint stiffness ratio

Built the soft module with the computed stiffness

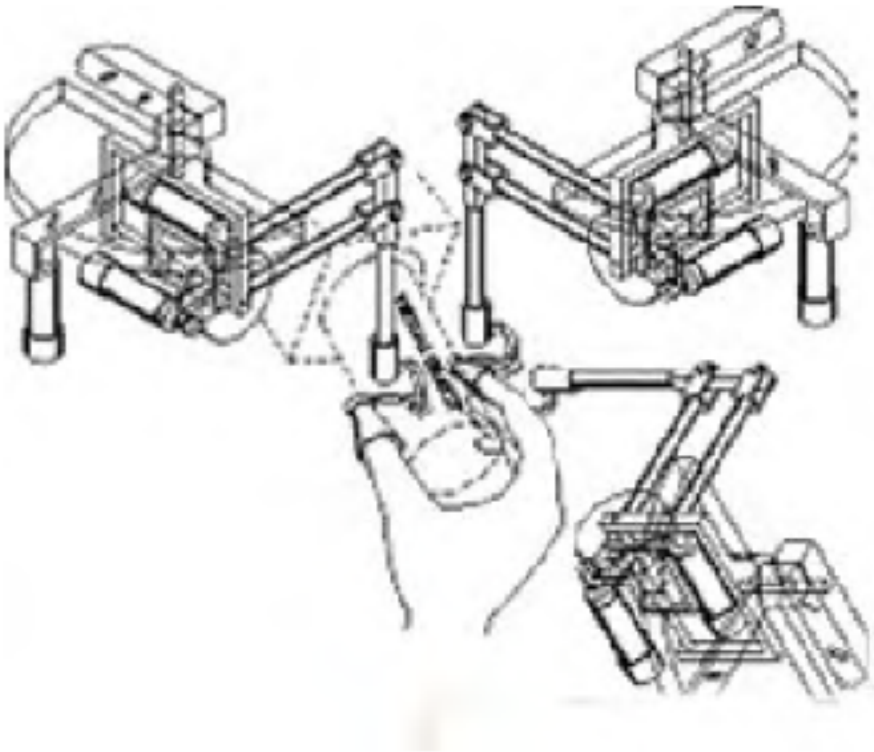
Build the finger

Same compliance at all joints

Joint compliance designed from fingertip trajectory


Manipulate
Touch

From single contact to multiple contacts



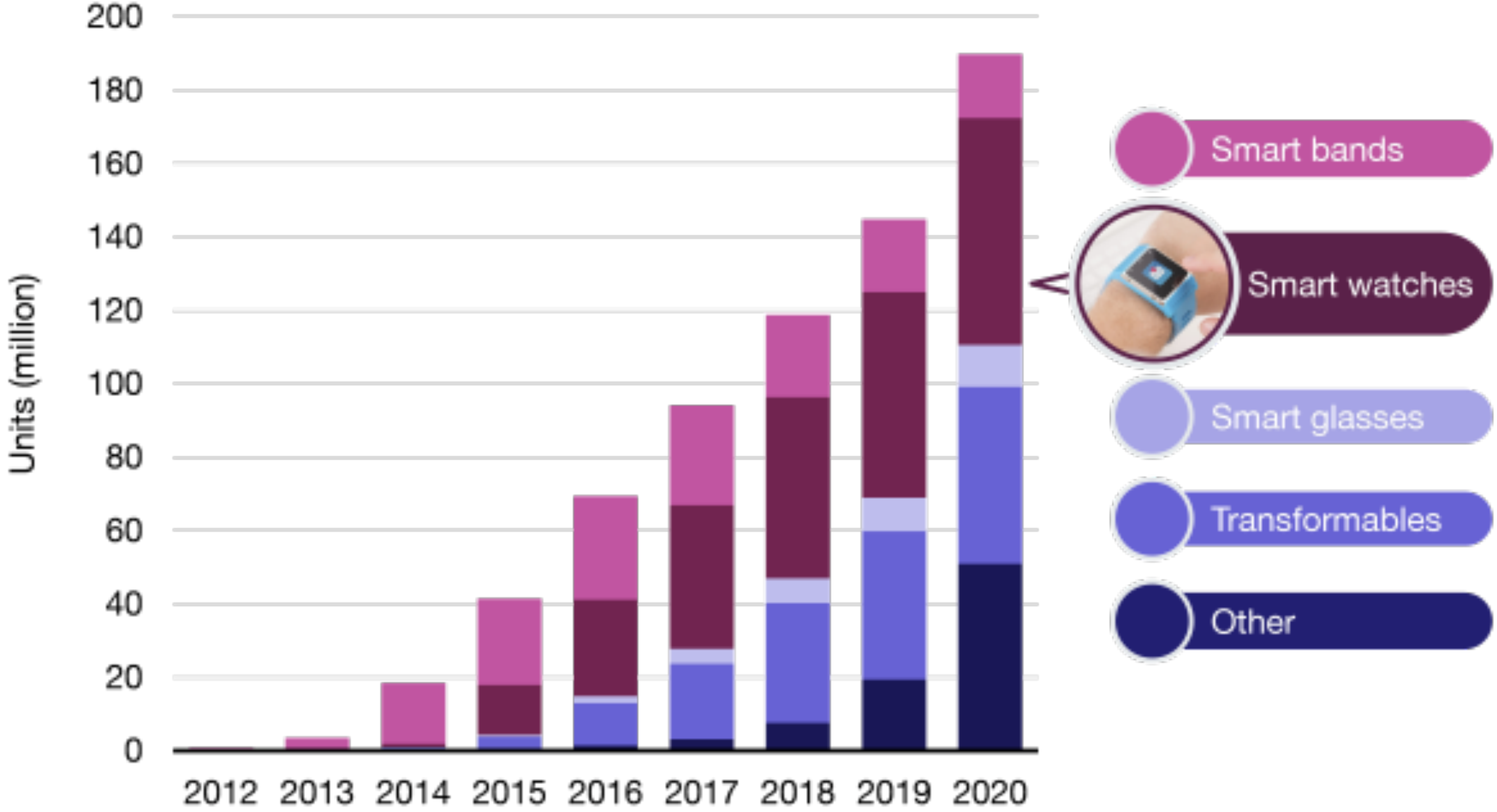
Gravity compensation by ADL

De Luca, A., Siciliano, B., and Zollo, L. (2005). PD control with on-line gravity compensation for robots with elastic joints: Theory and experiments. Automatica, 41(10), 1809-1819.

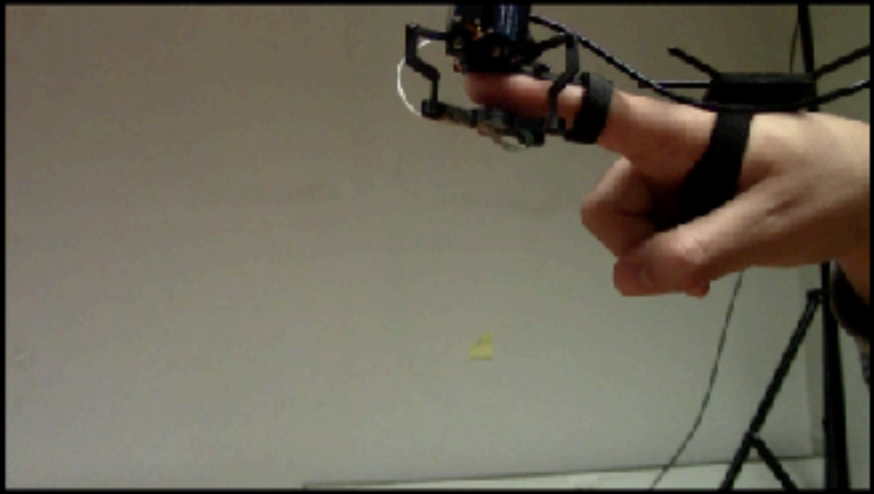
De Luca, A., and Siciliano, B. (1993). Regulation of flexible arms under gravity. IEEE Transactions on Robotics and Automation, 9(4), 463-467.

De Luca, A., and Panzieri, S. (1994). An iterative scheme for learning gravity compensation in flexible robot arms. Automatica, 30(6), 993-1002.

Wearables



Units (million)
200
180
160
140
120
100
80
60
40
20
0
2012
2013
2014
2015
2016
2017
2018
2019
2020
Smart bands
Smart watches
Smart glasses
Transformables
Other

Control principle

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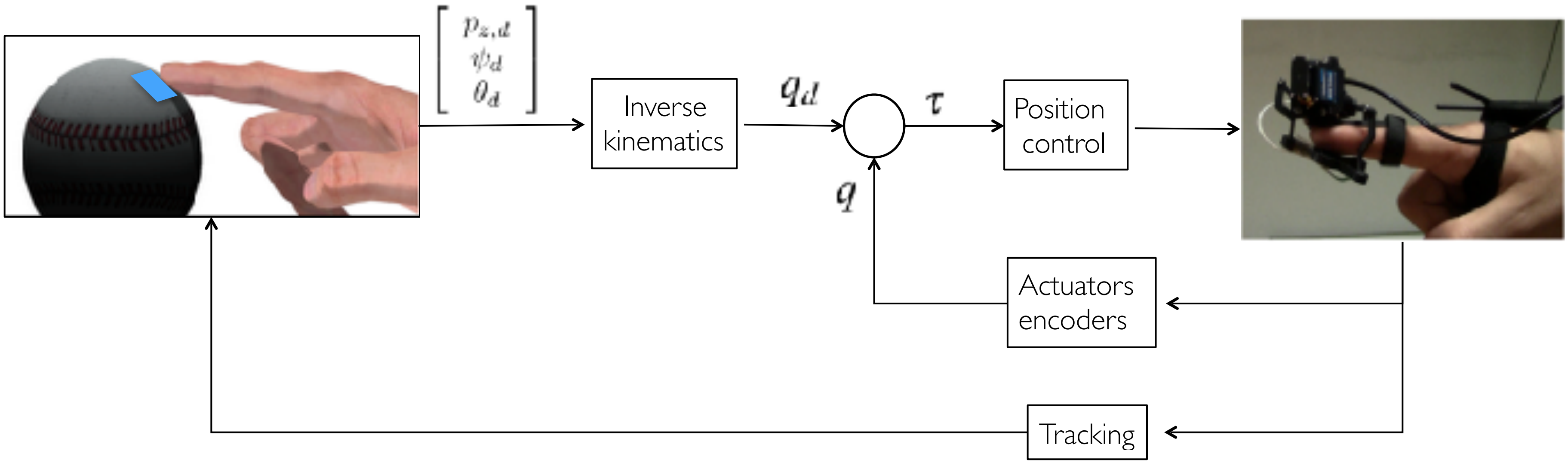
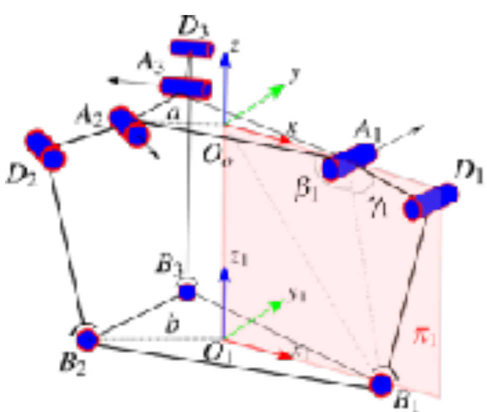




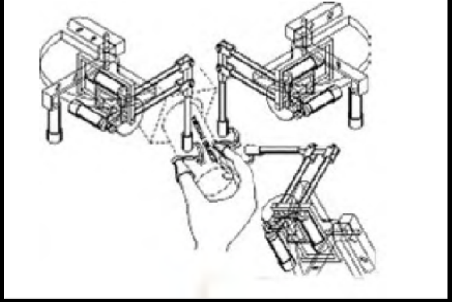
Controlled and uncontrolled variables

$$\phi = \phi(p_z, \theta, \psi), \;\; p_x = p_x(p_z, \theta, \psi), \;\; p_y = p_y(p_z, \theta, \psi).$$

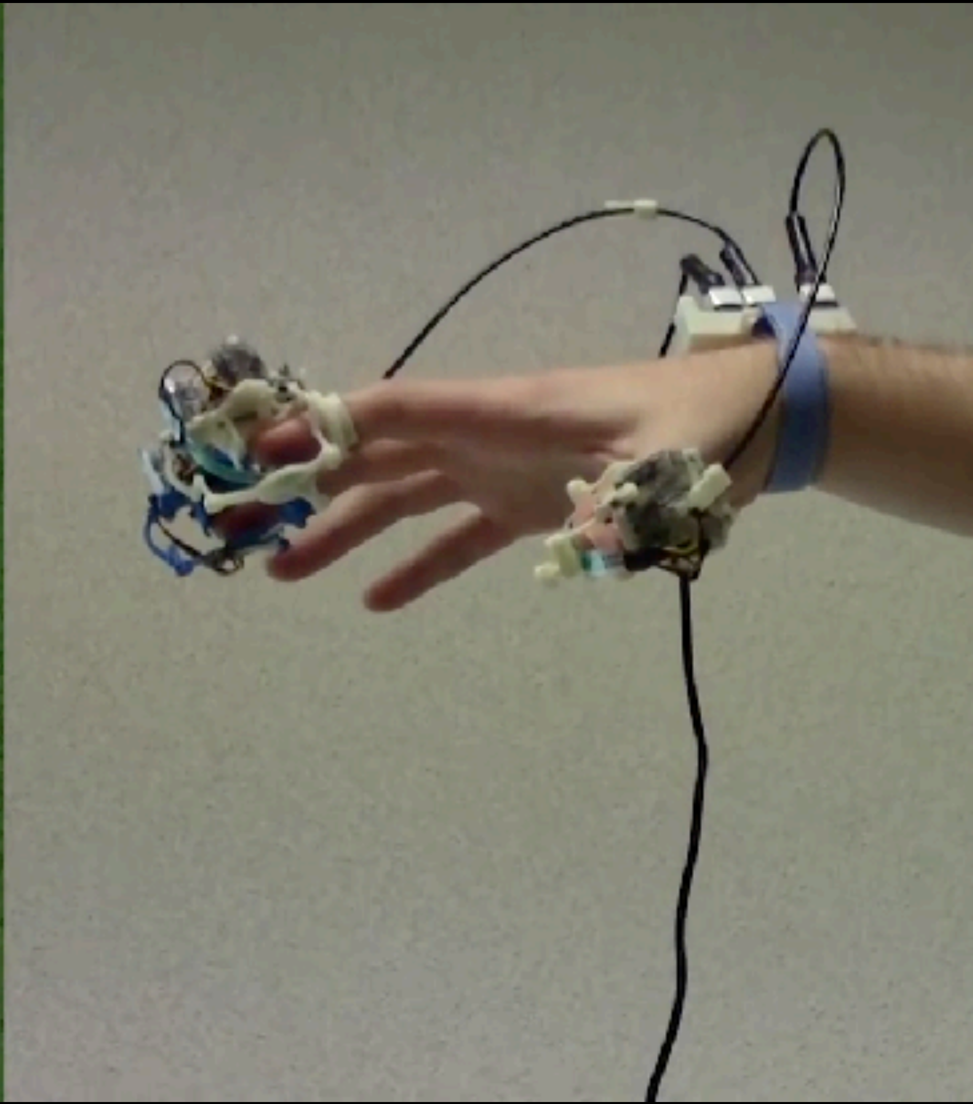
Inverse kinematics

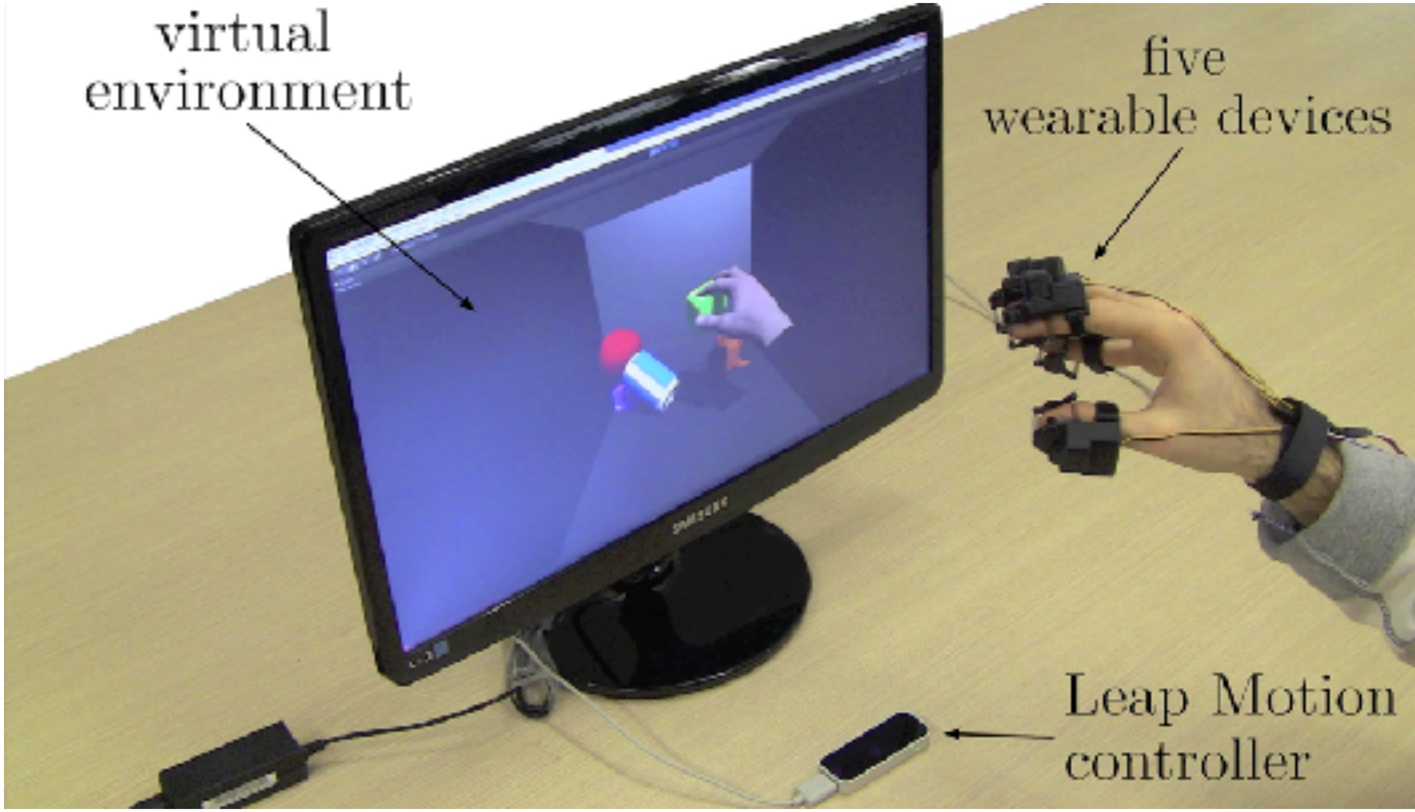
$$q_i = \beta_i + \gamma_i,$$

$$\beta_i = \arctan\left(\frac{s_{iz}}{\sqrt{s_{ix}^2 + s_{iy}^2}}\right), \;\; \gamma_i = \arccos\left(\frac{l_1^2 + s_i^2 - l_2^2}{2 l_1 |s_i|}\right)$$

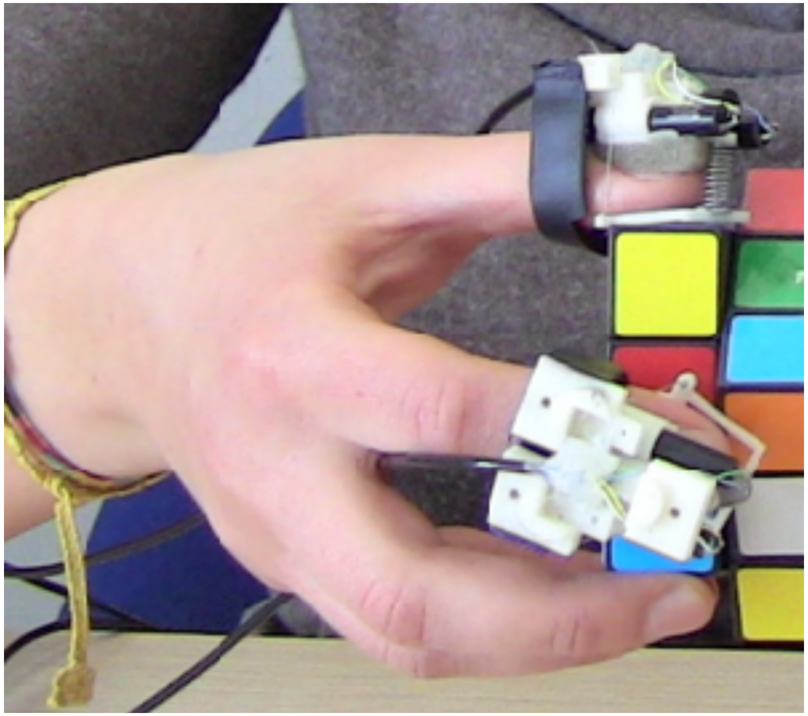



URJC
BICYCLE
STANDARD

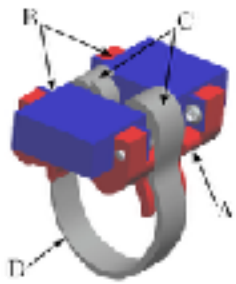



virtual
environment
five
wearable devices
Leap Motion
controller

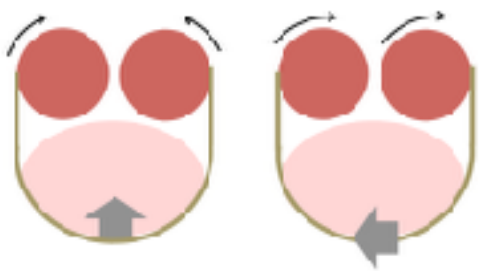
From fingertip to the proximal phalanx

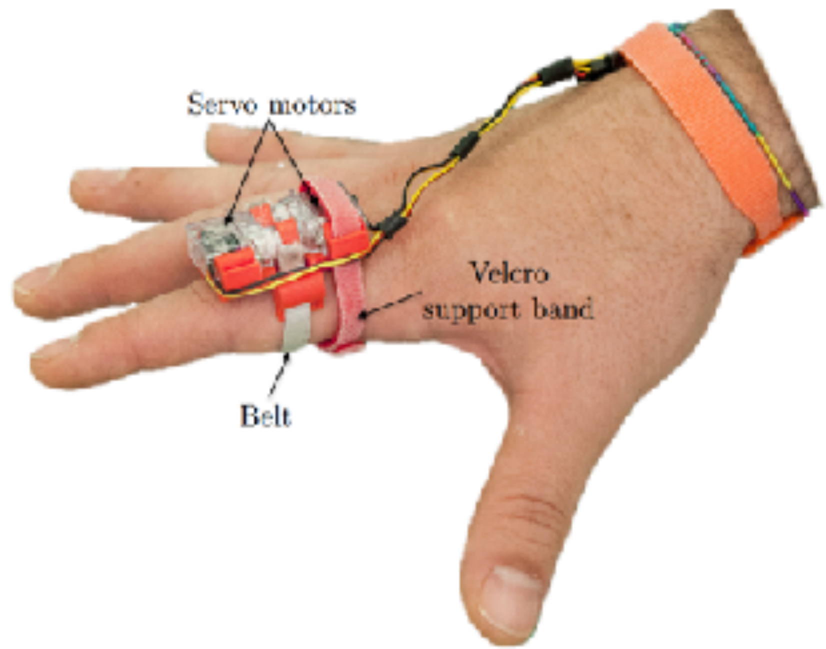


hRing - a novel cutaneous device for the proximal phalanx



(a) CAD design





A static platform two servo motors (0.05 Nm max) and two pulleys and a fabric belt that applies normal and shear stimuli to the proximal phalanx.

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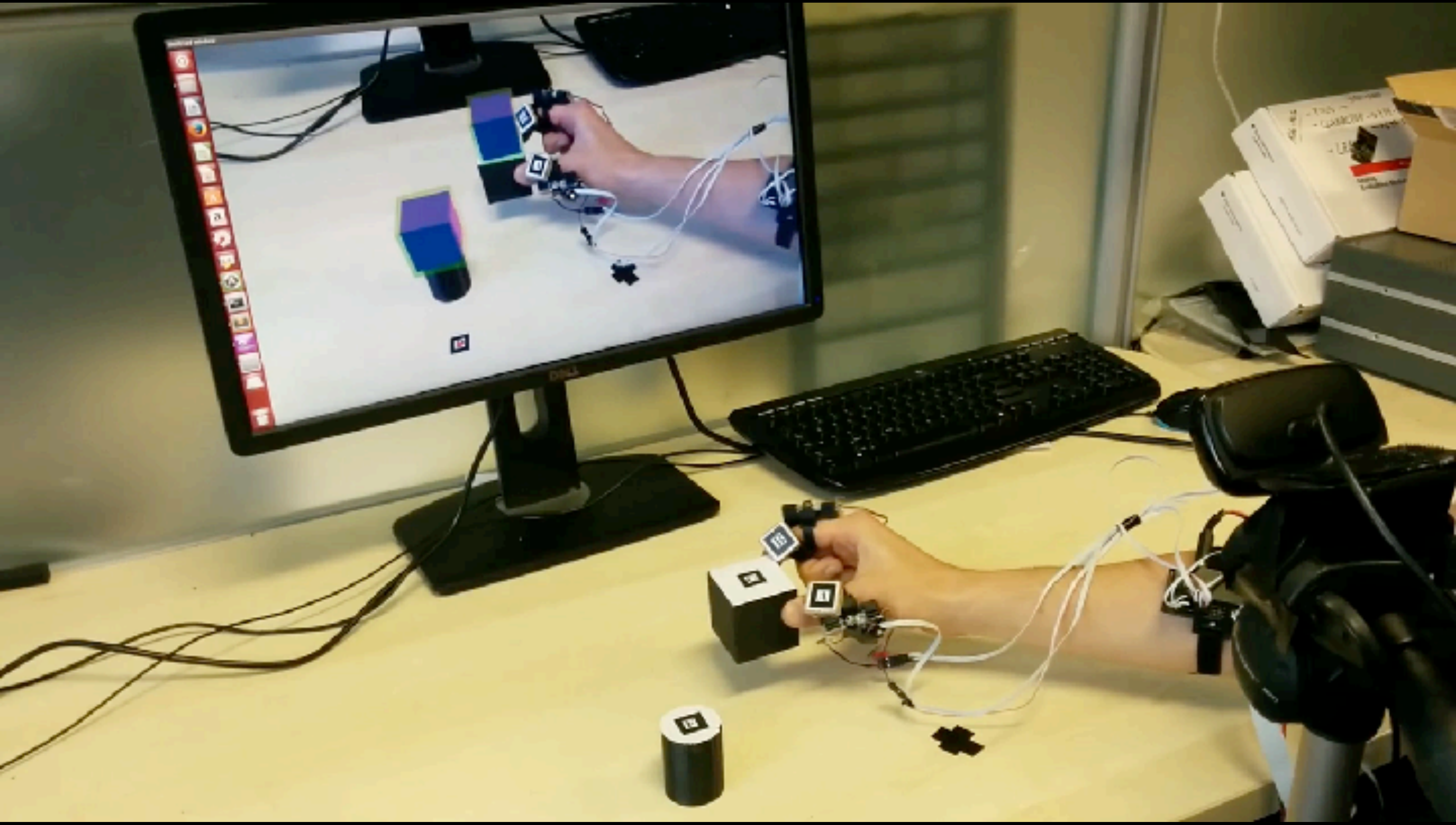
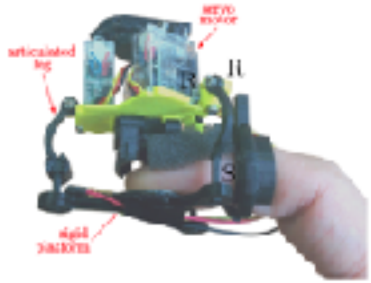


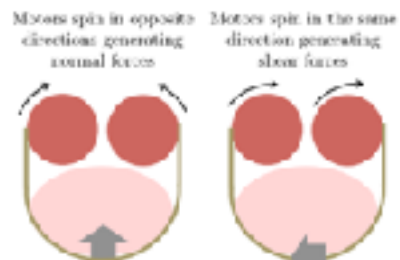
M. Maisto, C. Pacchierotti, F. Chinello, G. Salvietti, A. De Luca, D. Prattichizzo. Evaluation of wearable haptic systems for the fingers in Augmented Reality applications. IEEE Transactions on Haptics, 2017.



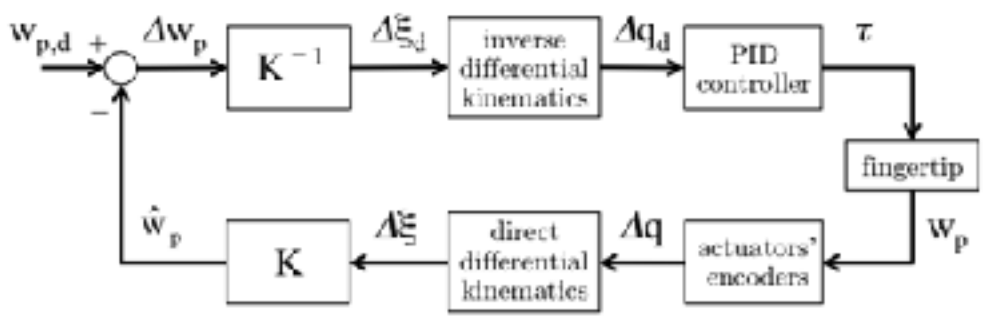
(a) 3-RRS fingertip device (side view, worn on the index finger).

(b) 3-RRS fingertip device (top view).

(a) hRing finger device.



(b) hRing actuation principle.



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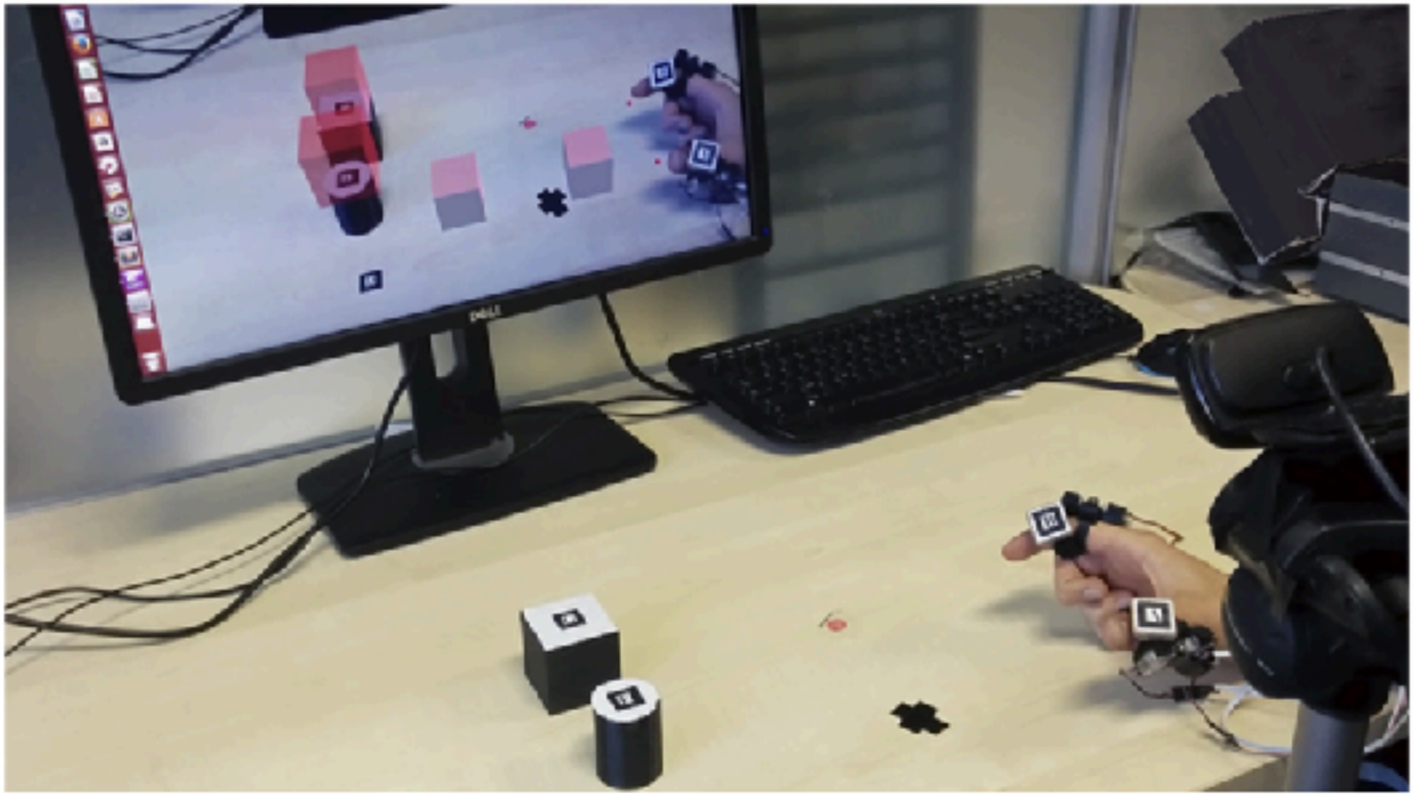

A user wearing haptic devices on two fingers feels both real and virtual objects in augmented reality. Domenico Prattichizzo

Finger devices let users ‘touch’ virtual objects

By Matthew Hutson | Apr. 25, 2017 , 3:00 PM


Manipulate
Touch
- Alessandro is a great Professor !

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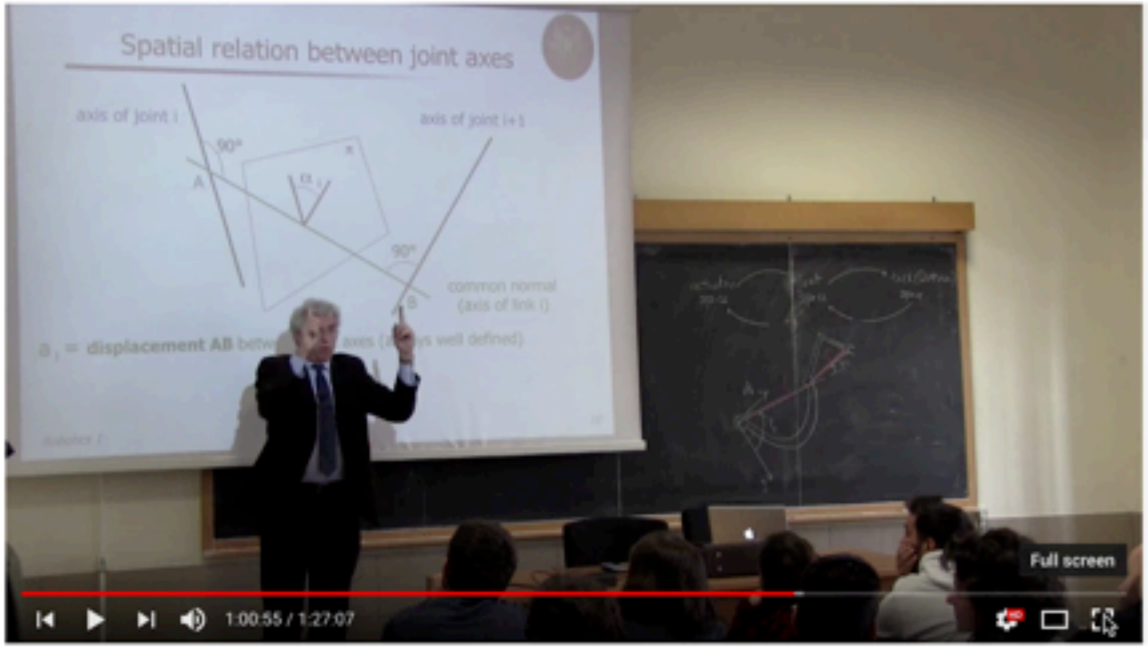

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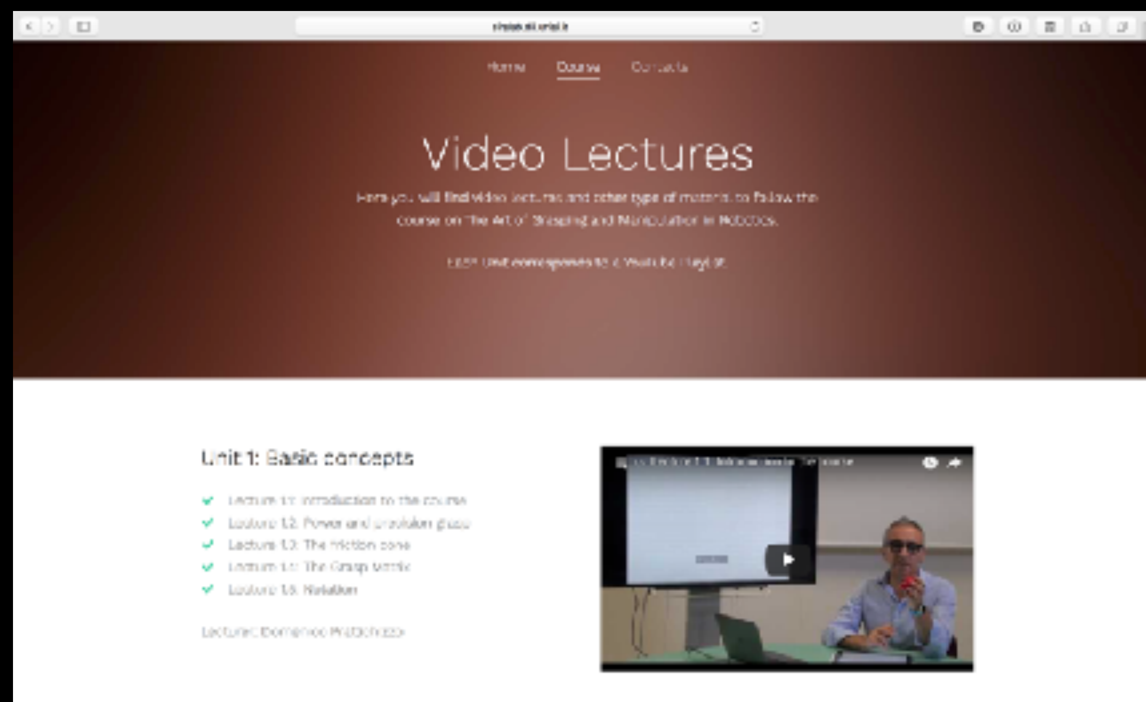
The Art of Grasping and
Manipulation in Robotics
Why should I take this course?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Unit 1: Basic concepts

Happy Birthday Alessandro and Thanks

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