

Cooperative learning for robot's social intelligence: a perspective from the iCub project

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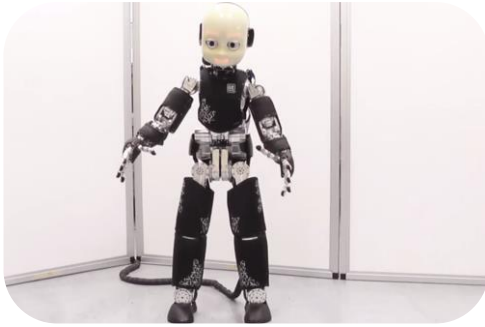
Istituto Italiano di Tecnologia, Genova

Robot's Social Intelligence and Natural Interaction Capabilities with
End User Development

Eu Robotics Forum, Vienna, 11 March 2015

The iCub project

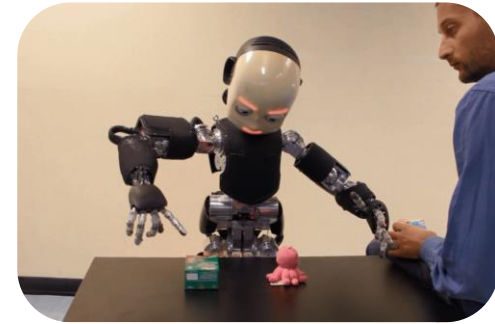
platform



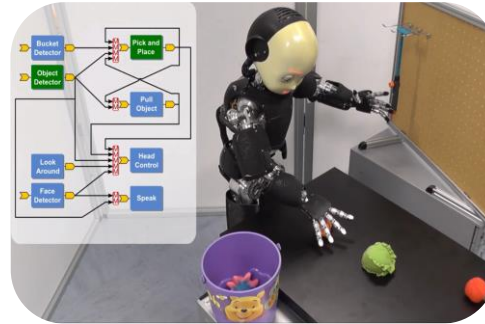
interaction



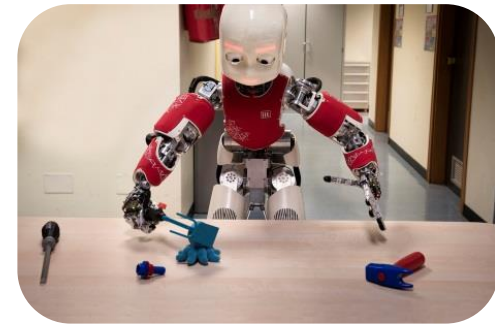
objects



system integration



tools



- Engineering
- Research/science

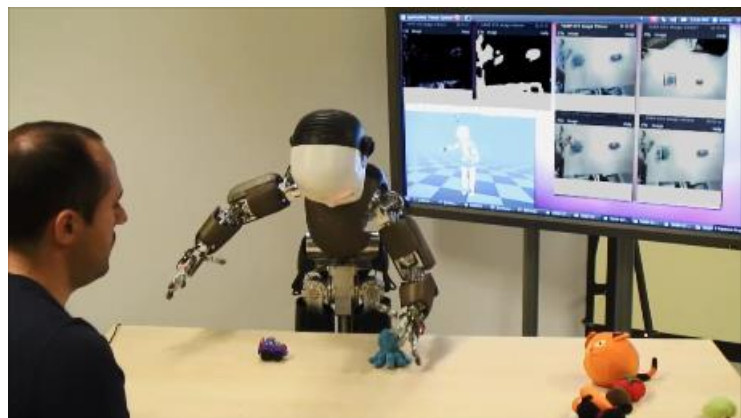
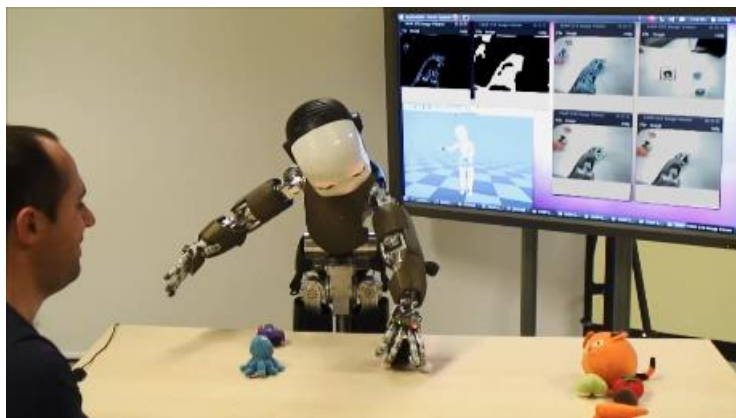
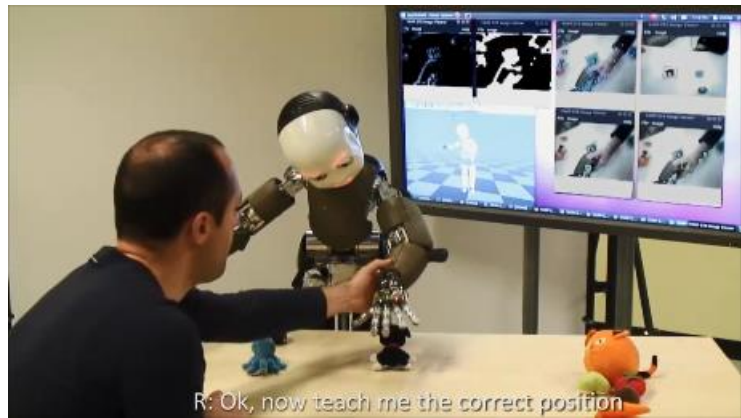
Motivations

Autonomous
Friendly (humans)
Perception & control
Size/Weight/Power
Safety





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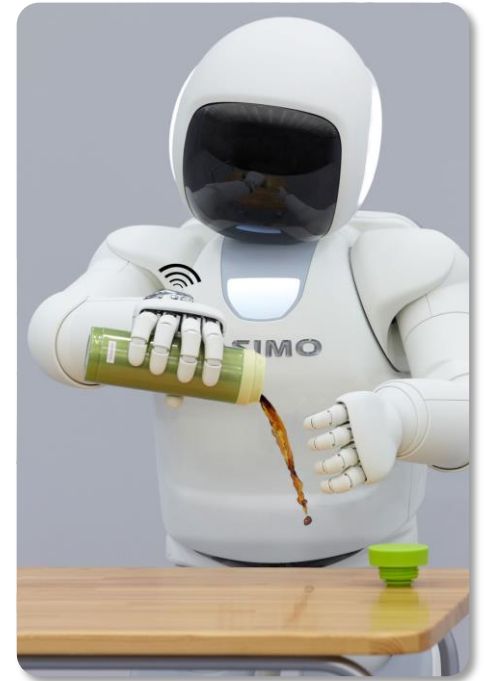


Current limitations

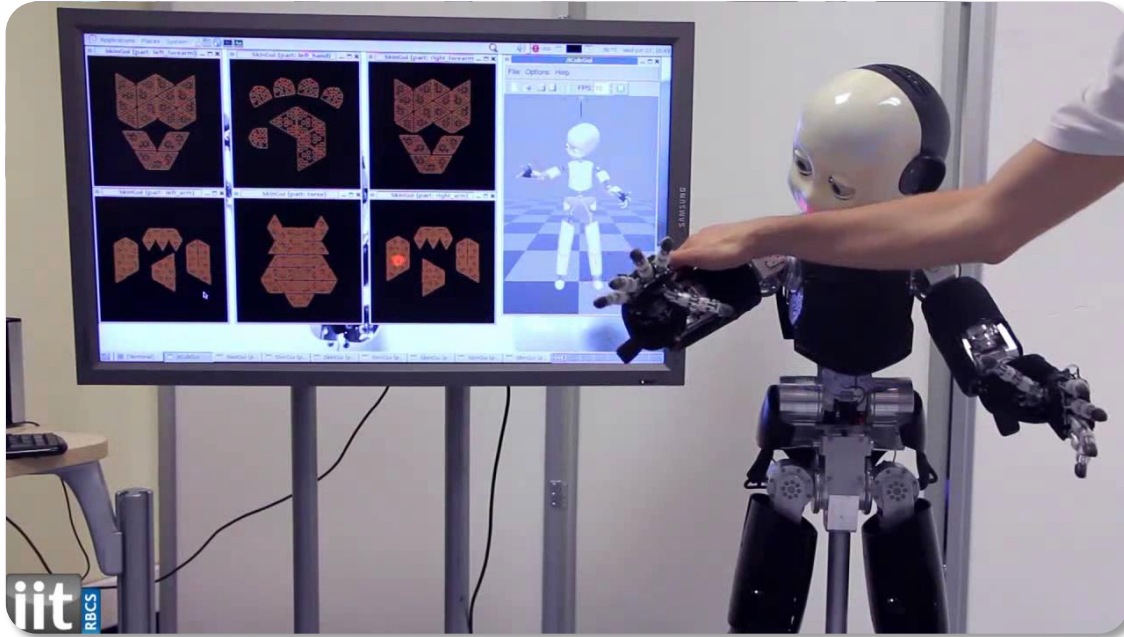
- Can an **untrained human** communicate with the robot?
- Insufficient feedback: humans **cannot adapt** to the robot
- Problems for **perception**: detect humans, their intentions, and behave accordingly
- Communication should be: **verbal, visual, tactile, behavioral...**

What is missing?

- Multimodal, perception (speech, vision touch, force)
 - Perception must be robust
- Whole-body
- Seamless, natural interaction
 - Backchannels
 - Continuous perception
 - Reactive behaviors



Towards whole body skin



Hands: 104x2

Forearms: 230x2

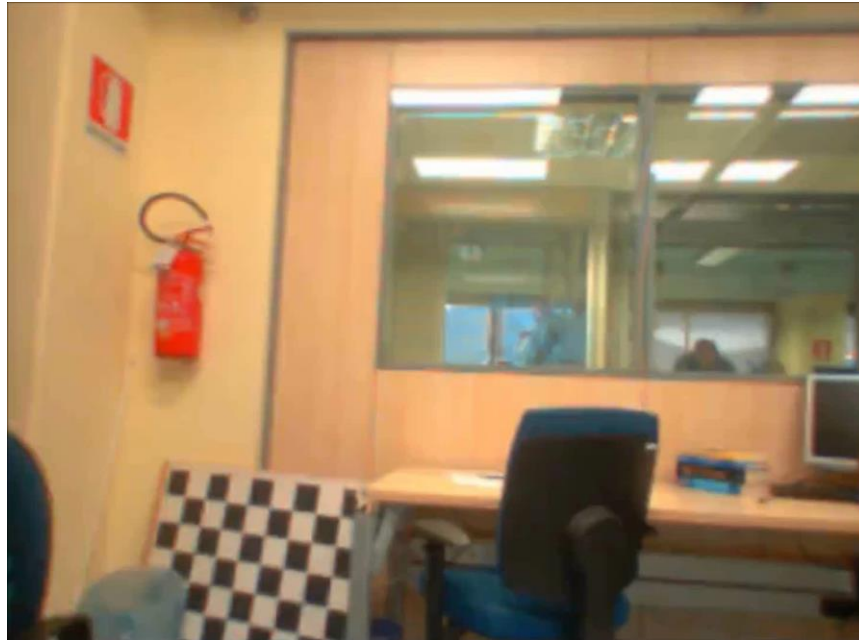
Upperarms: 380x2

Torso: 440

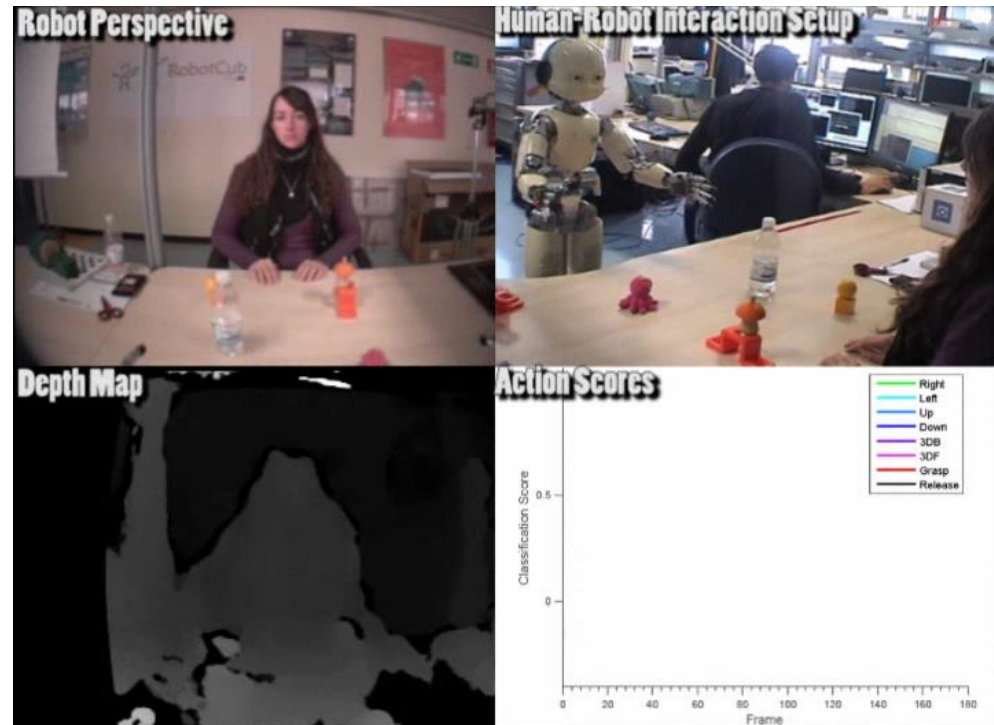
Legs and feet: 1310x2

Total: 4488 + accelerometers in the palms and arms

Towards better human perception



Head pose detection using HOG features and landmarks (Kazemi, Sullivan 2014)



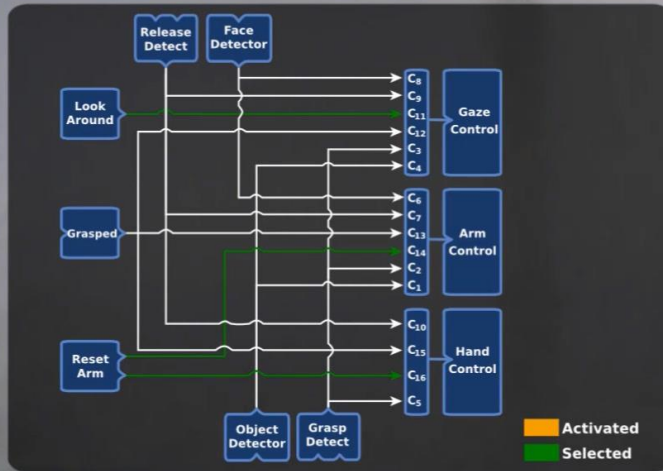
Gesture recognition, using HOF, sparse coding and ML

Programming reactive behaviors

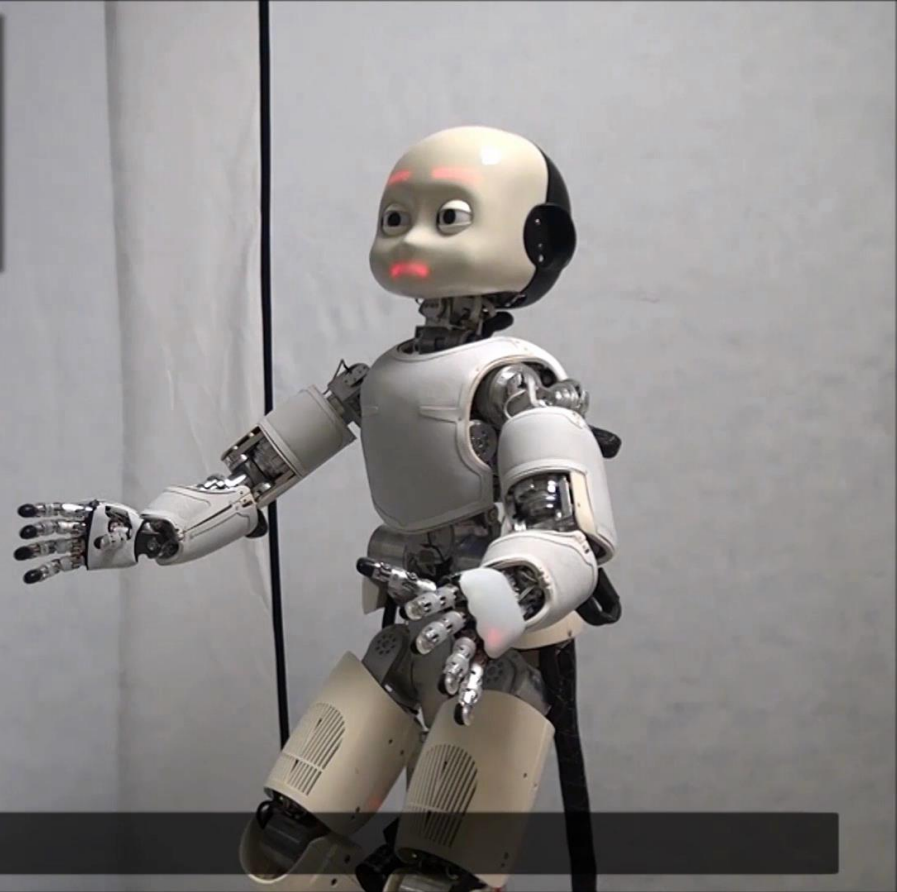


Object Detector

Face Detector



Icub is Looking for an object ...



Programming reactive behaviors

The image illustrates a reactive programming system for a robot. It features a state transition diagram on the left and a photograph of a robot on the right. The diagram shows the following components:

- Inputs:** Look Around, Grasp, Reset Arm, Release Detect, Face Detector, Object Detector, Grasp Detect.
- States:** C₁ through C₁₆.
- Control Modules:** Gaze Control (C₈, C₉, C₁₁, C₁₂, C₃, C₄), Arm Control (C₆, C₇, C₁₃, C₁₄, C₂, C₁), Hand Control (C₁₀, C₁₅, C₁₆, C₅).
- Legend:** Yellow arrow = Activated, Green arrow = Selected.

The robot on the right is holding a red ball. The top-left inset shows a person in a hallway with a yellow circle highlighting a green bin. The top-right inset shows the same person with a red circle highlighting their face.

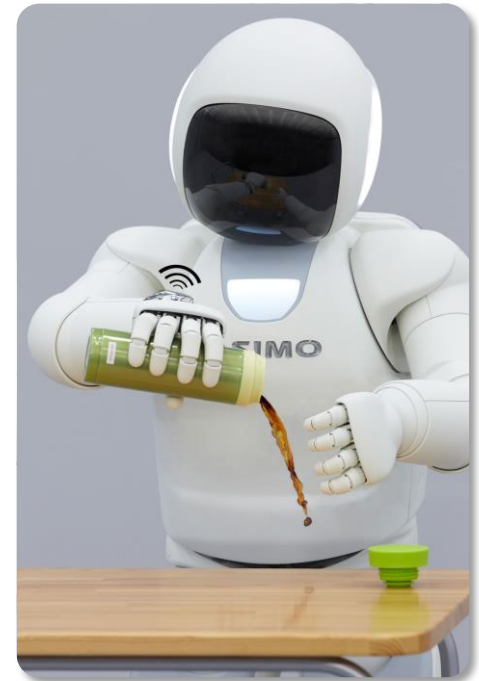
More on coordination

- Example: eye blinks
 - Need to notify perception that should ignore frames (this is non-trivial)
- Coordination between actions, gaze, pointing, nodding etc...
- *Put that there!*



Wrap-up

- Multimodal, robust, perception (speech, vision touch, force)
- Whole-body
- Seamless, natural interaction
 - Continuous perception
 - Reactive behaviors
- Benchmarking:
 - (performance metrics)
 - Dataset
 - Simulators
- Robots designed for social interaction (hardware and software)





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Thank you!