SBCCR LAB report

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Group-1/2

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Chapter 1

Lab3

The goal is this lab is to control a mobile robot equipped with a pan-tilt camera.

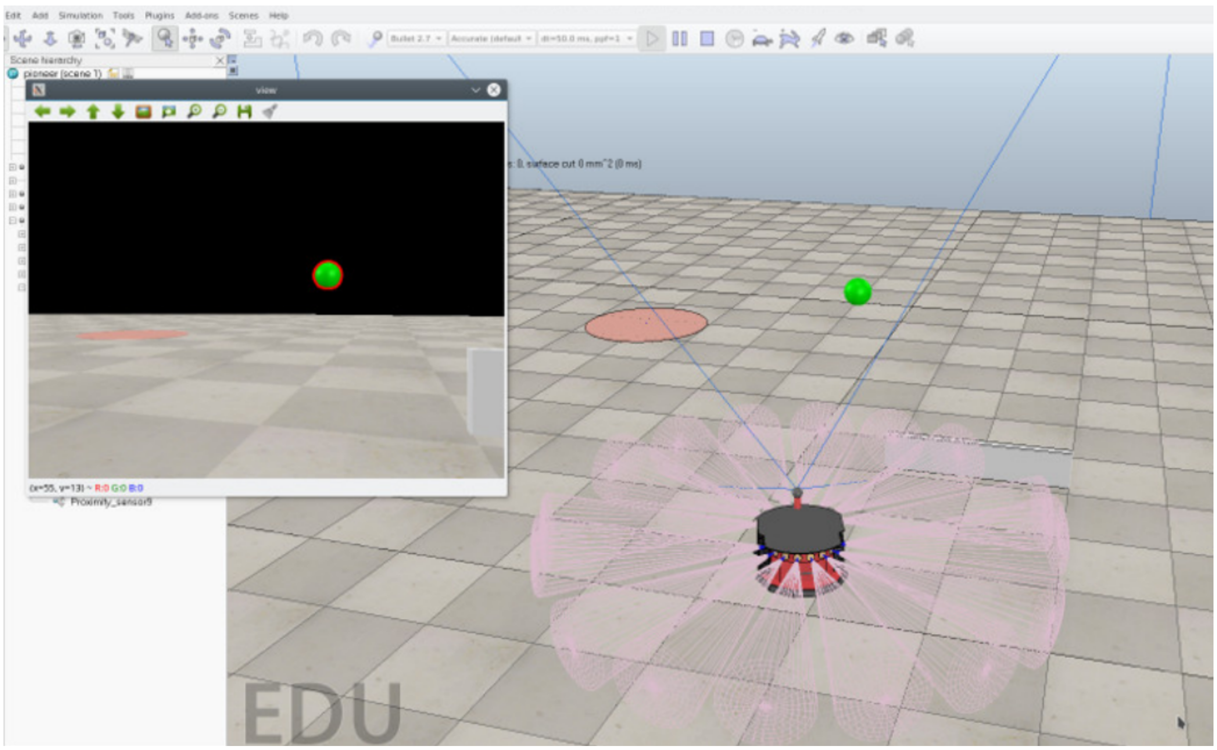

Figure 1.1: V-REP simulation with lab3

The website of this project is: `https://github.com/oKermorgant/ecn_sensorbased.git`
To use the simulation by clicking the play button and then use the commond
rosrun ecn_sensorbased pioneer

1.1 Desired Feature

In our cases, we have two set of desired feature:

1. The desired linear velocity and angular velocity
2. The desired joint velocity, which control the visibility

1.1.1 Position control

To get the desired position, we need to calculate the velocity of robot in case of sending the velocity to the robot in each iteration and then arrive the target. So we have:

$$\begin{cases} v^* = \lambda_v(x-d) \\ \omega^* = \lambda_\omega atan2(y,x) \end{cases} \tag{1.1}$$

x and y is the distance between the robot and the target along the x axis and y axis. So we can control the linear velocity and angular velocity there by the simply equation.
And the d here is the safe distance in case of when x and y is equal to zero and the value of atan2 is discontinue.
We would like to minimize the distance of trajectory by minimizing the velocity using following equations:

$$argmin\|(v-v^*)^2 + (\omega-\omega^*)^2\| \tag{1.2}$$

Under constraints(the velocity limits for each wheel):

$$\begin{cases} |\omega_l| < |\omega_{max}| \\ |\omega_r| < |\omega_{max}| \end{cases} \tag{1.3}$$

with

$$\begin{cases} v = \frac{r}{2}(\omega_l + \omega_r) \\ \omega = \frac{r}{2b}(\omega_l - \omega_r) \end{cases} \tag{1.4}$$

And the constraints(to make the robot follow the trajectoty we got previous

$$\frac{v}{\omega} = \frac{v^*}{\omega^*} \tag{1.5}$$

1.1.2 Visibility control

To make the sphere always in the image, we need to limit the position of sphere under the image limit.

$$\begin{cases} x^- \leq x_{sphere} \leq x^+ \\ y^- \leq y_{sphere} \leq y^+ \end{cases} \tag{1.6}$$

1.1.3 QP solver

Assuming the following formulation:

$$x = argmin\|Qx - r\|^2 \tag{1.7}$$
$$s.t. Ax = b \tag{1.8}$$
$$s.t. Cx \leq d \tag{1.9}$$

And we need the (Q,r,A,b,C,d,x)
with dimention:
$Q = 2 \times 4$,
$r = 2 \times 1$,
$A = 4 \times 4$,
$b = 4 \times 1$,
$C = 8 \times 4$,
$d = 6 \times 1$,
$x = 4 \times 1$
In our cases the $\dot{q} = (v, \omega, \dot{q}_p, \dot{q}_d)$
$x = argmin\|Qx - r\|^2$ regards to $argmin\|(v - v^*)^2 + (\omega - \omega^*)^2\|$

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} v \\ \omega \\ \dot{q}_p \\ \dot{q}_d \end{bmatrix} - \begin{bmatrix} v^* \\ \omega^* \end{bmatrix} = 0 \tag{1.10}$$

$Ax = b$ regard to $\frac{v}{\omega} = \frac{v^*}{\omega^*}$

$$\begin{bmatrix} \omega^* & -v^* & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} v \\ \omega \\ \dot{q}_p \\ \dot{q}_d \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} = 0 \tag{1.11}$$

$Cx \leq d$ regard to $\begin{cases} x^- \leq x_{sphere} \leq x^+ \\ y^- \leq y_{sphere} \leq y^+ \end{cases}$ and $\begin{cases} |\omega_l| < |\omega_{max}| \\ |\omega_r| < |\omega_{max}| \end{cases}$

$$\begin{bmatrix} \frac{1}{r} & -\frac{b}{r} & 0 & 0 \\ \frac{1}{r} & \frac{b}{r} & 0 & 0 \\ -\frac{1}{r} & \frac{b}{r} & 0 & 0 \\ -\frac{1}{r} & -\frac{b}{r} & 0 & 0 \\ J_c & & & \\ -J_c & & & \end{bmatrix} \begin{bmatrix} v \\ \omega \\ \dot{q}_p \\ \dot{q}_d \end{bmatrix} - \begin{bmatrix} w_{max} \\ w_{max} \\ w_{max} \\ w_{max} \\ \alpha(bound_{upper} - position) \\ \alpha(bound_{lower} - position) \end{bmatrix} \leq 0 \tag{1.12}$$

The problem is that the dimention of matrice J_c is 2×4 in our case, but I donot know what do other join control?

To solve this problem we assume that the jacobian is to control both the wheel joints and also the camera's joints.