Eye-hand online adaptation during reaching tasks in a humanoid robot

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Humans acquire body awareness through a process of sensorimotor development that starts in early infancy [1]. Such awareness is supported by a neural representation of the body that can be used to infer the limbs' position in space and guide motor behaviors: a body schema. Considering more specifically the visual based control of reaching, a form of visual-proprioceptive calibration of the body might be performed by infants during the first months of life, as they spend a lot of time observing themselves while moving [2]. Moreover, the theory of human motor learning and control postulates that forward and inverse internal models of the limbs are learned and kept up-to-date in the cerebellum[3]. For example, forward model can be combined with the actual sensory feedback through Bayesian integration to improve the estimation of the current state of the system [4].

Our objective is to improve the accuracy of an analytical model of the robot using visual information and Bayesian estimation techniques. In particular, we consider a visual based reaching scenario using the iCub humanoid robot and instead of learning an internal model from scratch, we exploit the iKin kinematic model of the robot [5] provided within the YARP/iCub software framework, and we adapt it online during reaching movements in order to cope with the modeling inaccuracies, allowing the robot to precisely reach for a desired position and orientation.

In the future work we want to use this improved internal model to do visual based hand control in grasping tasks since precise grasping requires a good awareness of the hand pose and it is typically very difficult to obtain an accurate analytical model of the system, due to hard-to-model aspects (e.g. elasticity) and changes that might occur over time (e.g. unalignment of a joint rotation axis)

Keywords: Internal model learning, humanoid robot, Bayesian estimation

References:

[1] C. von Hofsten, "An action perspective on motor development," Trends in Cognitive Sciences, vol. 8, pp. 266–272, 2004.
[2] P. Rochat, "Self-perception and action in infancy," Exp. Brain Res., vol. 123, pp. 102–109, 1998.
[3] D. M. Wolpert, R. C. Miall, and M. Kawato, "Internal models in the cerebellum," Trends in Cognitive Sciences, vol. 2, pp. 338–347, 1998.
[4] K. P. K¨ording and D. M. Wolpert, "Bayesian integration in sensorimotor learning," Nature, vol. 427, pp. 244–247, 2004.
[5] U. Pattacini, "Modular cartesian controllers for humanoid robots: Design and implementation on the icub," Ph.D. dissertation, Italian Institute of Technology, 2011.