DEXterous and autonomous dual-arm/hand robotic manipulation with sMART sensory-motor skills: A bridge from natural to artificial cognition

COGNITIVE SYSTEMS

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Goal

DEXMART is focused on artificial systems reproducing smart sensory-motor human skills, which operate in unstructured real-world environments. The emphasis is on manipulation capabilities achieved by dexterous and autonomous dual-arm/hand robotic systems. The goal is to allow a dual-arm robot including two multi-fingered redundant hands to grasp and manipulate the same objects used by human beings.

Research Issues

Bimanual manipulation of objects in an unstructured environment is a complex task which is a compound of different strategies, constraints, goals and actions at the same time. The robotic system has to possess the ability to autonomously decide between different manipulation options. It has to properly and quickly react to unexpected situations and events as well as understand changes in the behaviour of humans cooperating with it. Moreover, in order to act in a changing scenario, the robot should be able to acquire knowledge by learning new action sequences so as to create a consistent and comprehensive manipulation knowledge base through an actual reasoning process.

Key Innovations

The project attempts to extend a bridge from research on natural cognition to research on artificial cognition, as it will primarily contribute to the development of dual-arm/hand robotic systems operating with a high degree of autonomy. The key innovations are:

- development of original approaches to interpretation, learning, and modelling, from the observation of human manipulation at different levels of abstraction;
- development of novel techniques for task planning, coordination and execution so as to confer to the robotic system self-adapting capabilities and reactivity to changing environment and unexpected situations, also in the case of humans cooperating with it;
- design of effective control strategies for a dual-hand/arm robot manipulator that can be easily parameterised so as to preserve smoothness during the transitions at the contact with objects;
- design and development of new actuators and sensors, as well as mechanical structures and materials, able to overcome the limitations of current manipulation devices;
- development of meaningful benchmarks for dual-hand manipulation.

Expected Impact

The achievement of the research objectives proposed within the project will have an important impact toward the realisation of a robust and versatile behaviour of artificial systems providing intelligent response in unforeseen situations, and enhancing human-machine interaction. DEXMART has the ambition to fill the gap between the use of robots in industrial environments and the use of future robots in everyday human and unstructured environments, contributing to reinforce European competitiveness in all those domains of personal and service robotics where dexterous and autonomous dual-hand manipulation capabilities are required.