

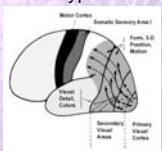
Developmental learning in non-markovian processes: Premises of a new biologically plausible cognitive architecture

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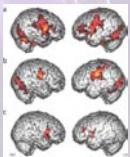
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Cognitive architecture

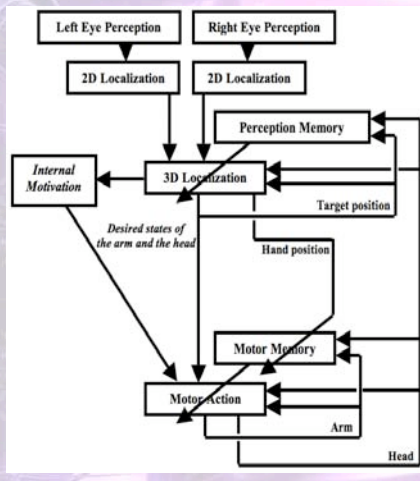
Physiological pathway hypothesis



Mirror Neurons



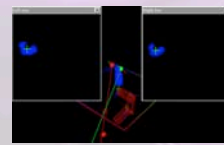
Embodiment



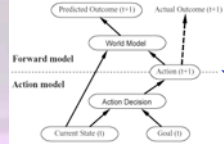
Interactive Activation Model



Triangulation



Forward Model



Experiments & Results

Exp 1: Localization

- Low levels performs color detection in each eye,
- Intermediate levels operates blob localization in each eye,
- Higher level achieves triangulation and retrieves the hand position in the Cartesian space

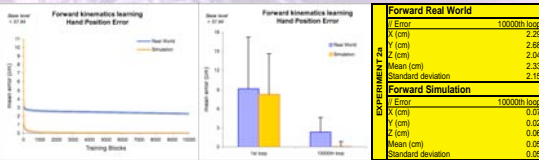


3D Localization	
X Error (cm)	3.48
Y Error (cm)	5.22
Z Error (cm)	4.21
Mean (cm)	4.30
Standard deviation	3.37

Experiments & Results

Exp 2: Learning of forward kinematics

- on the real robot or in simulation



- Hand position's prediction error along the Cartesian/Visual space either on the real robot or in simulation



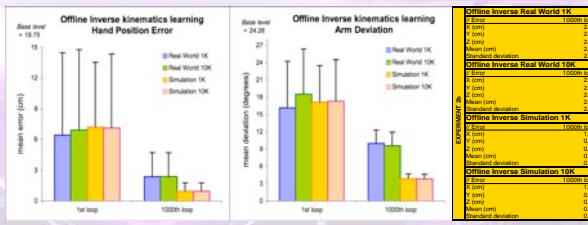
- Hand position's prediction error along the Geometrical/Motor space either on the real robot or in simulation



⇒ Preference for the motor space, which is more reliable

Exp 2b: Offline Learning of Inverse kinematics

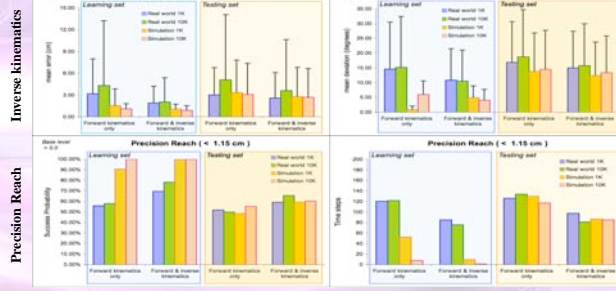
- on the real robot or in simulation
- with a good (1K) or a perfect (10K) model of forward kinematics



⇒ Approximate knowledge of forward kinematics is sufficient

Exp 3 and 4: Online Learning of Inverse Kinematics

- on the real robot or in simulation
- with a good (1K) or a perfect (10K) model of forward kinematics
- with the learning set and a new testing set
- with naive or already learned inverse kinematics



⇒ Better performances when inverse kinematics are previously learned
⇒ Loss of the simulation's advantage in real world testing

Discussion

- No effect of world's type (simulated or real) is retrieved in the overall performances in real world
- An approximate knowledge of forward kinematics allows the same level of performance as if knowledge was perfect
- Best performances are achieved thanks to a combination of offline and online learning phases of forward and inverse kinematics, independently of other conditions.

Condition	Perception Action	Reaching (cm)	Success probability	Time steps
Real 1K	4.31	1.03	0.43	49.50%
Real 10K	4.31	1.03	0.43	49.50%
Simu 1K	4.31	0.95	0.94	49.50%
Simu 10K	4.31	0.95	0.94	49.50%

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