GeRT

GENERALIZING
ROBOT
MANIPULATION
TASKS

TEACHING THE USE OF FUNCTIONAL OBJECT CLASSES THROUGH LEARNING BY DOING!

Once you have successfully handled a number of different cups you can handle and use them all. That means you have comprehended the function of this object class beside its actual geometry.

Currently robots, like Justin, can perform simple tasks such as making a drink. This task involves many actions, such as grasping a cup, which are encoded as rules or programs. Currently the rules for how to pick up each different cup must be programmed by a human. So the ability to manipulate five different cups means writing five different programs. To overcome this limitation, we take a small set of existing programs for the same manipulation task (e.g. tea making). These form a database of prototype solutions to the task.
Suppose Justin is confronted by a novel instance of the same task, such as making tea with differently shaped cups and jugs. Now to solve the task the robot needs to adapt its existing prototype solutions. To do this it must first establish appropriate correspondences between objects and actions in the prototype solutions and their counterparts in the novel scenario.

PROJECT

Planning

When confronted with a new task instance the robot must plan tasks on a logical level through generalized planning actions that in turn allow the generation of robot programs on the fly, which can be executed on the Justin platform. The project partners will develop a hybrid planner which accounts for the geometric constraints on individual manipulations that arise from the task. Also methods will be developed to generate plans for previously unknown instances of objects.

Perception

The visual system has to recognize functional object categories and parts, producing a geometrically detailed and precise interpretation of the scene. In GeRT, we will establish detailed correspondences between the surfaces of unknown objects in the scene and the surfaces of objects of the same category stored in a database. We therefore rely on range data taken from the scene and on detailed 3D object models respectively. The functional object categories have to be learned from just a few examples with a substantial degree of shape variation within each class. To achieve this specially tailored metrics to measure shape similarity will be developed.

Learning

Sensory input as well as abstract task state information will be taken from a few successful example programs produced by robotics experts. The robot will use these examples to learn generalized planning actions and action models suitable for an AI planning system. The focus will be on automatic acquisition of pre- and post conditions from the example programs. Additionally grasp controllers will be automatically found which either implicitly represent the task information or explicitly generalize the structure of the controller through examples and physical simulation.

Integration

The Justin system at DLR is one of the most advanced robotic manipulation platforms in the world. In GeRT, its state of the art robot control system will be adapted to the needs of the hybrid planners and generalized robot programs. Ways will be defined to model the effects of its actions so that they can be propagated to the higher level planning system. A major goal is to demonstrate a known functional task on a previously unknown set of objects.

CONSORTIUM

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SEVENTH FRAMEWORK PROGRAMME

GeRT

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