



# Semantic-aided visual grasping using a fuzzy description logic

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## Motivation and Objective

The aim is to build a system in which the objects are characterized by their parts to be used for grasp actions.

Every grasp action should not only have a geometric meaning as in (1), but also a functional meaning, namely a use-based description. For example, a fork can be grasped in many ways, but if the aim is to use it, then maybe we need just to know it has an handle. Furthermore, information coming from the real world is intrinsically not precise, so the description of the object should take this uncertainty into account.

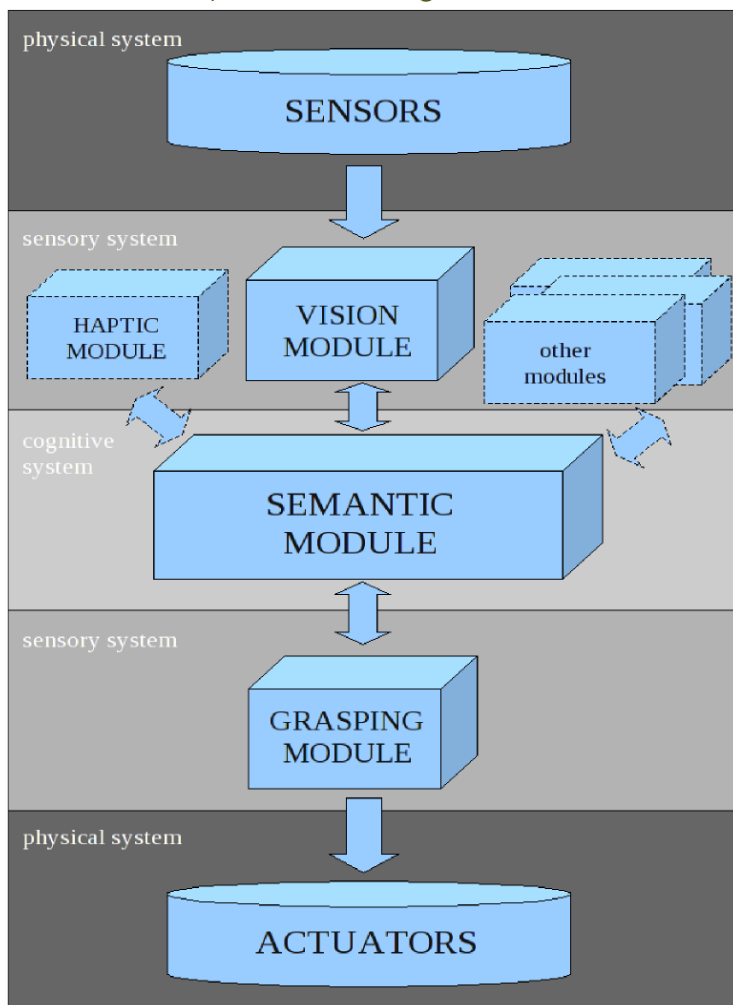
## The modules

The modules are structured as follows:

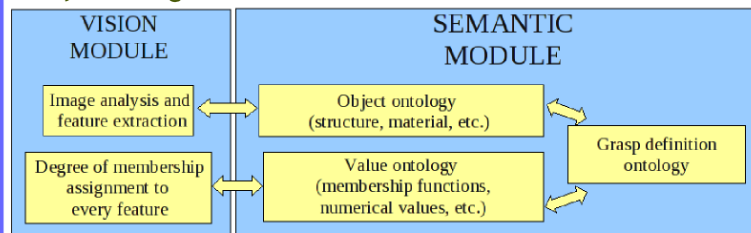
- the **vision module** extracts information from the image and to find the degree of membership to functions like *Big* or *Long*;
- the **semantic module** is used to define the concepts related to the geometric properties of the objects, the structure of the objects themselves and the types of grasps that can be used; moreover, it is used to perform the actual fuzzy reasoning to find the degree of membership of the object found in the image to a concept expressing a physical object, e.g. a fork.

## General architecture

The general architecture, including other sensory modules, is depicted in the figure:



The actually used modules are the vision module, implemented with MATLAB, and the semantic module, implemented with the experimental fuzzy reasoner FIRE (2) based on the f-SHIN logic.



## Examples

### Example TBox axioms:

Fork  $\equiv$  LongObject  $\sqcap$   $\geq 1$  hasHandle  
 $\sqcap$   $\geq 1$  hasEnding  $\sqcap$   $\geq 2$  hasTine

GraspableByHandle  $\equiv$   $\geq 1$  hasHandle  $\sqcap$  LongObject

NOTE:  $\geq pR$  used instead of  $=pR$  due to the OWA

Original image



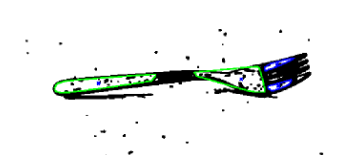
Whole object shape



Edge detection



Parts detection



### Example ABox assertions: LongObject(x)[ $\geq 1$ ]

hasHandle(x, p1)[ $\geq 0.88$ ]

Example semantics:  $(\geq pR)^T(a) = \sup_{b_1, \dots, b_p \in \Delta^T} \min_{i=1}^p R^T(a, b_i)$

## Conclusion and future work

Because of some limitations in the implementations, the domain is made up of few commonly used kitchen objects. We are planning to develop a more flexible f-SHIN reasoner and to include a stereovision system as well as other sensory modules.

(1) Cutkosky, M. R.: On grasp choice, grasp models, and the design of hands for manufacturing tasks. Robotics and Automation, IEEE Transactions on, 5(3):269-279, 1989.

(2) <http://www.image.ece.ntua.gr/~nsimou/FIRE>