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2019 Intelligent Sensing Summer School - 2-6 September

Robot self-calibration from touch events

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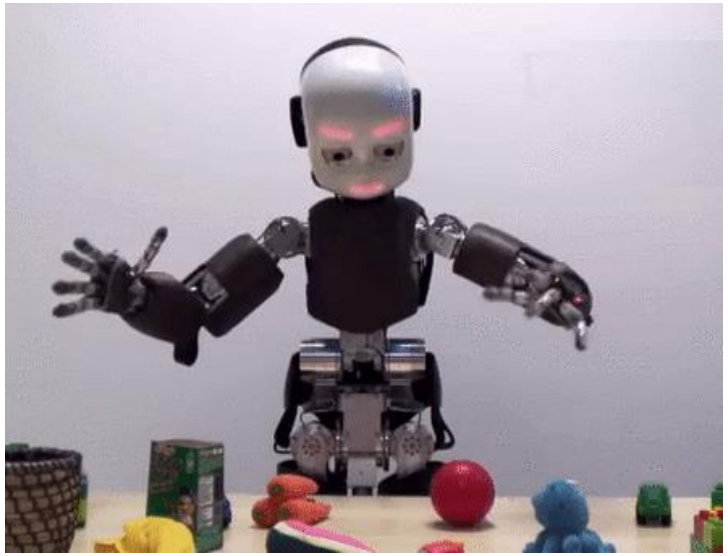
Personal Background

- Masters @ Instituto Superior Técnico
  Real-Time Distributed Control Systems
  Lisbon, 2012-2018
- MSc thesis @ VisLab Lisbon;
  Adaptation of a Robot Body Schema Based on Touch Events
  Institute for Systems and Robotics, Lisbon, 2017-2018
- PhD @ Queen Mary University of London
  Slip detection with a three-axis hall effect-based soft skin sensor.
  London, March 2019 - Present

Motivation

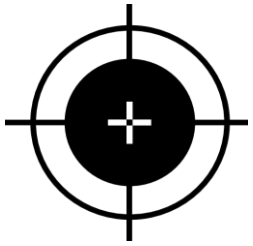
- How do children learn to control precise body movements?



- How can robots learn to improve their accuracy?

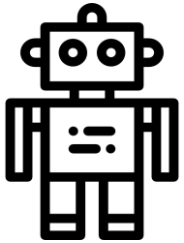
Objectives

- Online calibration involving contacts;

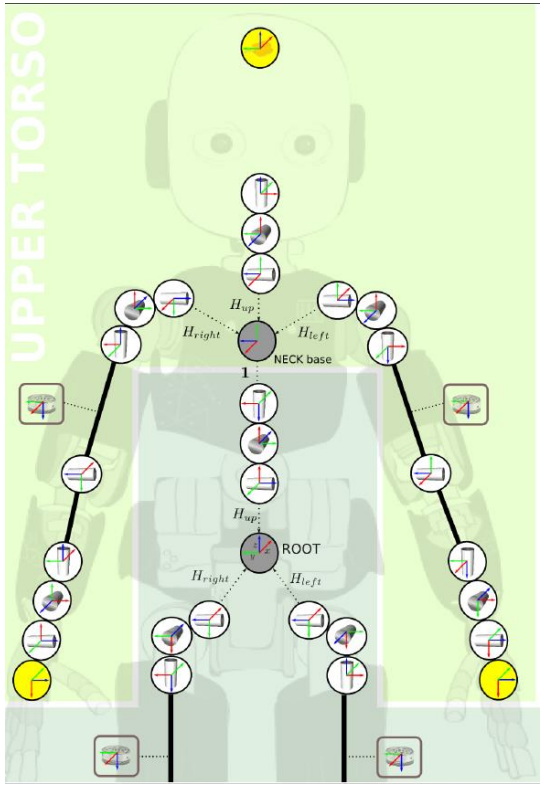


- Use tactile and proprioception sensors;

- Implementation on iCub robot simulator;



Problem Definition



iCub's upper torso DoFs.

- Our state (that we wish to estimate):

$$\boldsymbol{\beta}_t = [\beta_t^1 \beta_t^2 \dots \beta_t^N]^T$$

Proprioception (joint encoders) bias

- Our dynamic model:

$$\boldsymbol{\beta}_t = \boldsymbol{\beta}_{t-1} + \boldsymbol{\varepsilon}_t, \qquad \boldsymbol{\varepsilon}_t \sim \mathcal{N}(0, \mathbf{Q})$$

- Our observation model:

$$z_k\left(\boldsymbol{\theta}_k^p + \hat{\boldsymbol{\beta}}_t\right) = \alpha_k + \delta_k, \qquad \delta_t \sim \mathcal{N}(0, \mathbf{R})$$

Data Incorporation Strategies

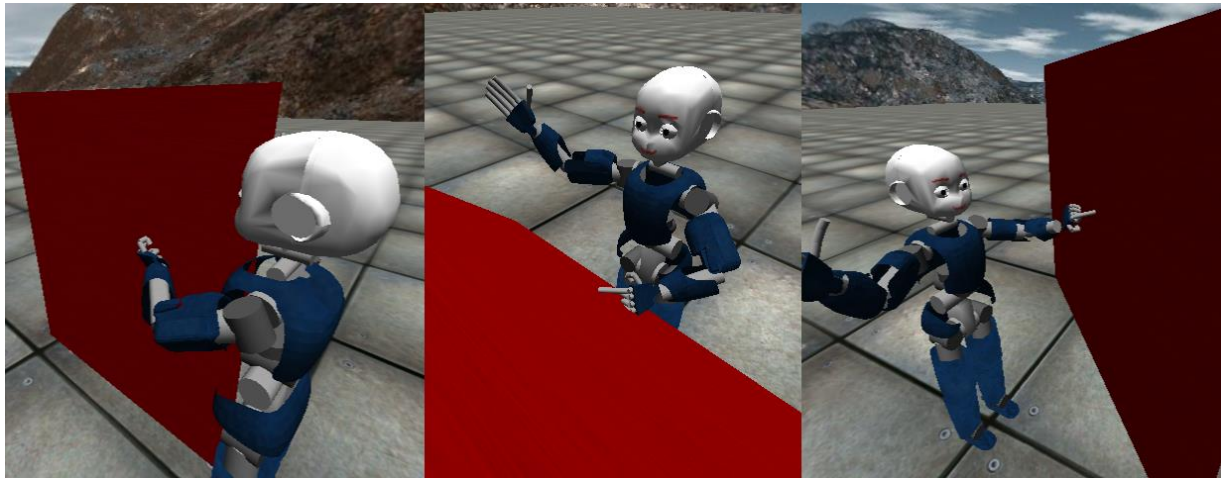
- 3 data incorporation strategies:

Aggregation of Multiple Observations

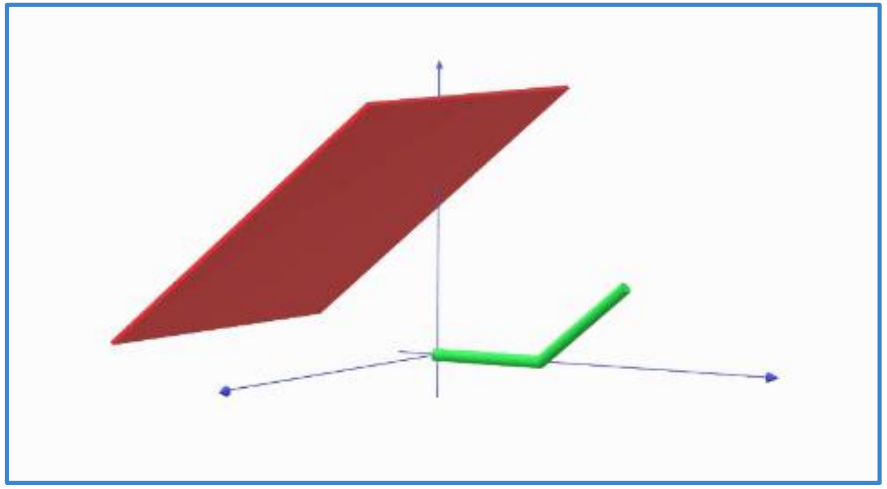
Estimation Differential Entropy Evaluation

Anti-Windup Control

Experiments



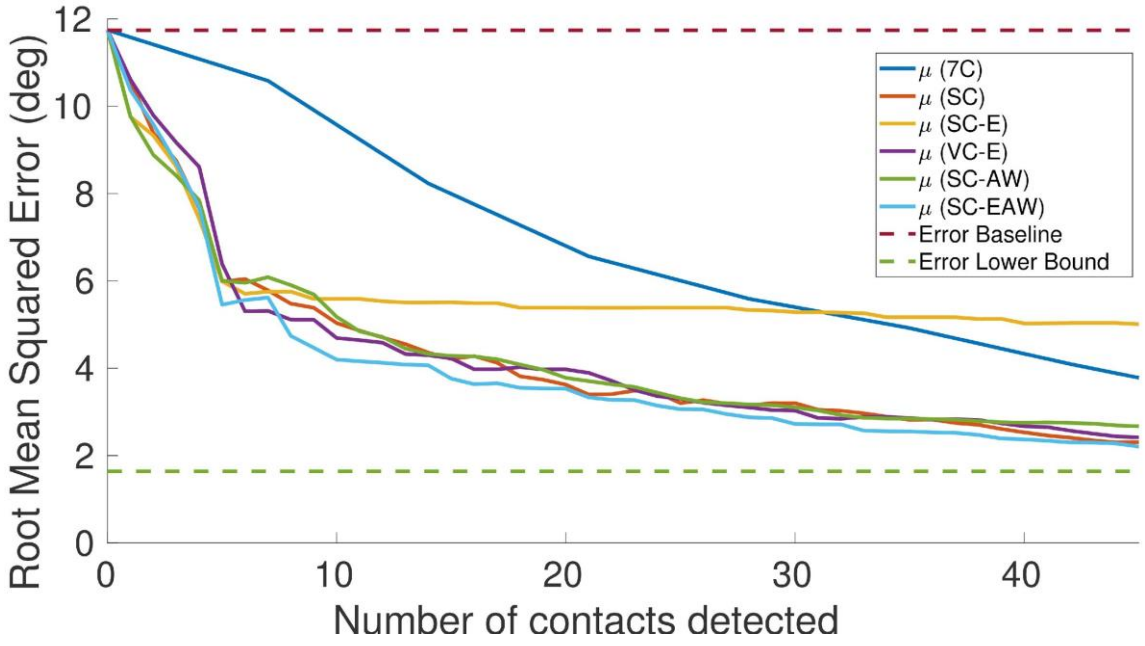
Experimental Environment.



Simplified iCub arm (2 DoF)

- iCub Simulator:
  - 3 reachable surfaces;
  - Artificially introduced offsets.

Results



10-Experiments estimation mean over 45 contacts on 3 different surfaces.

- Best results for SC-EAW;
- Up to 80% error reduction;
- Robust to different (and slow-time varying) offsets.

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