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COGNIRON

The Cognitive Robot Companion

Integrated Project

Information Society Technologies Priority

D 7.3.1
Set-up of the Key Experiment
"Curious Robot"

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Executive Summary

This report presents the set-up of the Key Experiment 2, "The Curious Robot". This experiment is meant to illustrate two main cognitive functions that we want the robot to exhibit: initiative taking and curiosity for discovering new knowledge about the environment. We describe the main functions involved in two scripts emphasizing each of these functions. The first script describes a situation in which the robot notices that its action is required – without being explicitly asked for – and decides to act. In the second script, the robot notices novelty in its environment, such as a new object, and decides to explore it with available sensors. Then it interacts with a human to name it or to complete its newly acquired knowledge. Manipulation abilities and some navigation abilities are necessary to achieve this Key Experiment. We describe two robots that will be used, the first one is Rackham, a B21R, and the second is a Neobotix platform with a Mitsubishi PA10 arm.

Remark: This report is strongly linked to report 7.1.1 on the specification of the Key Experiments and should not be read independently.

1 Key Experiment "The Curious Robot"

1.1. Introduction

This scenario is a framework for research on cognitive capacities, and more precisely "learning", "taking initiative", "intentionality attribution and manifestation" and "curiosity", as examples of manifestation of cognition. The scenario emphasizes the following main issues :

- Acquisition of sensory-motor models of objects (i.e, also by manipulating them). This includes object categorization.
- Reasoning about objects for interaction and re-access
- Communication about objects for acquisition and as part of everyday interaction
- Acquisition of skills by interacting with the objects
- Reasoning about tasks
- Interpretation of human activities and posture
- Intention attribution (robot intention expression to be legible to the humans)
- Navigation taking explicitly into account the presence and the activity of humans
- Manipulation in interaction with humans and taking explicitely into account humans

Two separate scripts will be developed, one emphasizing robot initiative and intentionality, and the other robot curiosity.

1.2 Script 1: Robot initiative

To illustrate the capacity of taking initiative, we envisage a situation in which the robot notices that some object is missing to fulfill a given objective, and takes the initiative to fetch it without explicitely being asked for. The general set up is a room, a person and a robot. The overall script is as follows : the person is busy with a task. The robot is doing its own tasks and also observes the human whose gestures and actions are not meant towards the robot. From the observation, an object seems needed by the human. The robot then takes the initiative to interrupt its own task, and to plan a course of actions to fetch the missing object, giving it to the person or putting it close, if it has manipulation capacities. If not, it would only ask the person if the object is needed.

One scenario example would be a person sitting, taking a cup, not drinking and putting it down (Figure 1). The robot would assess that the cup is empty and asks if the person needs a drink. Another example is a person writing on a white board with a pen which is almost empty (the lines appear very faint on the board). The robot would fetch a pen or ask if it is needed.

The main issues here are related to reasoning about the task, intentionality, and initiative. (RA6), interpretation of human activities (RA2), object recognition (RA5), close interaction with humans (RA3). To a lesser extent, dialogue (RA1) is also concerned.

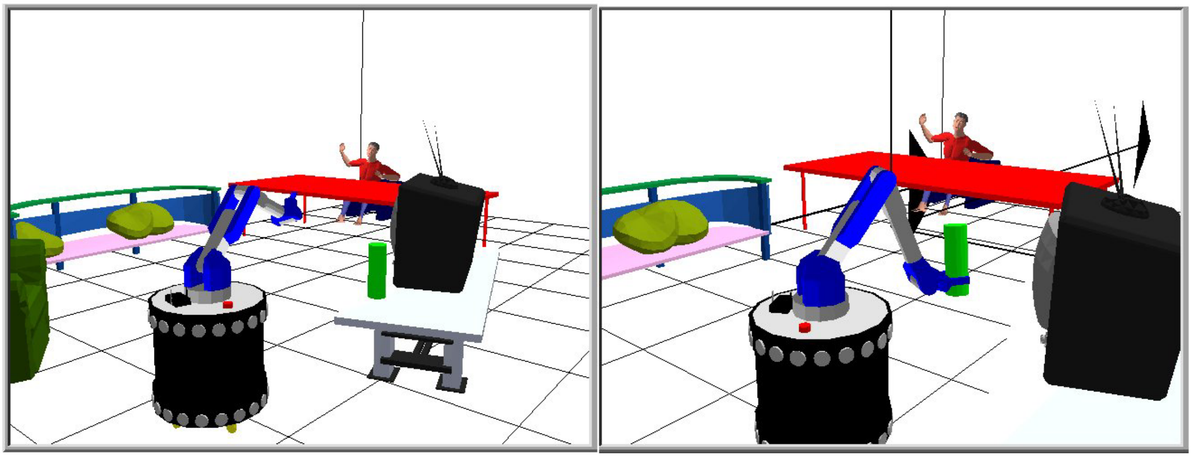

Figure 1. Illustration of a set-up for the initiative taking script : the robot brings an object to person.

1.3 Script 2: Robot curiosity

In this script, the robot exhibits a curoisity-driven behaviour. In its simplest expression, we consider a robot observing a table top. A person puts an object (e.g., a cup, a pen or a box) on the table. Upon detecting novelty in its field of view, the robot starts sensing the object with its sensors, including grasping it if possible, looking at it from different viewpoints. The robot then asks the human about some properties of the object (naming it, relation to other known objects or concepts, ...). A variant is to consider the robot to be already performing a task when new objects appear in its vicinity. These would enable to investigate the role of context in concept formation, and the trade off between achieving a task and acquiring new knowledge. The robot is driven by a need to increase its knowledge level or information quantity. Information acquisition can be considered as a "value" driving robot behavior.. One question to address is how does this interact with other values and other « motivations »?

Here the issues are taking initiative to explore and increase own knowledge (RA6), concept formation and categorization of objects (RA5), acquisition of skills to manipulate objects (RA4), communication about objects (RA1).

1.4 Robots to be used

The robot Rackham

Rackham is a B21r robot made by iRobot. It is a cylindrical robot (53cm x 185cm, 140kg) with 4 driving wheels. It is equipped with 3 Intel Pentium III processors under Linux, IEEE 802.11b Wireless lan (11Mb/s), odometry and an optical fiber gyroscope, 48 Sonar range sensors, 24 Infrared proximity sensors, 1 Sick® 2D Laser Range Finder, 2 color cameras on pan & tilt platforms, a flat panel touch screen, speech synthesis and loudspeakers (Figure 2).

Figure 2. The robot Rackham

Current Architecture of Rackham

The software architecture is an instance of the LAAS architecture [1]. It is a hierarchical architecture including a a number of modules and a supervisor written with openPRS (tools for building modules and the supervisor are freely distributed at http://softs.laas.fr/openrobots). A module is an independent software component that can integrate all the operational functions with various time constraints or algorithmic complexity (control of sensors and actuators, servo-controls, monitorings, data processings, trajectory computations, etc.). The robot has a graphical interface on the touch screen which displays maps, status, and a talking head. Figure 3 shows the current architecture of Rackham.

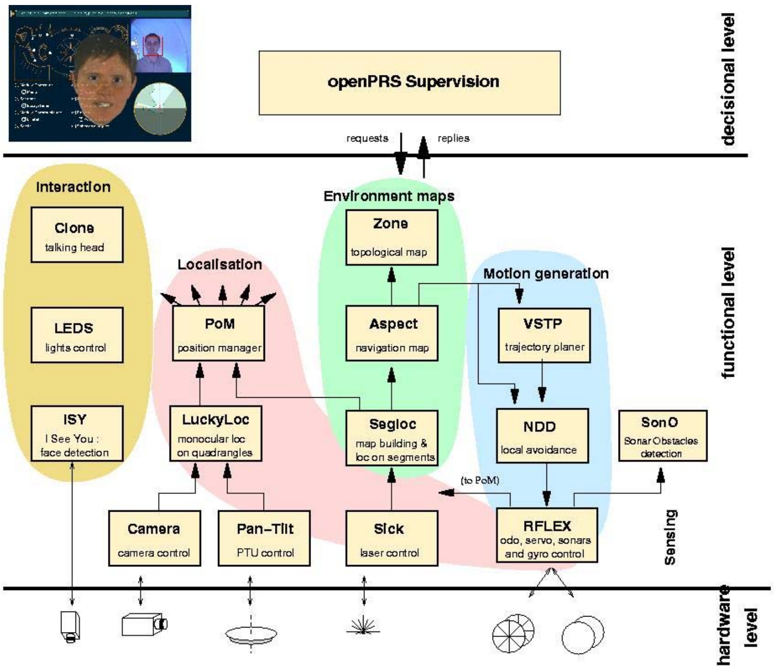

Figure 3. Current software architecture of Rackham

The Neobotix Platform

This robot (Figure 4) is currently being acquired by LAAS. It is equipped with a Mutsubishi PA-10 manipulator. It is a "cubic" robot (square footprint: 65.5 cm x 65.5 cm, height: 56 cm, weight: 150 kg). it is equipped with a Pentium III and a flat display, odometry, gyro, two sick lasers, a stereo head and Wireless Ethernet (IEEE 802.11).

Figure 4. The Neobotix Platform

1.6 Related Cogniron Functions

The main cogniron functions to be used in this key experiment are described in the specification document 7.1.1:

CF-IA: Intentionality attribution
The outcome of this function, resulting from user studies, will be mostly used as source of guidelines to design the robot behaviour in such a way that it gives indications on its decisions and initatives to the human.

CF-SOC: Socially acceptable interaction with regard to space
Similarly, this function will provide guidelines for close interaction with humans when handling objects to them or putting objects in their vicinity. This is necessary in the initiative taking scenario when the robot will bring an object to the person.

CF-OR: Object recognition and modeling
This is a main function in both scripts. In the initiative taking script, we suppose a known object shape and location. Therefore, the main issue is object recognition using a known model. The main perceptual modality will be stereo. In the curious robot script, object modelling from multiple views, vision being the main sensor, and from manipulation is the central issue.

CF-RET: Reasoning about tasks, about own abilities
This function is central for initiative taking. Situation assessment for taking initiative is followed by action planning for the achievement of the goal of fetching the missing object. This requires a representation of robot capacities, and a means to synthesise a course of action to achieve the goal which is not given explicitly to robot. That last issue is an important novelty since in classical planning, the goal is given to the system.

CF-NHP: Navigation in the human presence
There is a close interaction with humans in the initiative taking scenario. Navigation and manipulation in presence of humans and for handling objects to human will be two important functions here. Currently rackham can navigate in presence of humans considering them in two fashions: either as obstacles to avoid or as people to guide. In the former case, humans are not recognised as such. However, navigation in human environments is considered by computing trajectories that anticipate their presence [2]. In the latter case, there is a face detection and tracking system. The navigation capacities will be developed to consider different speeds of motion in presence of humans or other objects as well as face recognition mechanisms.

CF-MHP: Manipulation in the human presence
The Neobotix platform with the PA10 manipulator will be the robot used in this case. The manipulation system will have force feedback and will be visually guided. A motion planning system based on the Move3D platform [3] developed at LAAS will be used, and motion control will integrate these two modalities.

CF-ACT: Detection and interpretation of human activities and postures
This function will be used to detect the human activity going on in the initiative taking script. It is the first step to recognise the situation and to assess that a component is missing.

Other functions will be also used, even if they are not the focus of this Key Experiment:

CF-DLG: Multi modal dialog
CF-PTA: Person tracking and detection of attention
CF-TBP: Tracking of human body parts for observation

2 Future work

In the next phase, the integration of the Neobotix robot will be a first step towards implementing the key experiment. A navigation system based on state of the art capabilities will be implemented as well as a software controller for sensor-based manipulation.

The experimental scenarii will be refined as well as the specific functions to be demonstrated and their coherent integration.

Several functions and algorithms will be incrementally demonstrated in isolation.

3 References

3.1 Applicable documents

Deliverable D3.5.1: Architecture of the placement planner for human-robot close interaction.
Deliverable D6.1.1: Specification of an architecture for a cognitive robot.
Deliverable D7.1.1: Specification of the COGNIRON Key-Experiments,

3.2 Reference Documents

[1] R. Alami, R. Chatila, S. Fleury, M. Ghallab, F. Ingrand An Architecture for Autonomy. International Journal of Robotics Research. Special Issue on ``Integrated Architectures for Robot Control and Programming'', Vol 17, N° 4, Apri1 1998.

[2], K. Madhava Krishna, R. Alami and T. Simeon. Safe Pro-active Plans and their Execution. submitted to Robotics and Autonomous Systems.

[3] T. Siméon, J-P. Laumond, J. Cortès, A. Sahbani. Manipulation Planning with Probabilistic Roadmaps. International Journal of Robotics Research, Vol 23, N° 7-8, August 2004.