iTaSC 2.0
Human-Robot Comanipulation Demo

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version 0.1

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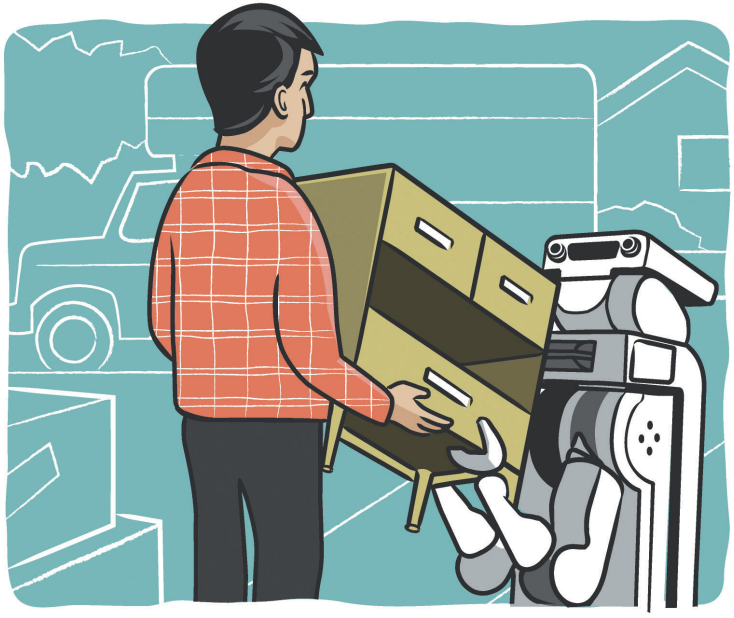
Example

Mobile co-manipulation task of a human and a PR2-robot



Tasks:

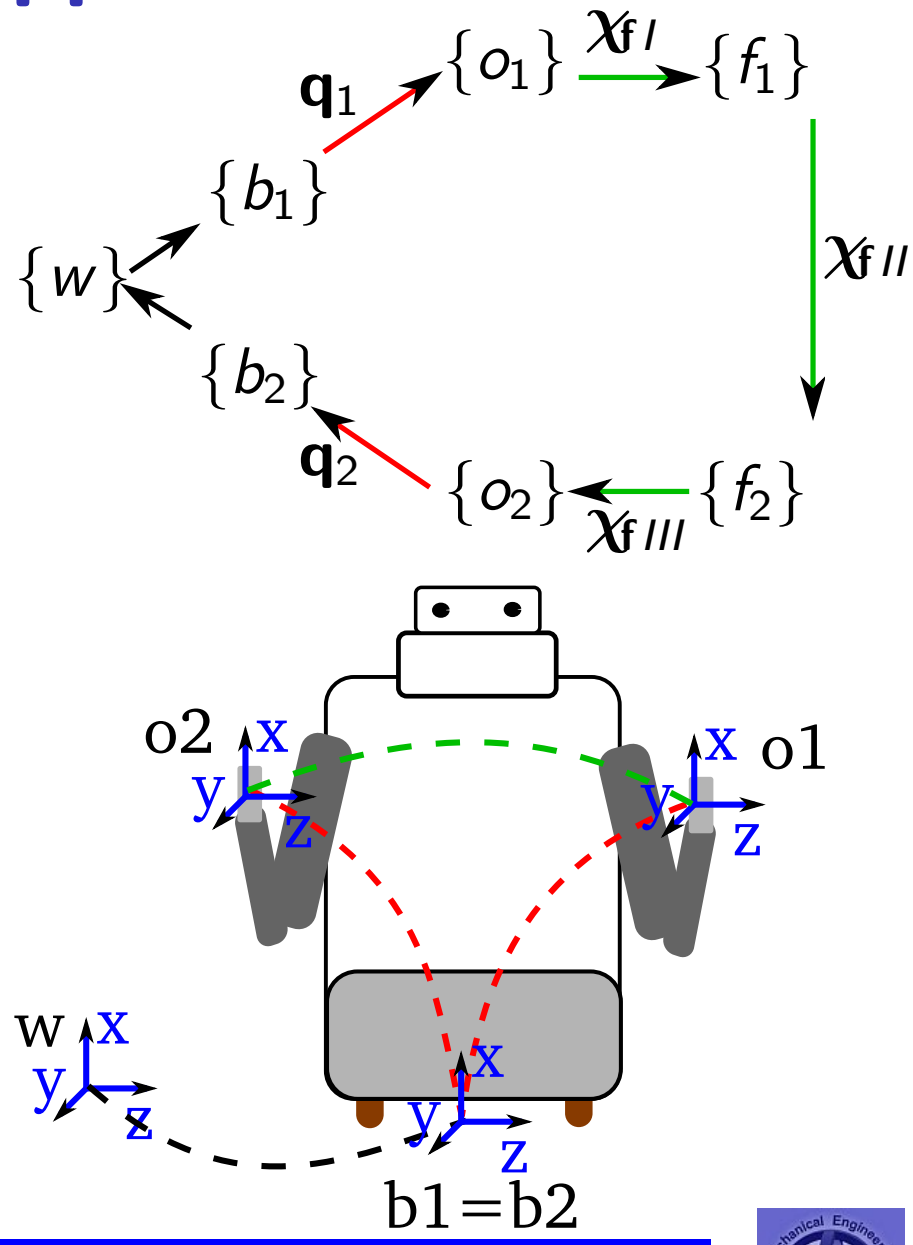
- Track the head of the human
- Null the force exerted on the left arm
- Null the force exerted on the right arm
- Stay away from joint limits
- Keep the grippers parallel at a chosen distance
- Avoid obstacles

Example

A movie is available at:
http://people.mech.kuleuven.be/~dvanthienen/IROS2011PR2/

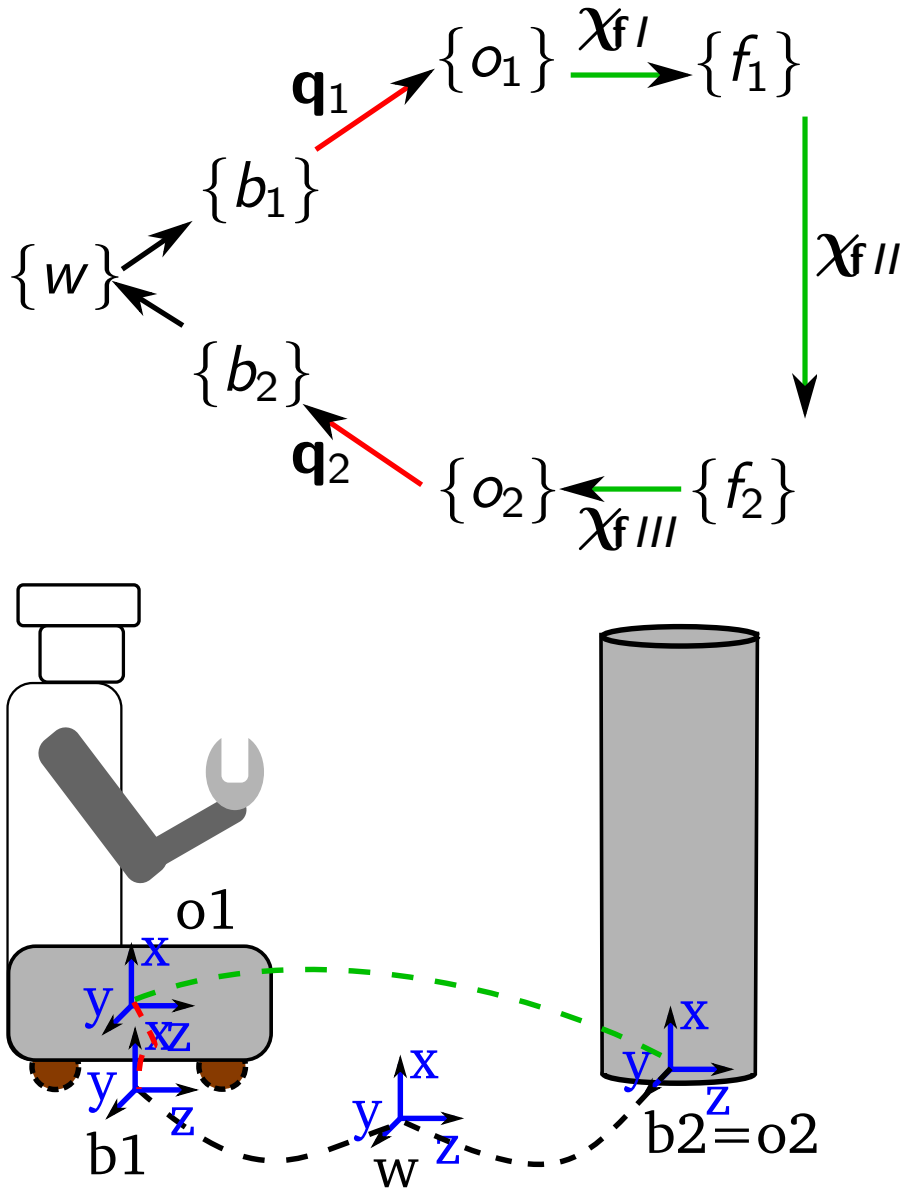
Task 1: Keep Grippers Parallel

- frames
  - $o_1 = f_1 =$ left gripper
  - $o_2 = f_2 =$ right gripper
- feature coordinates
  - $\chi_{\mathbf{f}\,I} = (\text{-})$
  - $\chi_{\mathbf{f}\,II} = (x,\, y,\, z,\, \phi,\, \theta,\, \psi)$
  - $\chi_{\mathbf{f}\,III} = (\text{-})$
- outputs
  - $\mathbf{y} = \chi_{\mathbf{f}} = \chi_{\mathbf{f}\,II}$
- constraint equations
  - $y_{1d} = x_d = 0\ m$
  - $y_{2d} = y_d = 0\ m$
  - $y_{3d} = z_d = 0.3\ m$
  - $y_{4d} = y_{5d} = y_{6d} = 0\ rad$



Task 2: Obstacle Avoidance

- frames
  - $o_1 = f_1 =$ robot moving base
  - $o_2 = f_2 =$ center of obstacle
- feature coordinates
  - $\chi_{f\,I} =$ (-)
  - $\chi_{f\,II} = (\theta,\ r,\ z,\ \alpha,\ \beta,\ \gamma)$
  - $\chi_{f\,III} =$ (-)
- outputs
  - $\mathbf{y} = r$
- constraint equations
  - $y_{2d} = r_d = 1\ m$



Task 3: Joint Limits

- frames
  - none needed
- feature coordinates
  - none needed
- outputs
  - $\mathbf{y} = \mathbf{q}$
- constraint equations
  - $\dot{y}_d = \dot{\mathbf{q}}_d$ (figure 1)
- weight
  - task activated close to the limit
  - weight increases closer to the limit
  - shown in figure 2

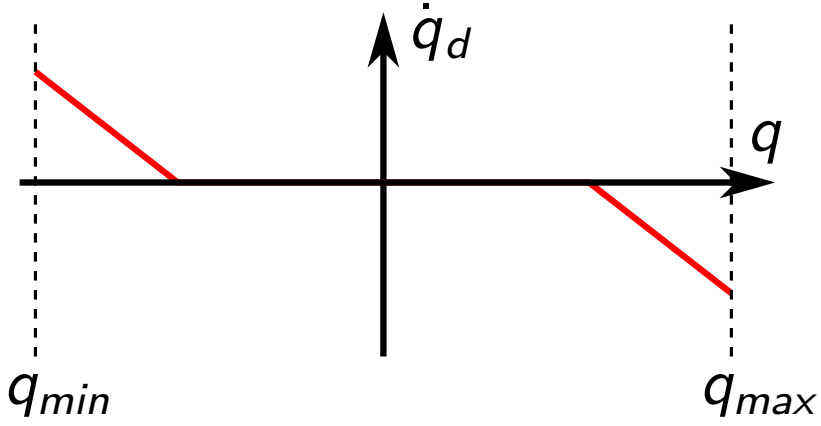


Figure: Constraint

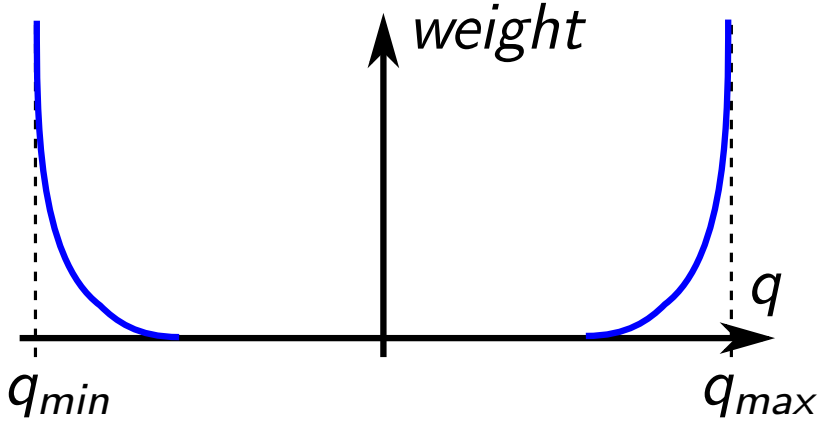
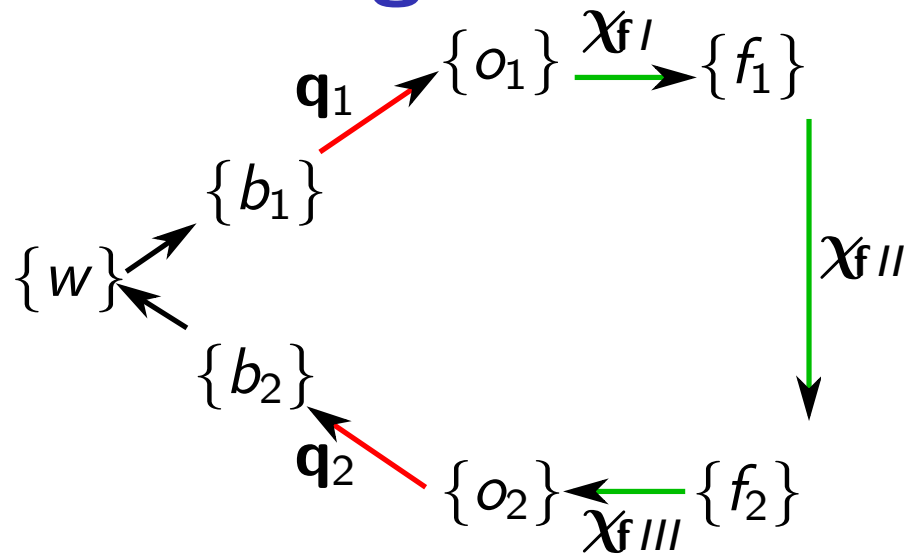
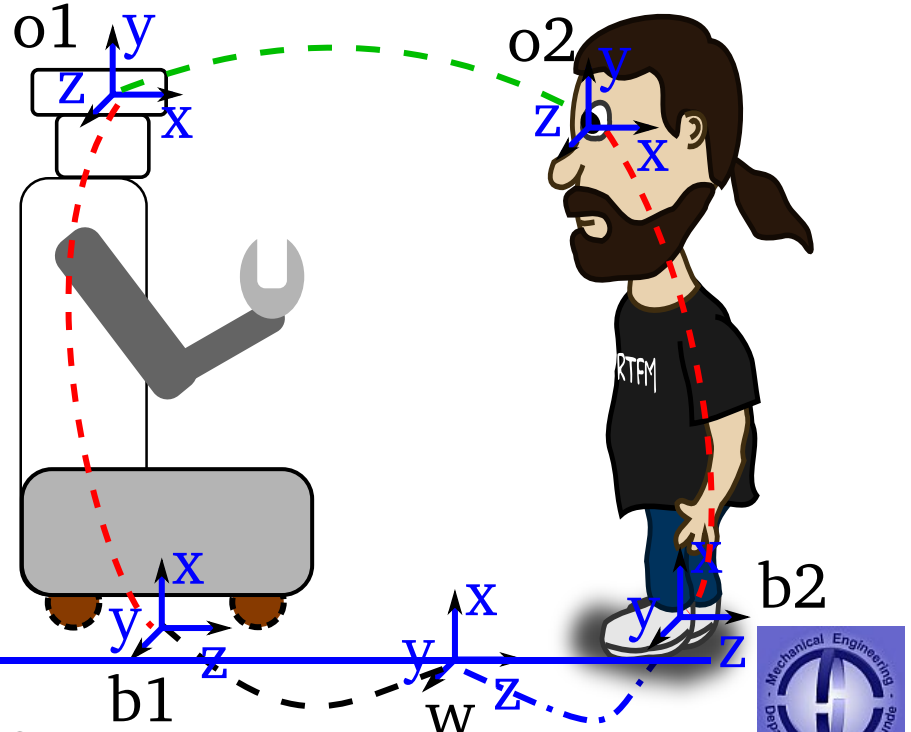


Figure: Weight

Task 4: Head Tracking

- frames
  - $o_1 = f_1 =$ robot head
  - $o_2 = f_2 =$ head of person
- feature coordinates
  - $\chi_{f\,I} = (\text{-})$
  - $\chi_{f\,II} = (x, y, z, \phi, \theta, \psi)$
  - $\chi_{f\,III} = (\text{-})$
- outputs
  - $\mathbf{y} = y, z$
- constraint equations
  - $y_{2d} = y_d = 0\ m$
  - $y_{3d} = z_d = 0\ m$

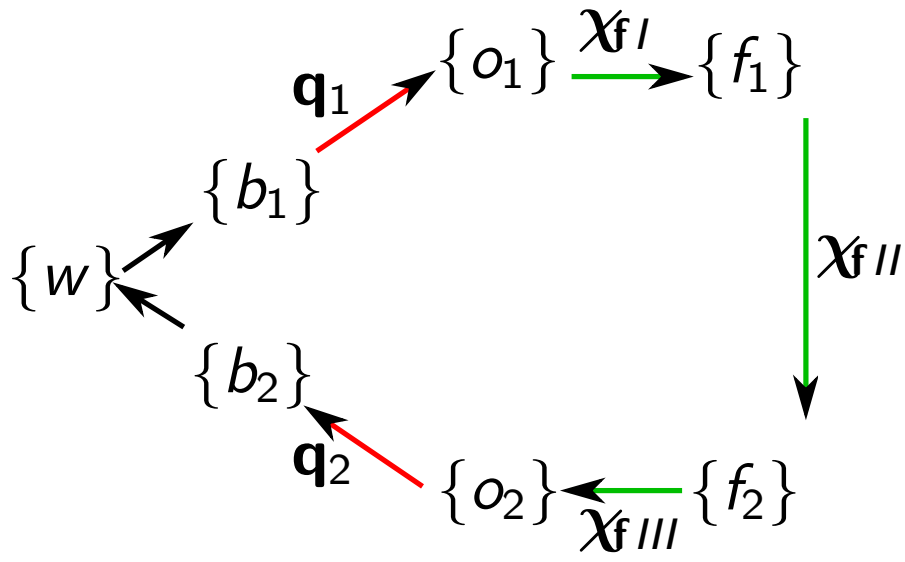




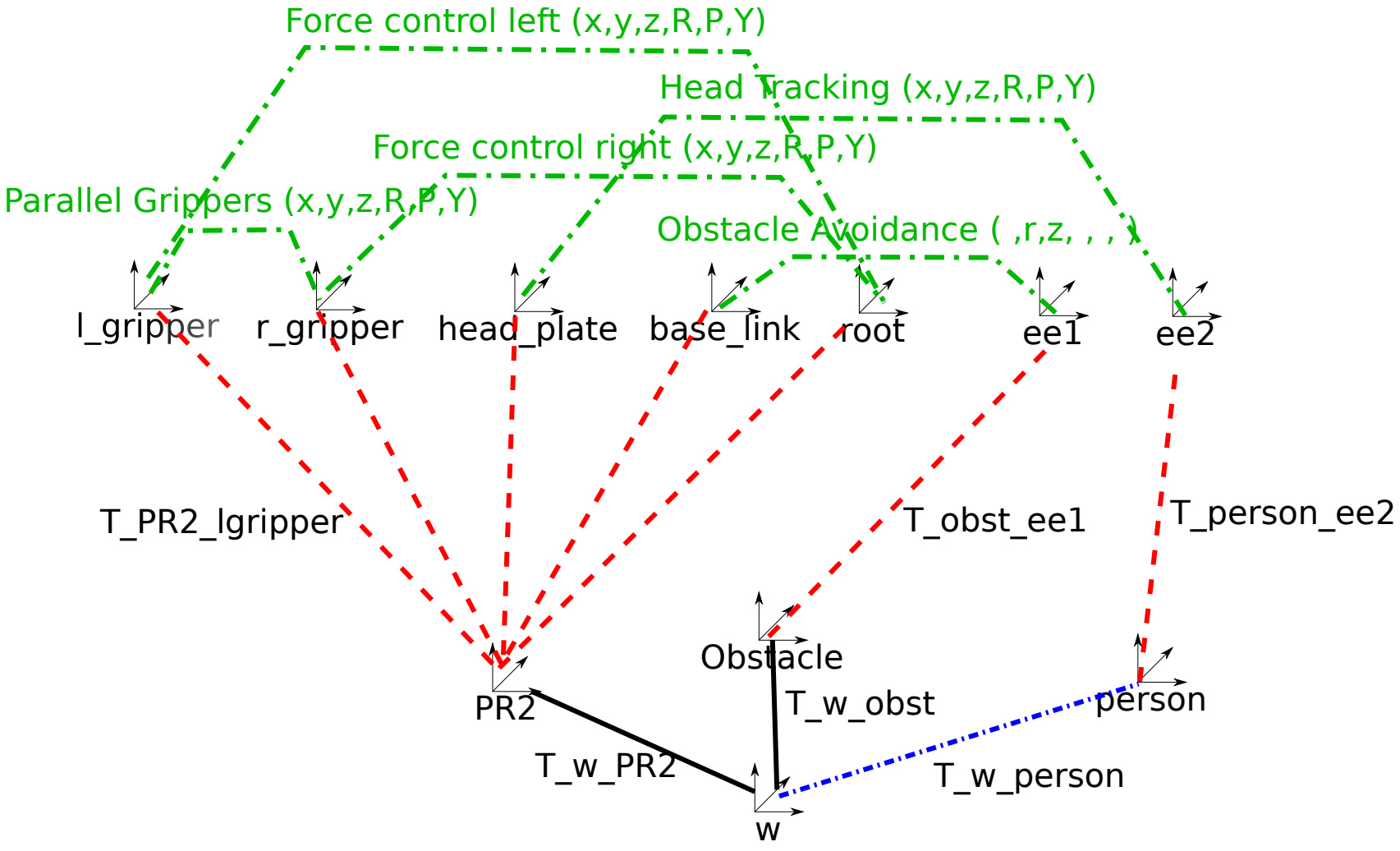
Task 5: Force Nulling

Right arm (similar for left arm):

- frames
  - $o_1 = f_1 = b_1$ = robot fixed base
  - $o_2 = f_2$ = robot right gripper
- feature coordinates
  - $\chi_{\mathbf{f}\,I} = (\text{-})$
  - $\chi_{\mathbf{f}\,II} = (x,\ y,\ z,\ \phi,\ \theta,\ \psi)$
  - $\chi_{\mathbf{f}\,III} = (\text{-})$
- outputs
  - $\mathbf{y} = \chi_{\mathbf{f}} = \chi_{\mathbf{f}\,II}$
- constraint equations
  - $\dot{\mathbf{y}}_d = \mathbf{t}_d = \mathbf{J}_{\mathbf{q}}(\dot{\mathbf{q}}_d - \dot{\mathbf{q}})$



Overview


Force control left (x,y,z,R,P,Y)
Head Tracking (x,y,z,R,P,Y)
Force control right (x,y,z,R,P,Y)
Parallel Grippers (x,y,z,R,P,Y)
Obstacle Avoidance (,r,z, , ,)
l_gripper
r_gripper
head_plate
base_link
root
ee1
ee2
T_PR2_lgripper
T_obst_ee1
T_person_ee2
Obstacle
PR2
T_w_obst
person
T_w_PR2
T_w_person
w