robOCD: Robotic Order Cups Demo
An Interactive Domestic Service Robotics Demo

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The Bigger Picture

- Application in Domestic Service Robotics (DSR) as is aimed for in RoboCup@Home league [3]
- Combine modules for interaction with deliberation
- Make use of sophisticated logic-based high-level control which allows for decision-theoretic planning like in [10]

The Robot Caesar

- Intelligent domestic service robot [6]
- Based on former soccer platform
- Component-based control software [7]
- Logic-based [9] high-level control using a Golog [2] dialect called ReadyLog [1]

The Perception

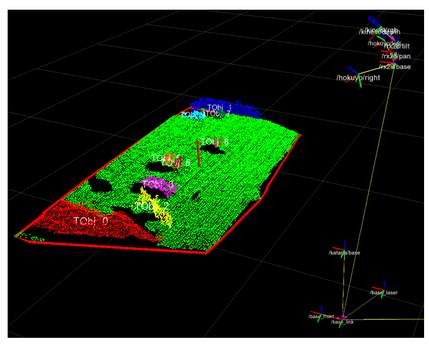
- Data from RGB-D camera (Kinect)
- Fit model for tables and cups

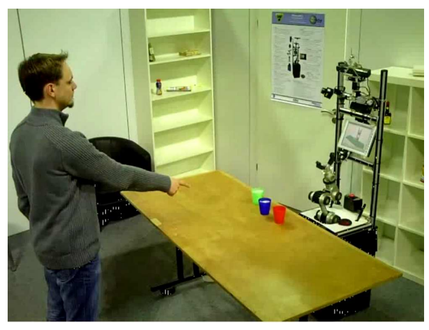
The Interaction Modules

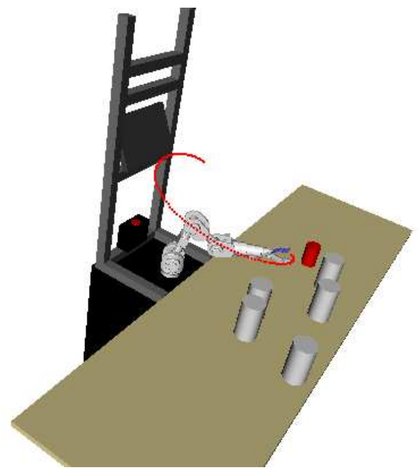
- Robust speech recognition [4]
- 3D (pointing) gesture recognition [5]
- Post output to central blackboard

The Execution Cycle

- Robot perceives scene with initial cup setup and generates local model for motion planning
- User anounces color of cup to place at a position and indicates the desired positions with pointing
- Robot starts planning to compute a program that re-orders the cups with a minimum #moves
- Robot plans trajectories using OpenRAVE [11] and moves cups with 5 DOF arm (Katana6M)







The Task

- Robot should help re-decorating the table
- Gather desired setup of cups on desk from user
- Come up with optimal course of action wrt #moves

The High-level Program

ReadyLog [1] program for robOCD.

- p_1 to p_4 denote four positions on the table
- I_i and P_i are variables that hold color of cup at position i in initial and goal situation, respectively
- $pos(C)$ returns position of cup with color C

```
1  proc order_cups_demo,
2     get_Initial_Order(I1, I2, I3);     %% perceive initial order
3     get_Goal_Order(P1, P2, P3);        %% inquire about goal order
4     sort_cups(P1, P2, P3, 4);          %% start planner
5  endproc

6  proc sort_cups(P1, P2, P3, H),
7     solve(H, reward_cup(P1, P2, P3),
8        while(¬(p1 = pos(P1) ∧ p2 = pos(P2) ∧ p3 = pos(P3))) do
9           pickBest(cup, {red, green, blue},
10             pickBest(to, {p1, p2, p3, p4}, move_cup(cup, pos(cup), to)))
11       endwhile
12    endsolve
13 endproc
```

The Result of Planning

Simplified ReadyLog policy for example run

- initial order was “green, blue, red”
- desired order is “red, green, blue”

```
1  exogf_Update, if ¬done then
2     move_cup(blue, cup_position(blue), p4),
3     exogf_Update, if ¬done then
4        move_cup(green, cup_position(green), p2),
5        exogf_Update, if ¬done then
6           move_cup(red, cup_position(red), p1),
7           exogf_Update, if ¬done then
8              move_cup(blue, cup_position(blue), p3)
9  done
```

Extended Scenario

- Robot drives around looking for tables
- Moves cups from one table to another
- Uses localization & path planning
- Shown at RoboCup German Open & int’l conf.

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