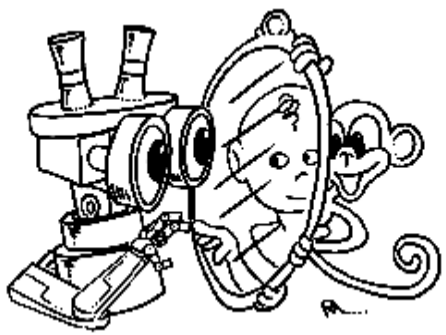
Information Society Technologies

MIRROR Project Review
IST-2000-28159

Brussels – December 1st, 2003



Agenda

First Hour

Introduction

1. Overview of Mirror Projects – Giorgio Metta

Highlights of the second year results

2. Model of the learning artifact – Jose' Santos-Victor
3. Biological experiments – Luciano Fadiga
4. Development of action – Claes von Hofsten

Project funded by the Future and Emerging Technologies arm of the IST Programme FET-Open scheme "Artefefacts that live and grow"

Consortium

- LIRA-Lab, DIST, University of Genova – Italy:
  G. Sandini, G. Metta
- Dept. of Biomedical Sciences University of Ferrara – Italy:
  Luciano Fadiga, Laila Craighero
- Instituto Superior Técnico – Lisbon, Portugal:
  Josè Santos-Victor, Alex Bernardino, Manuel Cabido-Lopes
- Dept. of Psychology – University of Uppsala – Sweden:
  Claes Von Hofsten, Kerstin Rosander

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Scientific framework

The project investigates the association between visual information and motor commands in the learning, representation and understanding of complex manipulative gestures (grasping).

taking inspiration from…

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Mirror neurons (and 'canonical' neurons)

MIRROR

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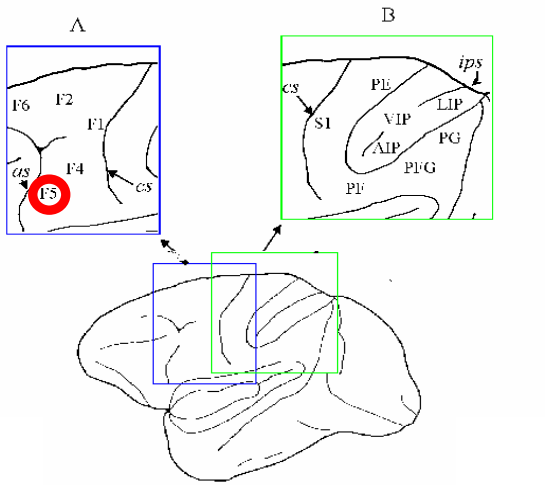

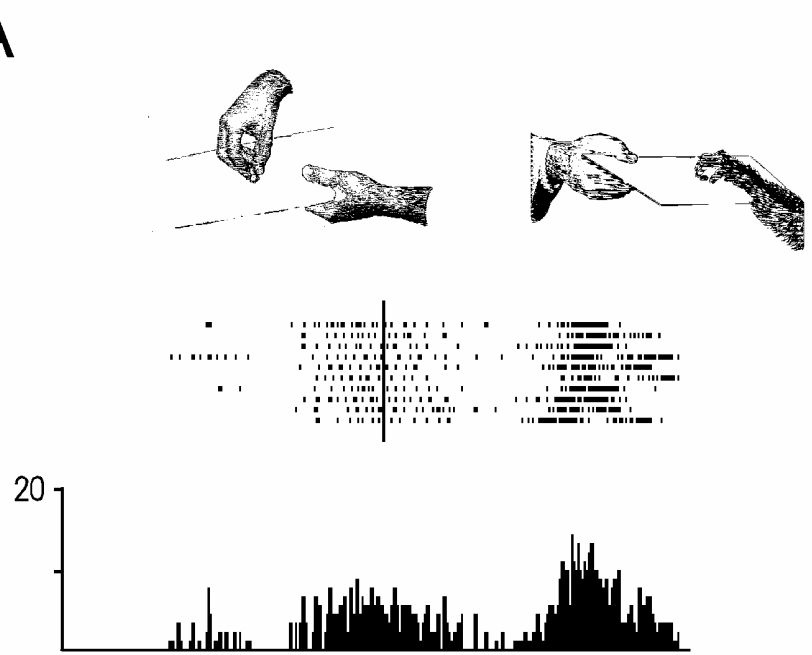

The neuron is activated by "seeing" someone else's hand performing a manipulative action **and** while the monkey is performing the same action

A mirror neuron is a motor neuron that "recognizes" gestures

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Projects objectives

- Realize an artificial system (artifact) able to interpret human gestures (hand grasping) by means of a *mirror system*
- Study the ontogenesis of motor (mirror) representation in humans, monkeys, and robots

MIRROR combines physiology, psychology, and computer science in building a model of the mirror system.

In doing so, we aim at enlarging our understanding of action recognition, interpretation, and communication in biological systems.

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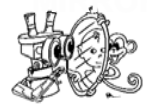
Developmental approach



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…understanding someone else's actions is much simpler by **being able of performing that action**

In other words the person's ability in interpreting and/or imitating motor acts is facilitated by having learned how to perform that action while observing, **visually and "motorically"**, his/her own body

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Elements of the model

- What do two individuals have in common?
  - The effects of the action are shared (visually for example)
  - The target object of the action maybe shared
  - A similar (if not the same) motor repertoire

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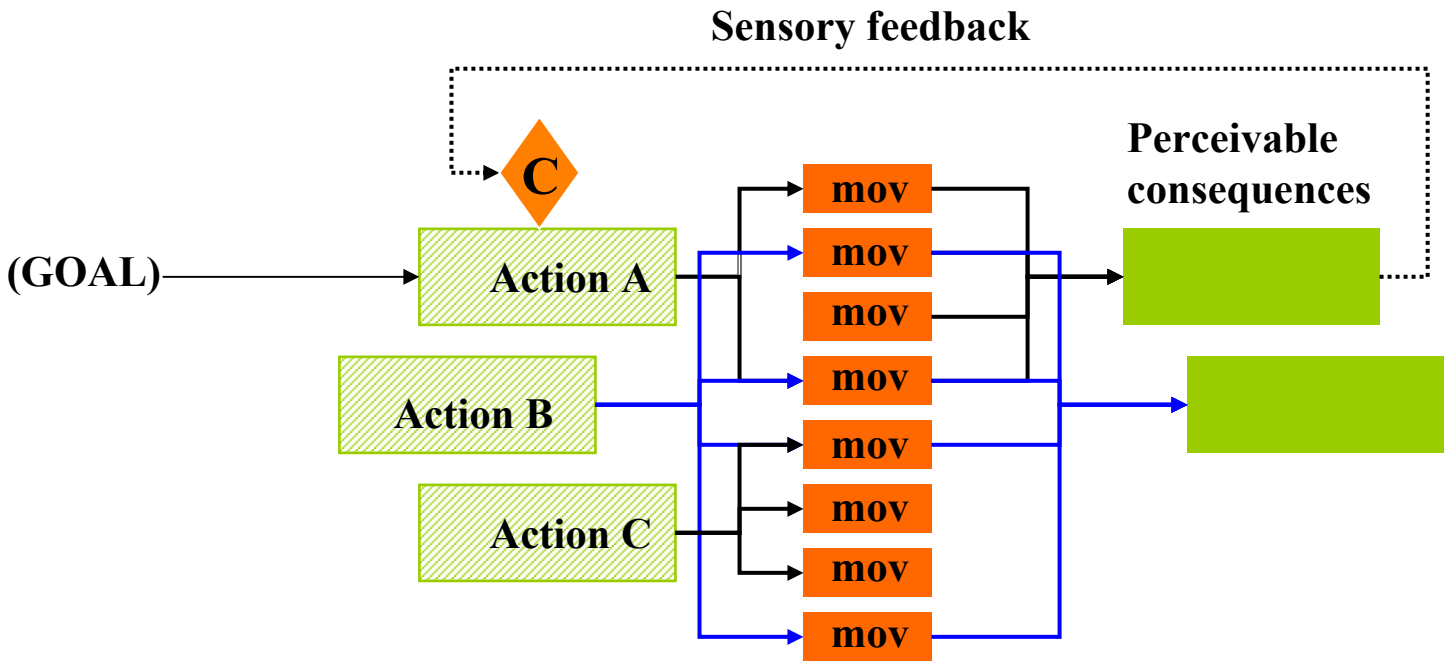
Conceptual schema



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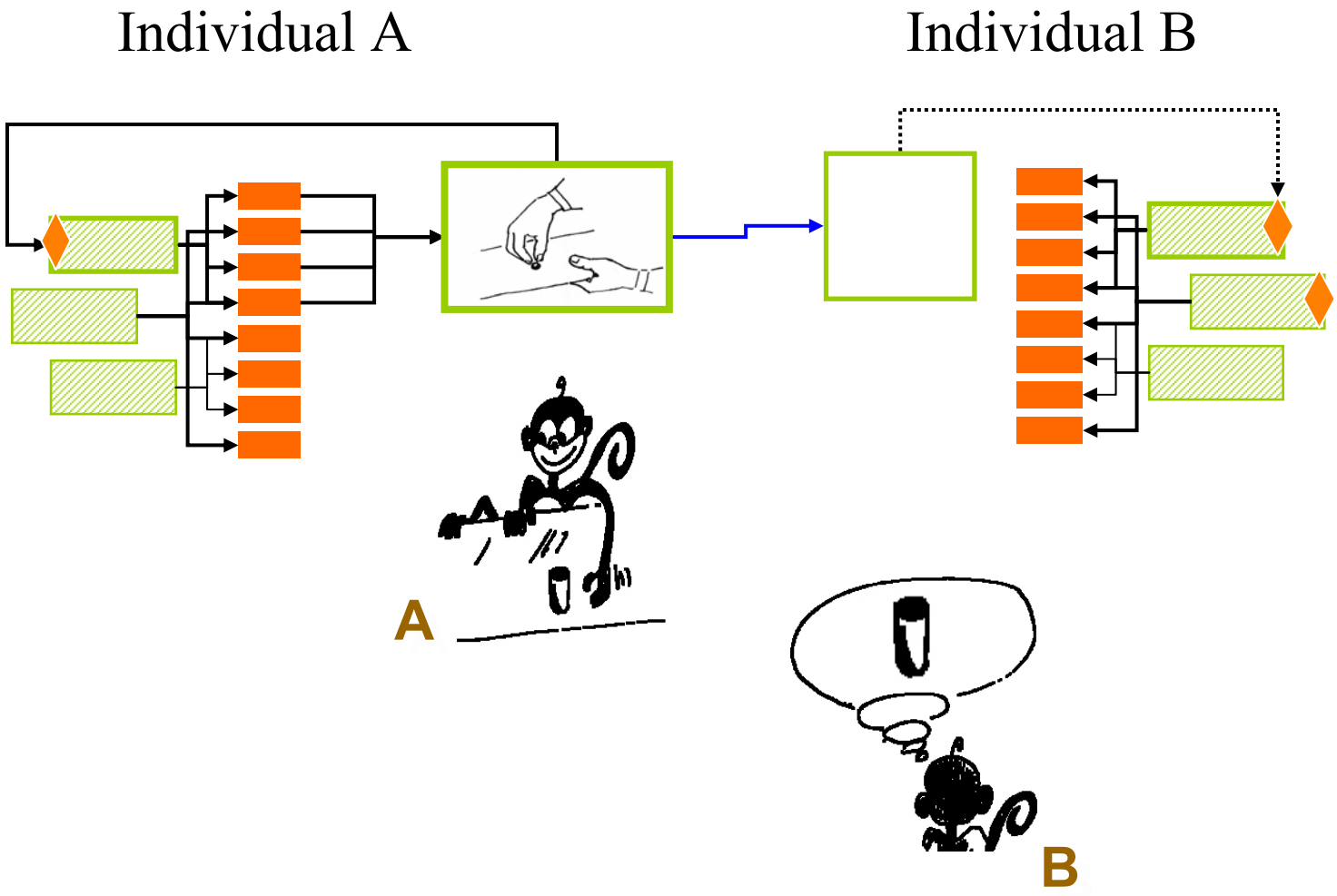
Exchange of information



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Object affordances

- An individual can apply his/her own experience in determining which actions are more likely to be successful in manipulating an object
- Knowledge about objects can be acquired by actively manipulating them

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Experimenting w/ affordances

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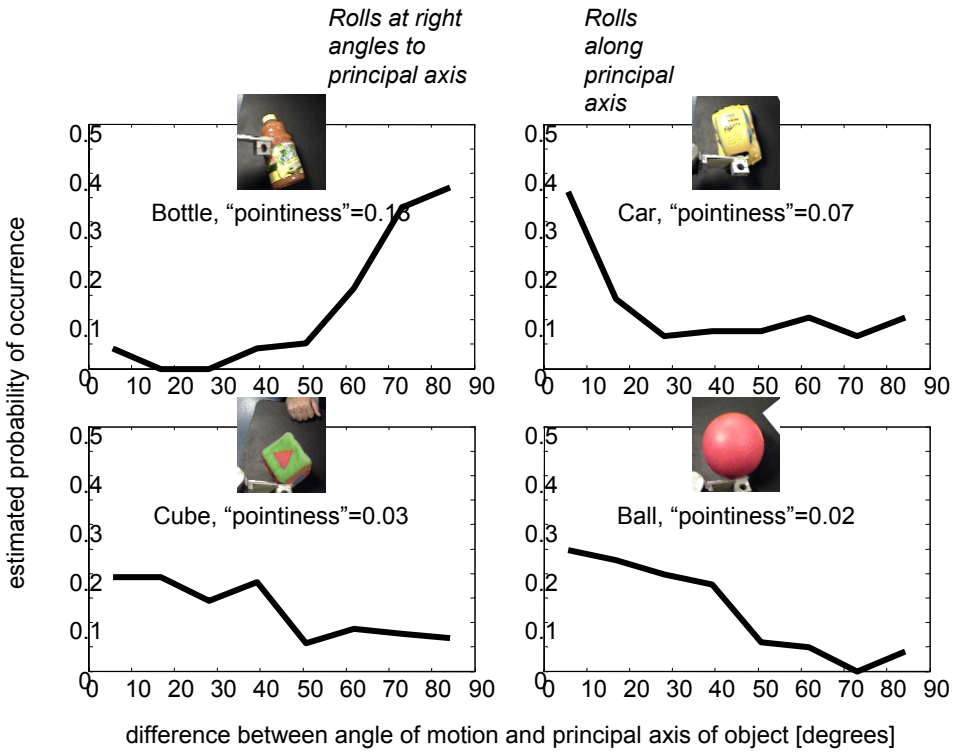

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Development of mirror system

Interpretation of other individual's actions can be acquired gradually…

- Learn how to control the hand (acquire motor actions and their visual consequences)
- Learn to associate feasible grasping to object characteristics (associate between objects with their affordances)
- Learn to associate actions performed by others to our own internal representation (recognize) → mirror system

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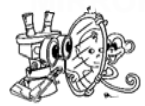
What we are going to show



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- A formal probabilistic model of affordances and recognition based on motor information
- Investigation on the role of visual information for the response of mirror neurons
- Investigation on the contribution of visual information in interpreting someone else's action
- Investigation on the development of action in human infants

…and of course results!

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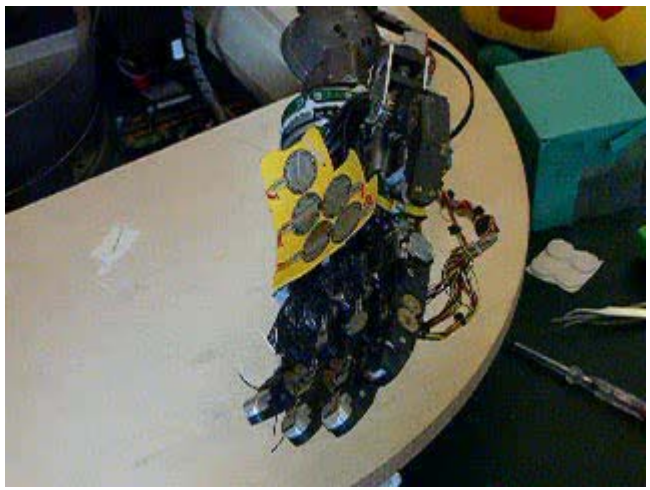
…what's next?

- Full fledged implementation on a robotic system
- Better understanding of the model

ergo…

- Better understanding of biological systems



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Intentionally blank

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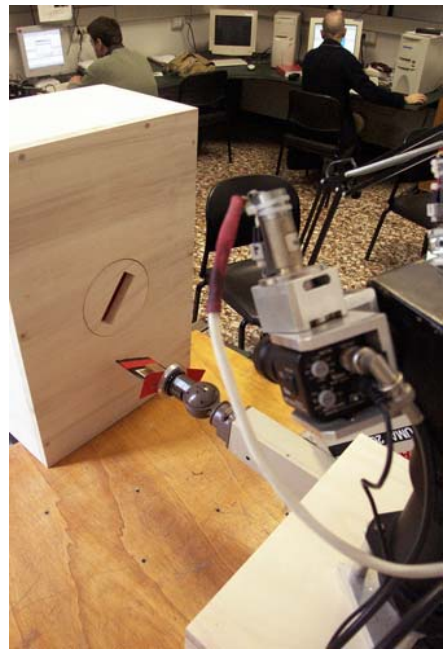
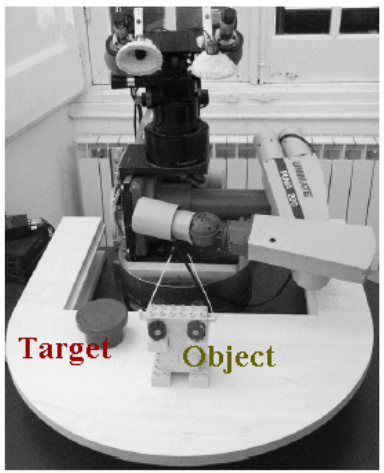
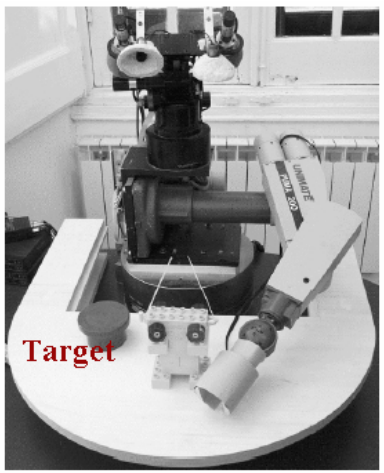
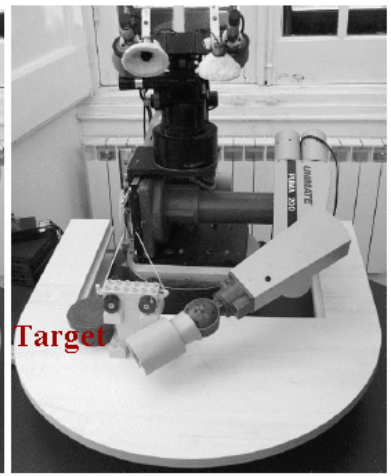
Development…

- Reaching and grasping (1 or 2 mechanisms?)
  UU – Rotating rod (Babies)
  DIST – Posting Task (Robot)
- Understand effects of manipulation actions









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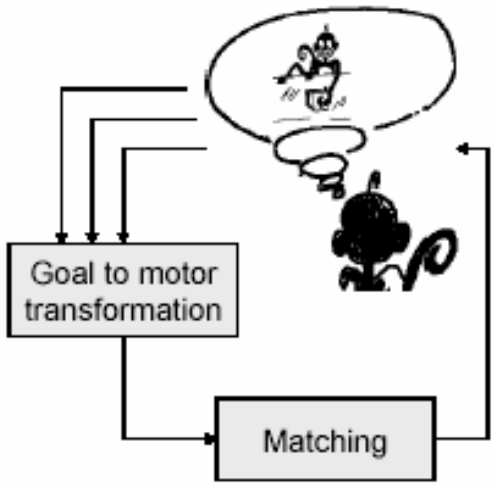
Two sensorimotor components

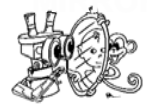
A grasping action has two components

- Visual: how a grasping action looks visually (object + hand)
- Motor/proprioceptive (the motor commands to generate a grasping and the resulting proprioceptive signals)



Performed grasps provide all components while observed grasp are only visual

The role of vision



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- How can the association between motor , proprioceptive and visual components be exploited during learning self-generated actions?
- What is the role of vision in learning how to grasps?
- Which visual information is required to “recognize”?

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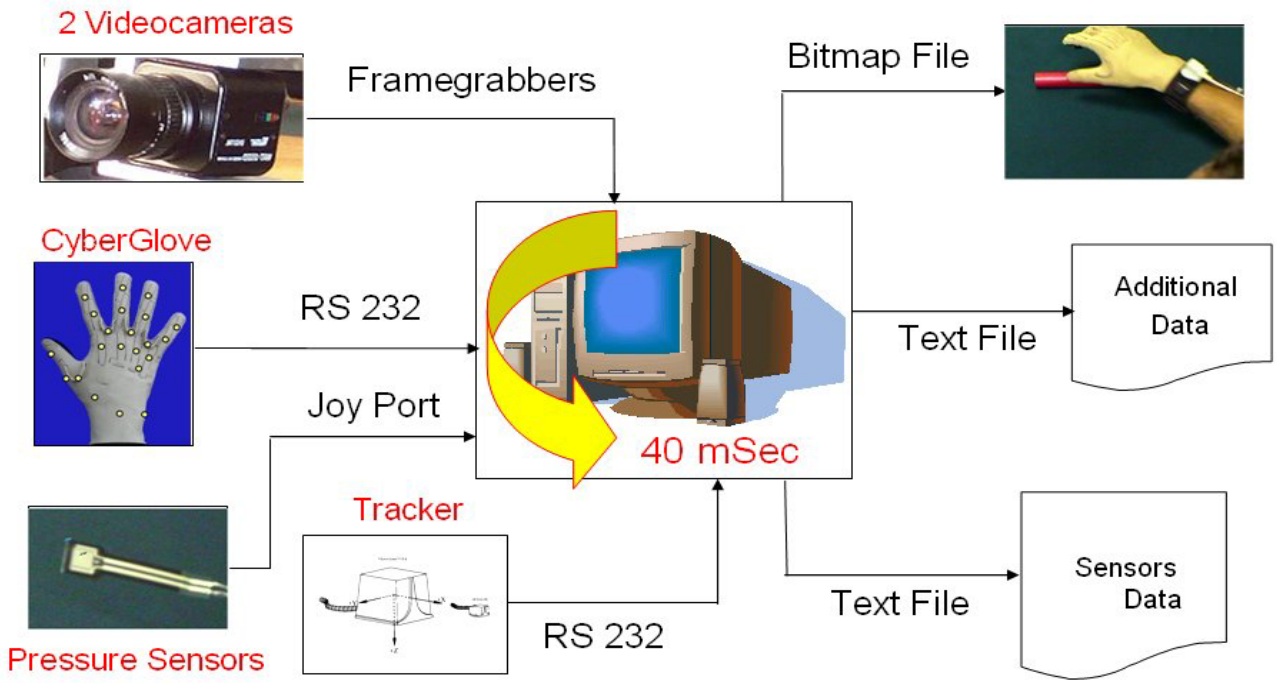
Visuo-motor association

- Setup for the acquisition of visual and proprioceptive information to test different learning strategies and visual and motor parameters



DIST and IST

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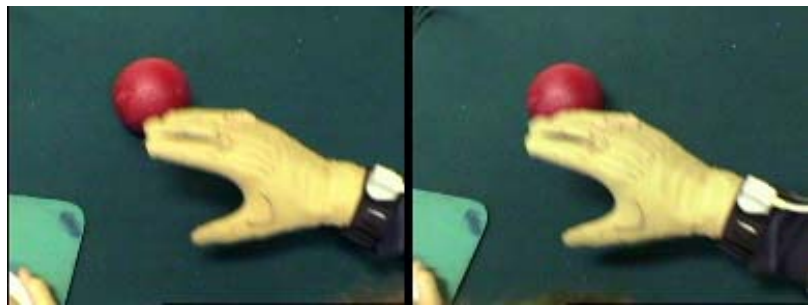
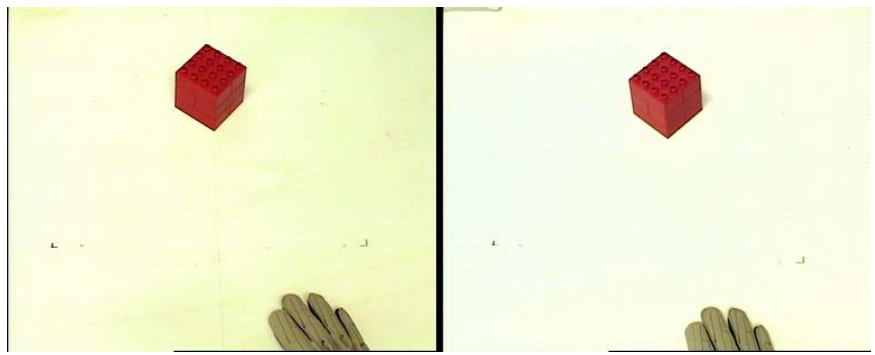
Grasp Data Acquisition

Kinematic data

FrameNumber	HandPositionY	HandPositionZ	IndexPressure
1	23.889401	15.478011	0.373547
2	23.885006	15.482406	0.351573
3	23.889401	15.482406	0.373547
4	23.889401	15.482406	0.351573
5	23.889401	15.486801	0.351573
6	23.889401	15.482406	0.3296
7	23.885006	15.49559	0.307627
8	23.889401	15.49559	0.241707
9	23.889401	15.49559	0.175787

Stereo vision





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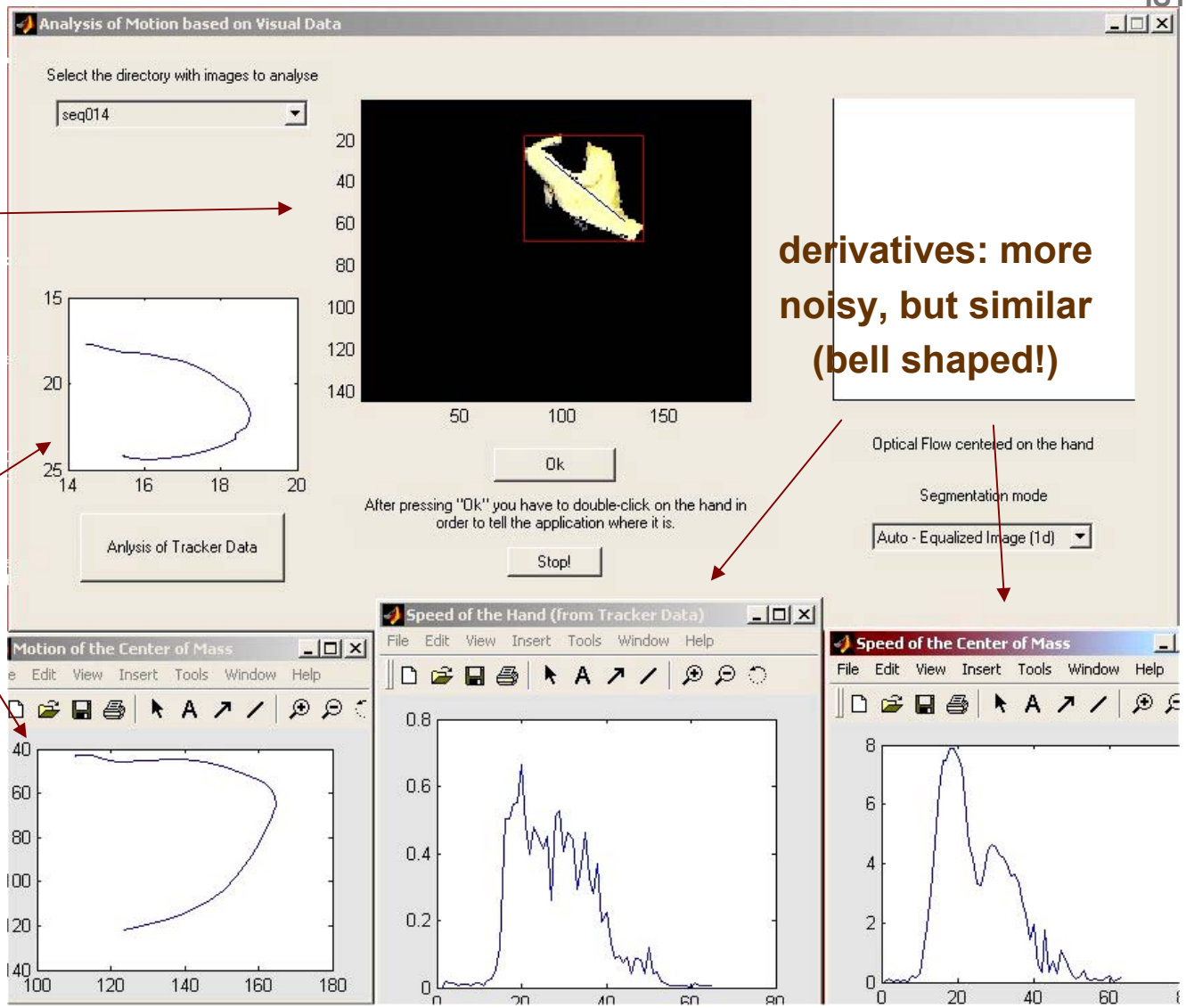
Grasp Data Acquisition

cylindrical Power grasp

good matching!!

derivatives: more noisy, but similar (bell shaped!)



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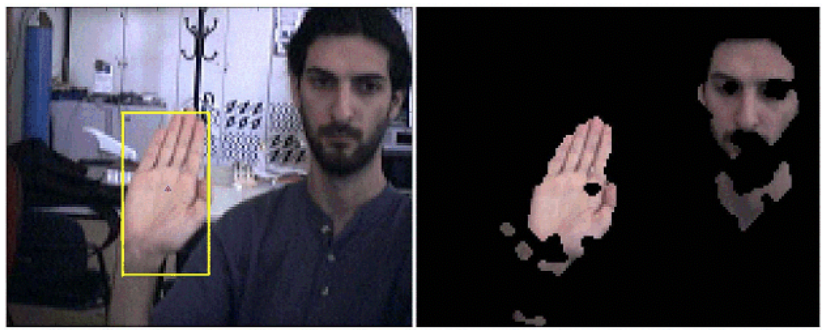
Grasp-related Visual Data

- Early processing of grasp-related visual data (Stereo – viewpoint transformation)



Viewpoint Transformation

Stereo Vision

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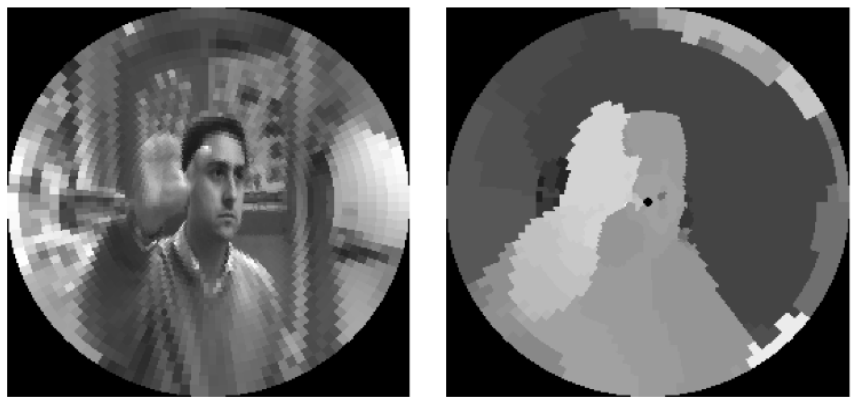

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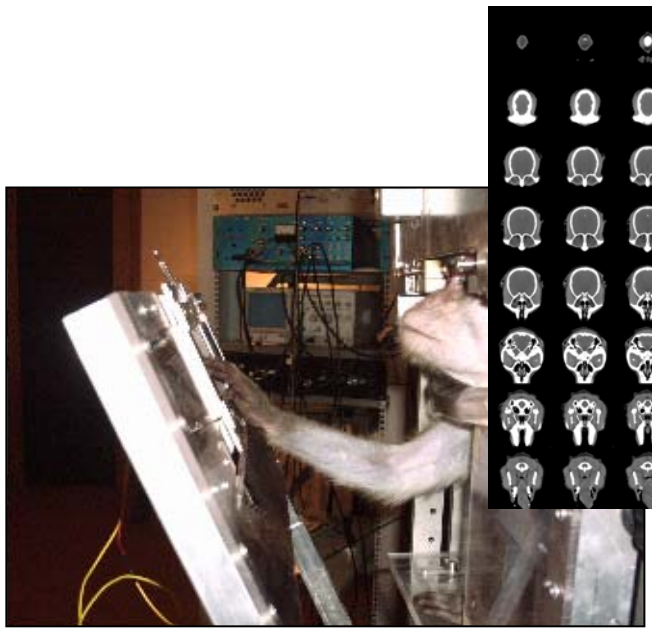
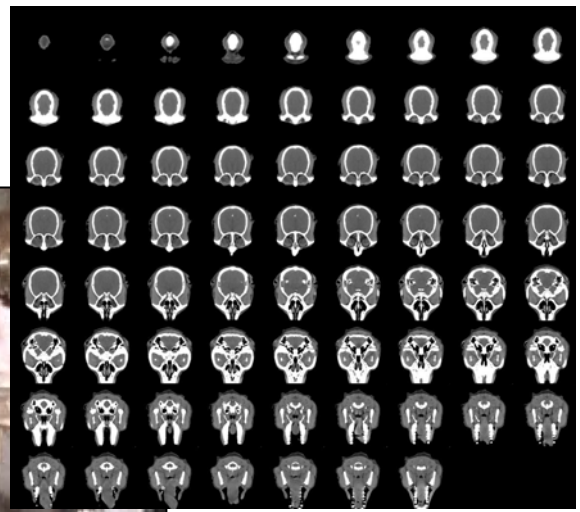
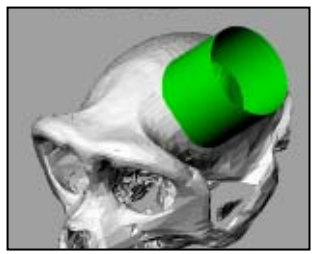
Role of vision in Mirror System

- Test the influence of “seeing the hand” and the object in the mirror system (Setup)







UNIFE and IST

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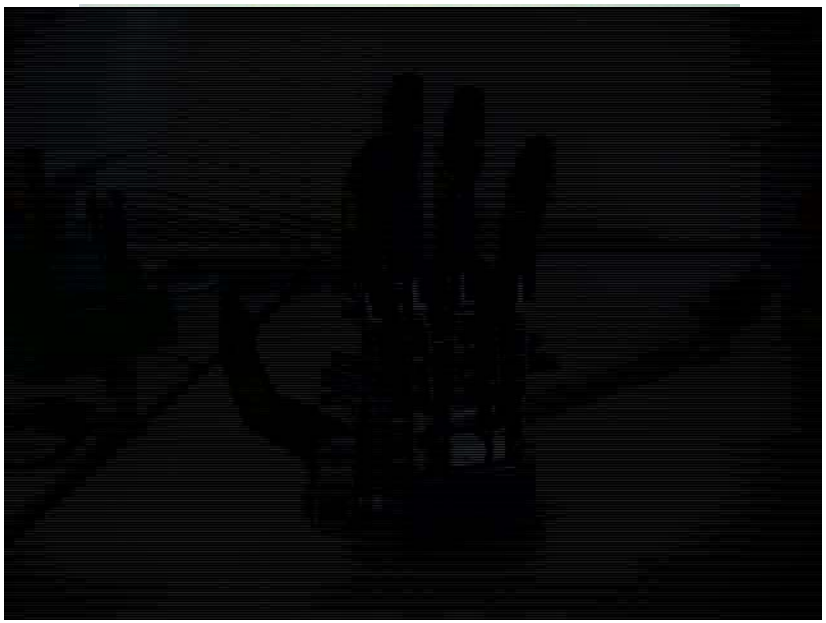
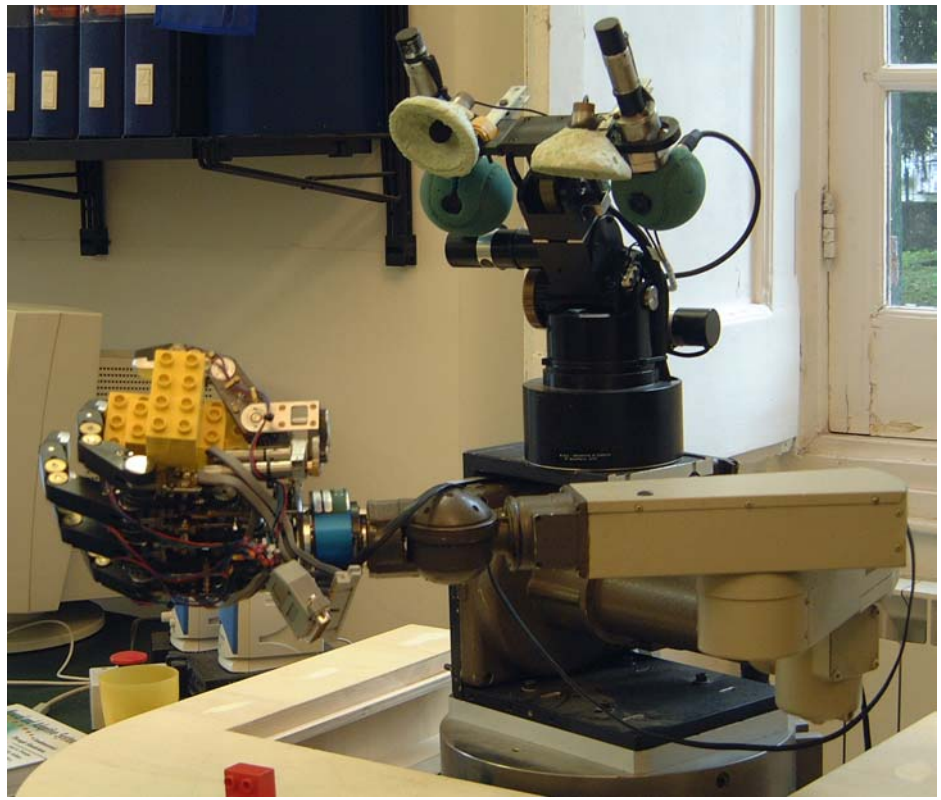
Robot Hand

- 16 degrees joints
- 6 controlled d.o.f.
- Elastic components on all joints
- Hall sensors on all joints





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