Object characterization using robotic vision and grasping exploration

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Objectives

- Recovering 3D object shape using probabilistic map: Integrating grasping exploration and features acquired by vision;

- Object Characterization by its geometrical properties;

- Recognize if it is deformable or not;

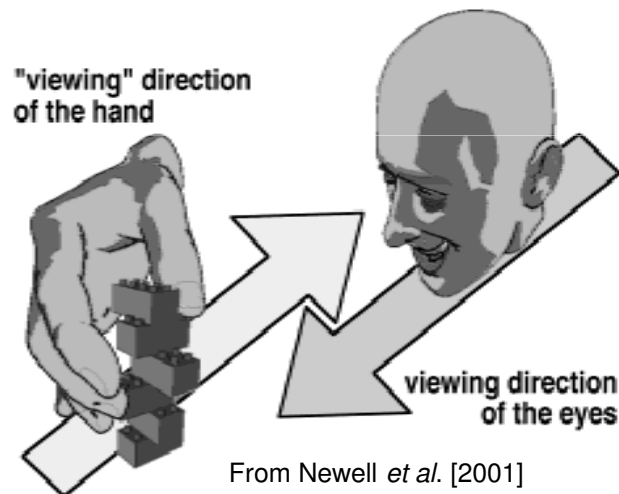- Object affordance to endow a robot with skills for imitation learning.

Introduction

By combining diferents sources of information (in our case bimodal) it's possible to produce responses which are potentially more reliable than simply relying on an individual sense modality.

"viewing" direction of the hand

viewing direction of the eyes

From Newell *et al*. [2001]

Newell *et al*. [2001, 2003] showed that both visual and haptic object recognition is dependent on the orientation of the object relative to the observer, and that they thus complement each other and cooperate:

> The best view for object recognising for the *haptic modality*, however, is the side the fingers naturally explore the most: *the back*.

> The best view for recognising an object *visually* is the learned view (usually *the front*)

Newell, F.N.; Ernst, M.; Tjan, B. & Bulthoff, H. Viewpoint dependence in visual and haptic object recognition. *Psychological Science,* 2001*, 12 (1)*, 37-42.

Newell, F.N.; Bülthoff, H.H. & Ernst, M.O. Cross-modal perception of actively explored objects. *Eurohaptics 2003 Conference Proceedings,* 2003*, -*, 291-299.

Introduction

- Integrating information of different sensors like vision and manipulation some tasks like object recognition, object affordance and imitation learning can be improved.

- Methods of occupancy grid give us enough information to achieve object reconstruction and to make the object characterization. Object characterization allow us acquiring information about object affordance.

- We can extend these activities to imitation learning, integrating movements performed with objects and object information (characterization and affordance).

- The next slides show the ideia and proposal for the next activities.

Object shape by stereo vision
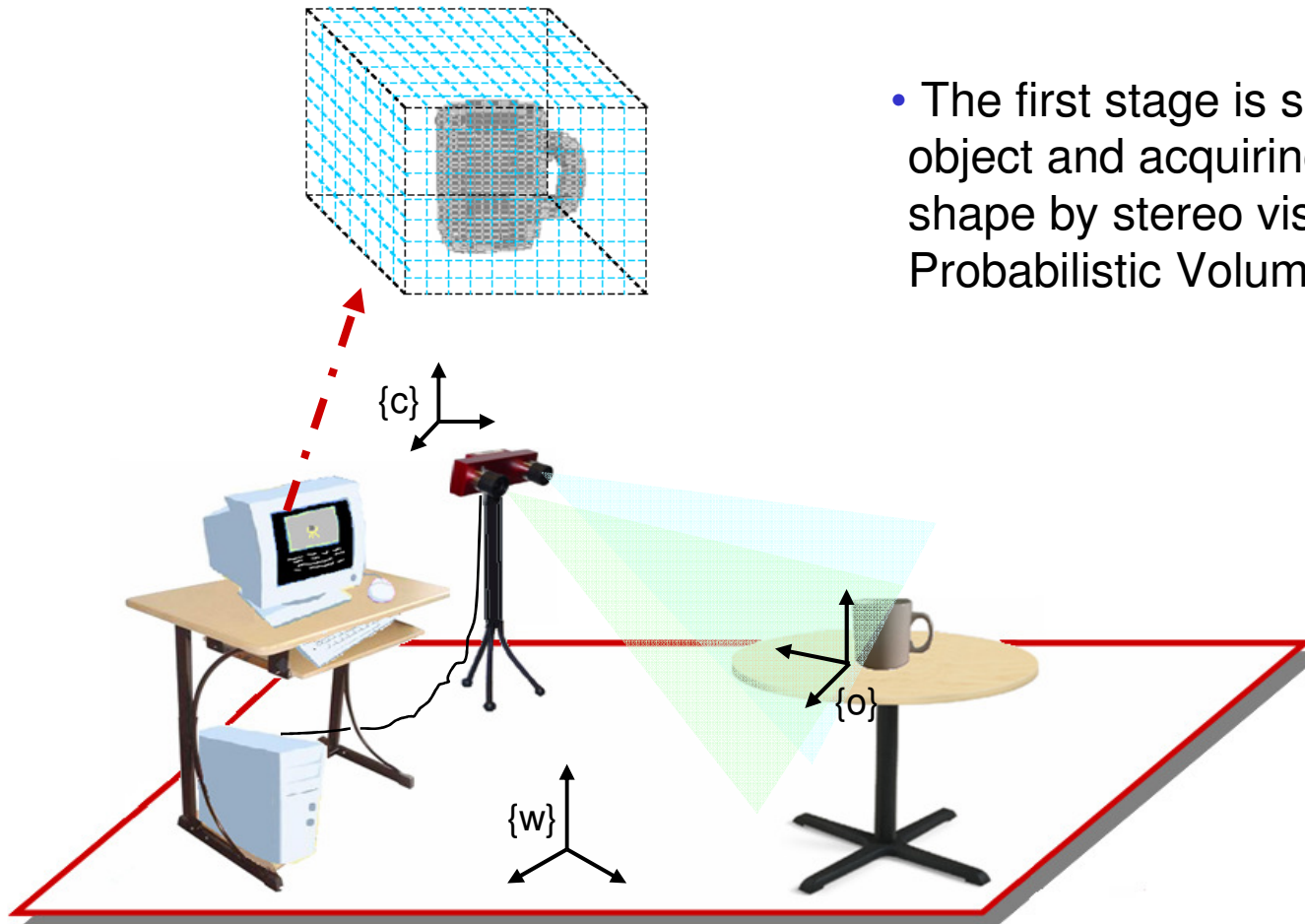
• The first stage is segmenting the object and acquiring the 3D shape by stereo vision using a Probabilistic Volumetric Map.
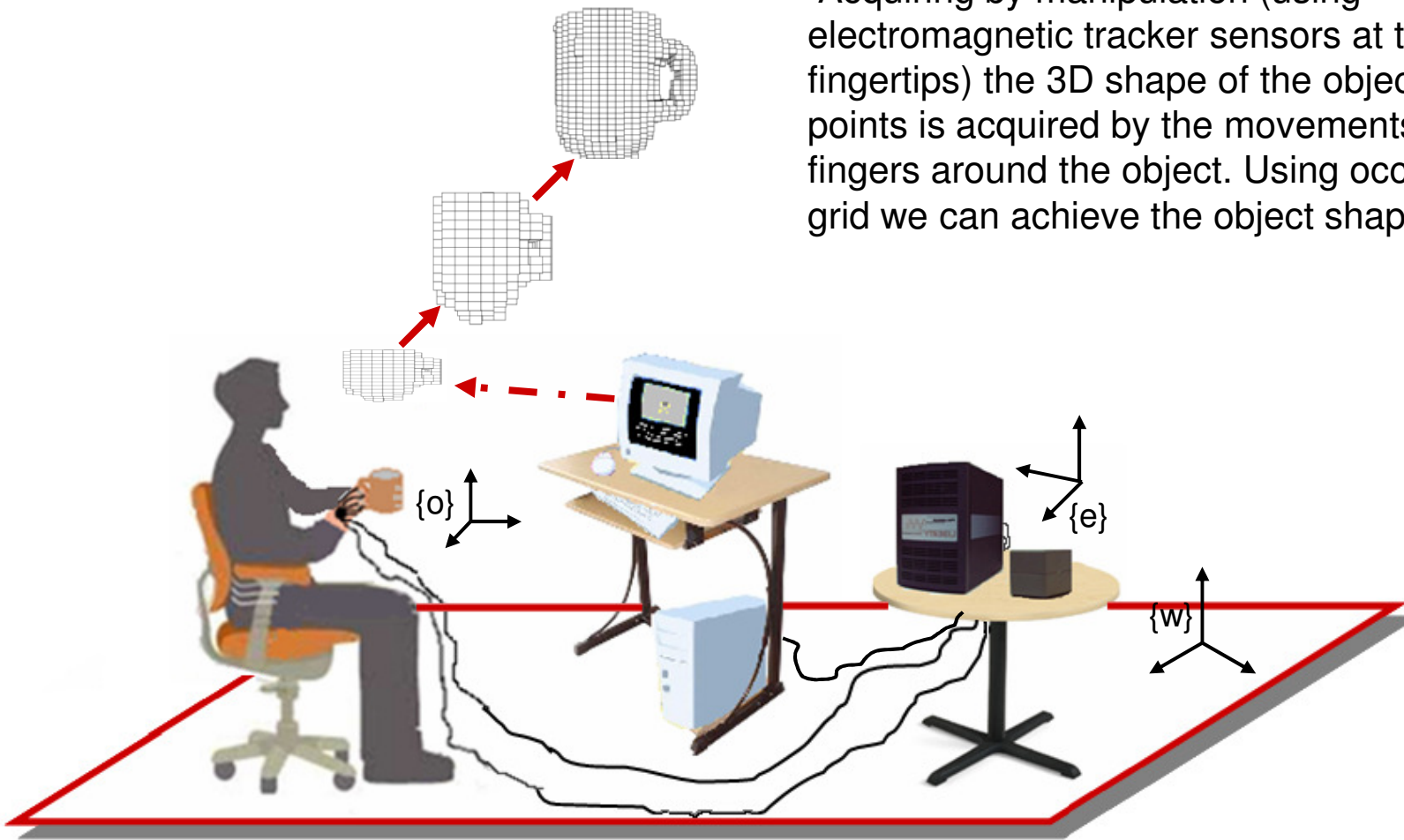
Grasping exploration

- Acquiring by manipulation (using electromagnetic tracker sensors at the fingertips) the 3D shape of the object. The 3D points is acquired by the movements of the fingers around the object. Using occupancy grid we can achieve the object shape.
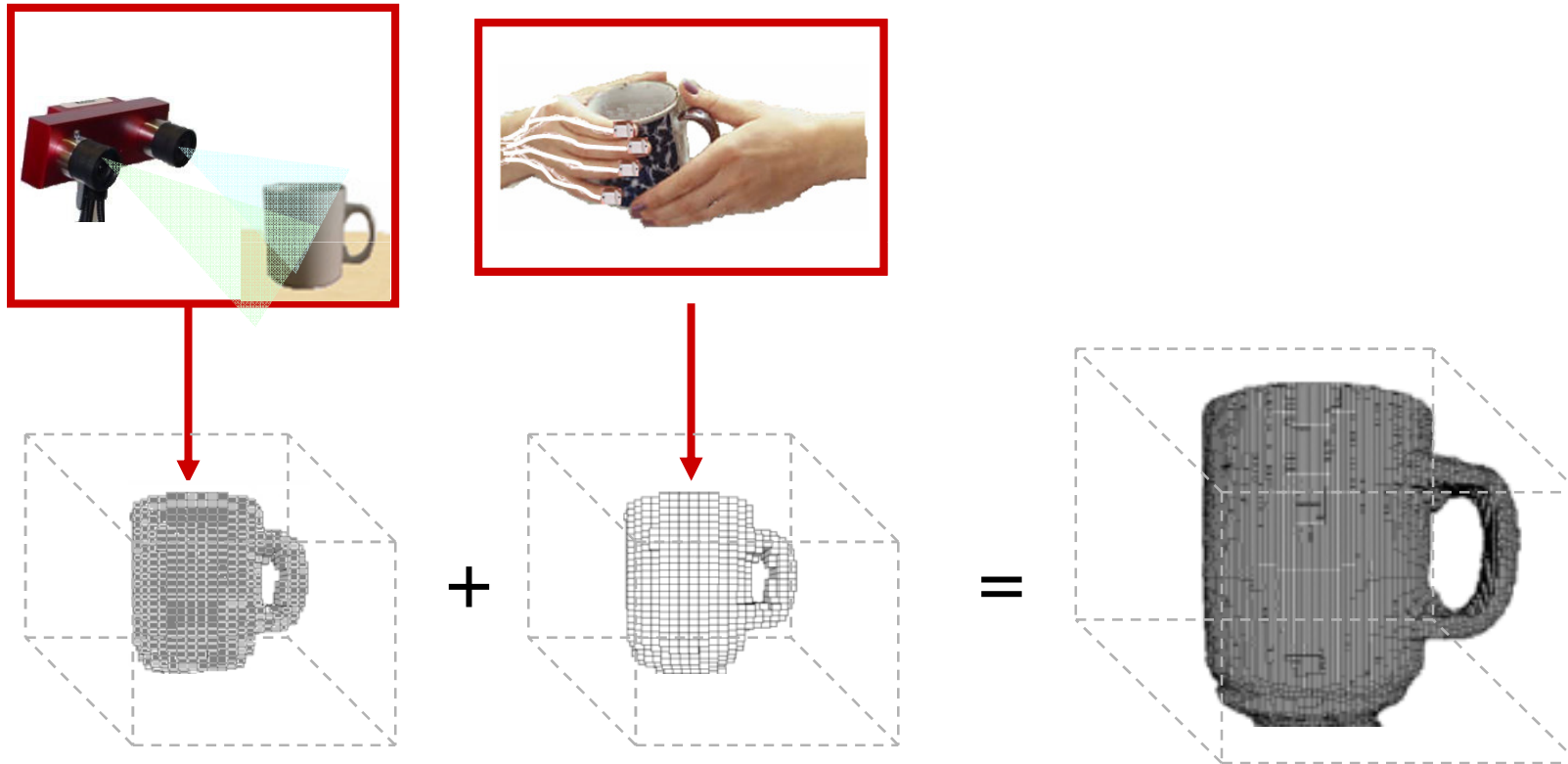
{o}

{e}

{w}

Sensors Data Fusion

- Integrating information of vision and manipulation trying to achieve a better reconstruction of the object. Map fusion:
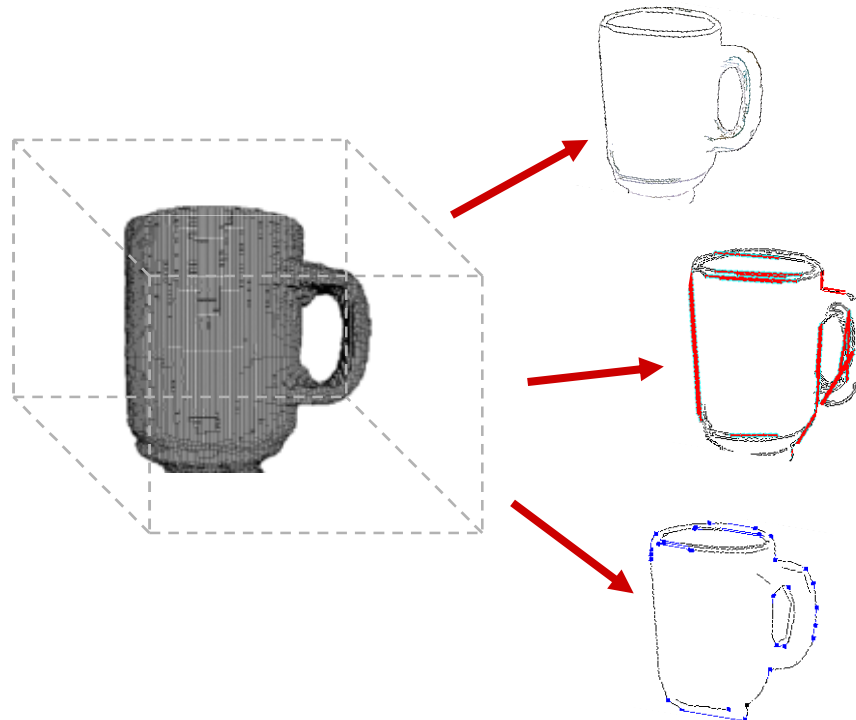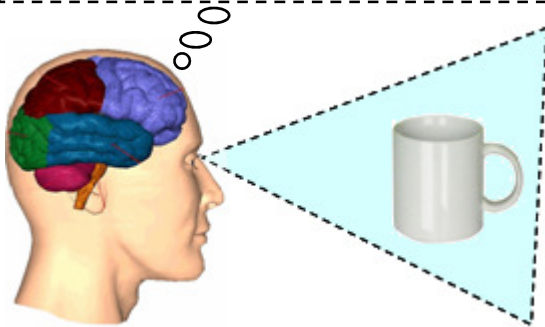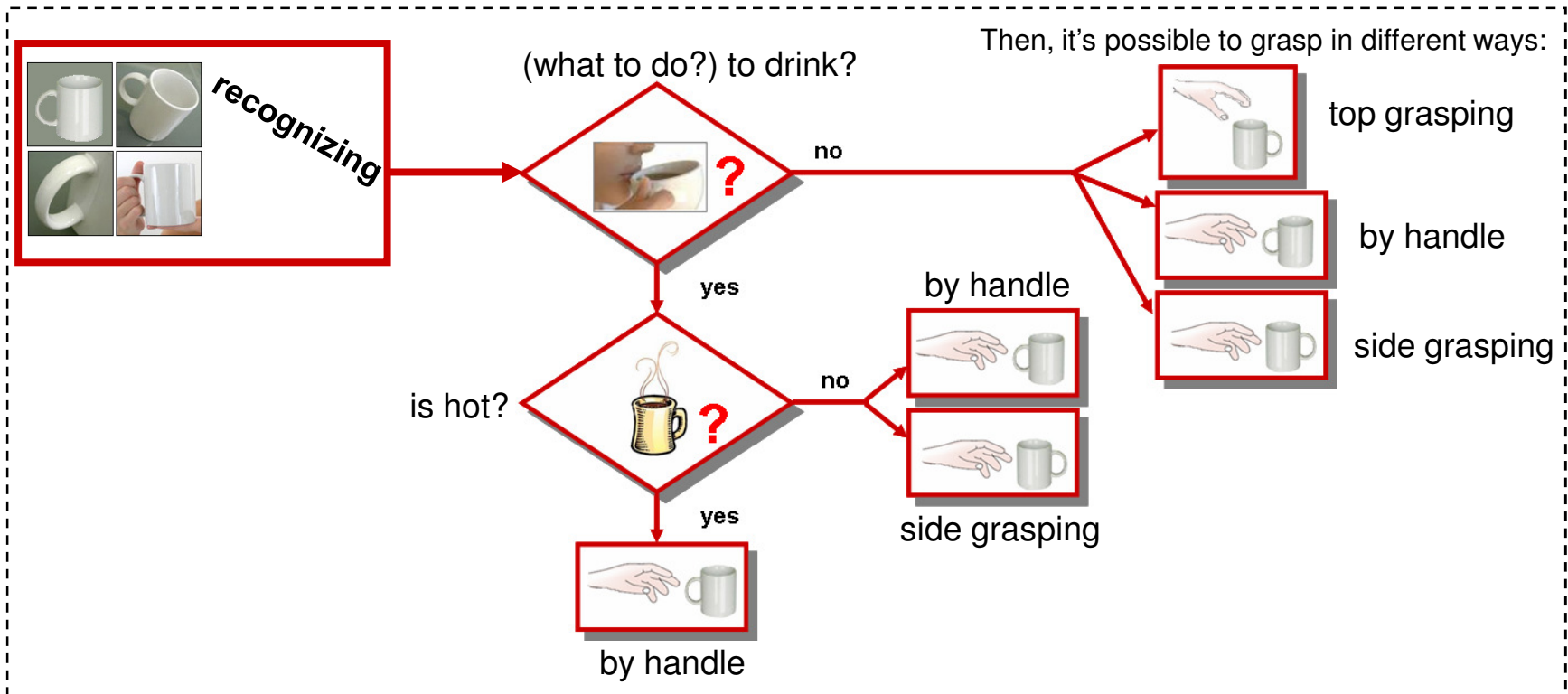
Object Characterization

- After object reconstruction by mapping, geometrical features can be extracted like contourn, lines, corners, etc. for the characterization of the object.

Object Affordance

recognizing

(what to do?) to drink?

Then, it's possible to grasp in different ways:

no → top grasping

by handle

side grasping

yes

is hot? ?

no → by handle

side grasping

yes → by handle

• Looking to object properties is possible getting some affordance according to its shapes, geometry, color, size and weight.

Object Affordance

- Observing activities performed with specific objects, the robot can learn how to use it (what to do with the object) and how to classify it by affordance properties. By visual information, methods of imitation learning are used to classify object and actions.

- The robot can be endowed with capabilities to discover affordances associated to manipulation actions applied to different object categories (different shapes, colors and sizes).
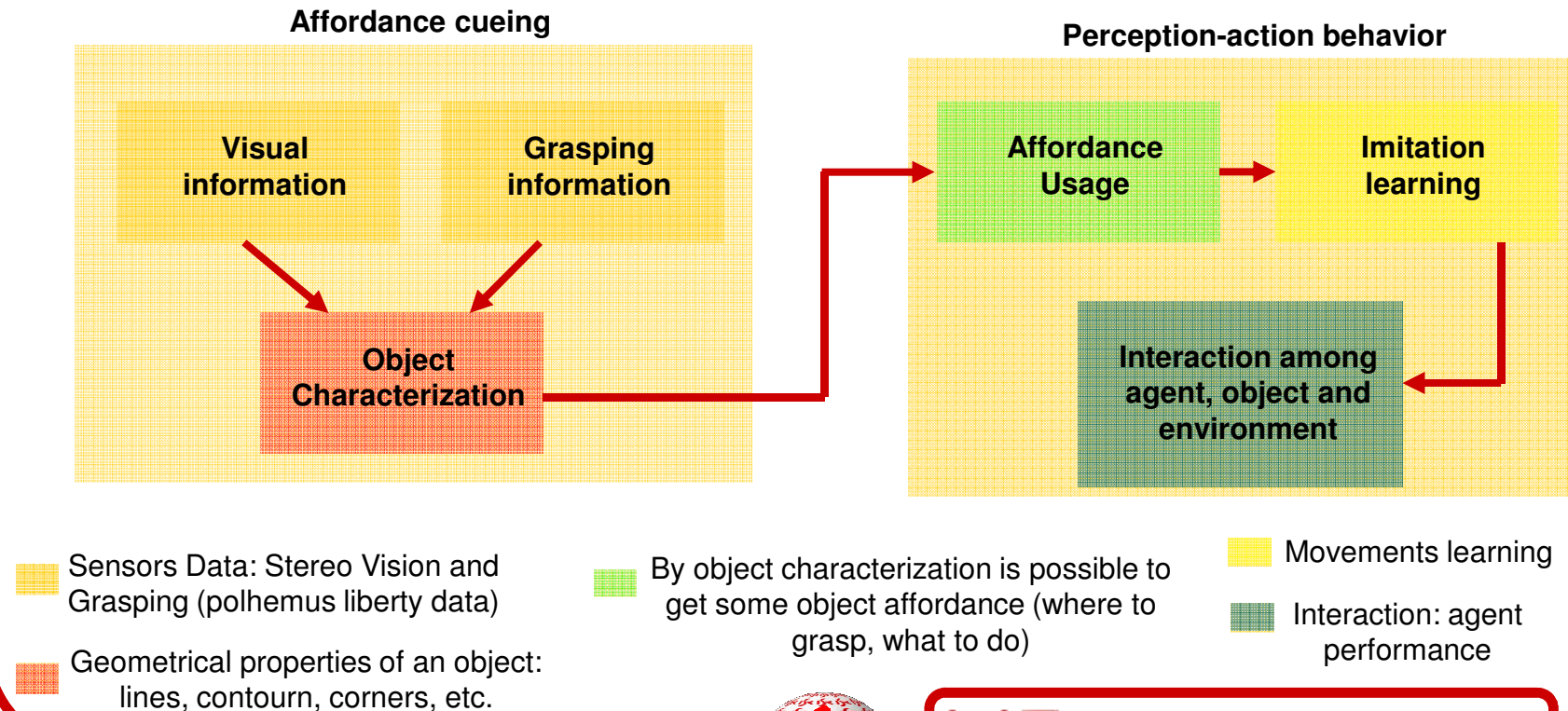
Object Affordance

- Affordance cueing based visual and grasping object representation (multimodal perception) aims achieving the perception-action behavior, that is, the interaction among an agent, an object and the environment.

- Our work can be divided in the following steps:

Affordance cueing

Perception-action behavior

Visual information	Grasping information

Object Characterization

Affordance Usage	Imitation learning

Interaction among agent, object and environment

Sensors Data: Stereo Vision and Grasping (polhemus liberty data)

Geometrical properties of an object: lines, contourn, corners, etc.

By object characterization is possible to get some object affordance (where to grasp, what to do)

Movements learning

Interaction: agent performance

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Thank you for your attention!

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