Final Project

1 Overview

Deadline of Report: 11:59pm 5 Doc. 2022
Grouping: **2** in a group; with exception at most 3 persons per group

Please make an appointment before the deadline by email and then bring your computer to office to give a live demonstration. Please try the best to collaborate with your partners. In the demonstration, please notify the TA who has done which part of work. Further contact: khuangak@connect.ust.hk(HUANG Kan, TA of the course)

2 Tasks

You have to finish five tasks with given simulation environment and give a live demonstration based on which we grade your final project.

Here are the tasks and their weights:

1 Build 2D grid map with laserscan data and show it via rviz such as Fig. 2 20%

2 Control the mobile robot in the simulation environment with keyboard (drive it to move) 5%

3 Image Recognition and localization. There are five images of different people in the environment and you have to

   (a) judge whether the target images occurred in current vision data(we provided)

   (b) if yes, estimate the location of target images

(c) add markers to the map in rivz which stands for the target images position

30%

4 Visual Servoing. There is a slowly moving yellow (rgb:255,255,0) ball (Fig. 6) in the environment and you have to write program (rosnode, in c/c++ or python) to control the mobile robot to follow the ball. 20%

5 The room is devided into serveral areas, as Fig 1 shows, let the robot judge which area it locates. 20%

6 Write a launch file to roslaunch all of above programs at once. 5%

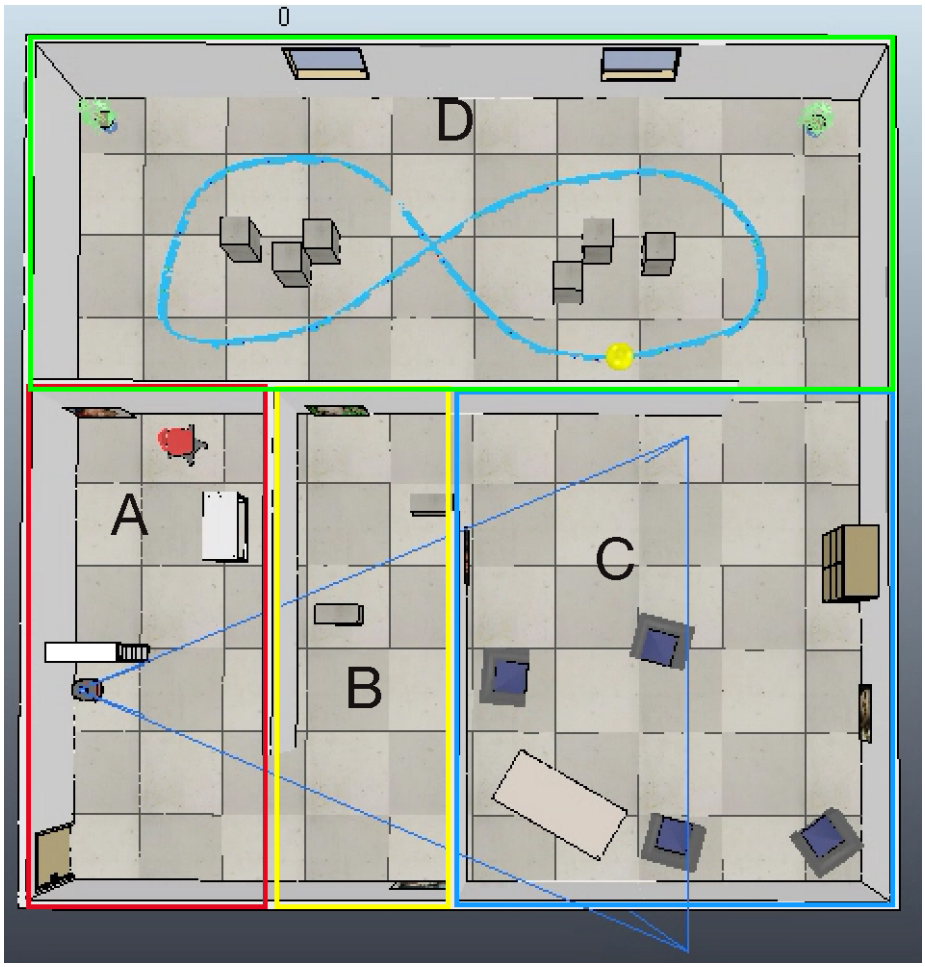


Figure 1: divided areas

NOTICES: **you can use existing packages for task 1 & 2**. You are encouraged to write your own code for other tasks.

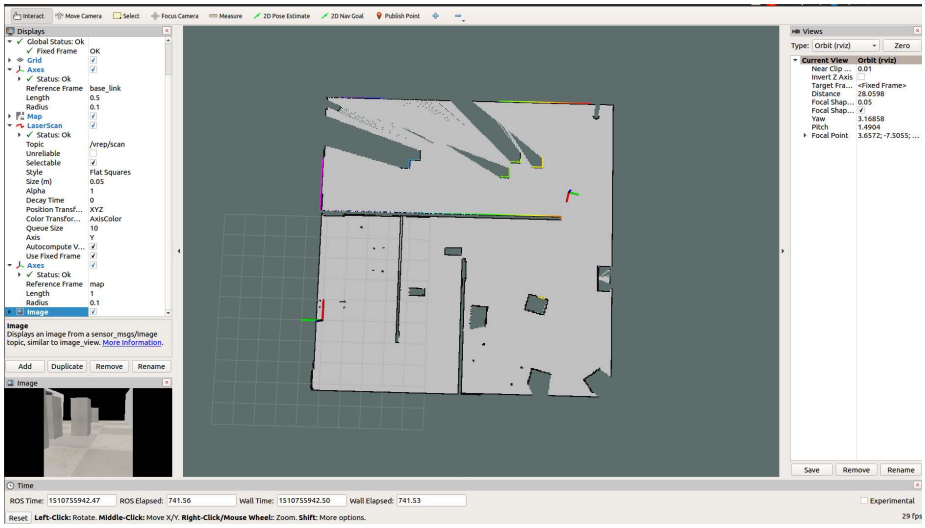


Figure 2: Grid map in Rviz

3 Prerequisite

To finish the final project, you are supposed to

1 Have basic knowledge of Linux (e.g. Ubuntu)

2 Finish the beginner level tutorials [1] of ROS and know how to use existing packages

3 Use V-REP [2] to perform simulation

4 Be able to integrate ROS and V-REP

5 Be familiar with C++ or Python

6 Master the content of pf_example exercise

4 Simulation Environment

A V-REP scene file, named env.ttt, is given with this document. The Fig. 3 shows the simulation environment in which the blue path of yellow ball is

[1] http://wiki.ros.org/ROS/Tutorials
[2] http://www.coppeliarobotics.com/

invisible for the vision camera on mobile robot. The simulation environment already includes tested scripts which implements all functions. Hence, it is not at all necessary to alter the simulation scene. You only need to click the start button and then work with ROS nodes and topics. As introduced in the first lab session, in the simulation script we publish/subscribe several topics:

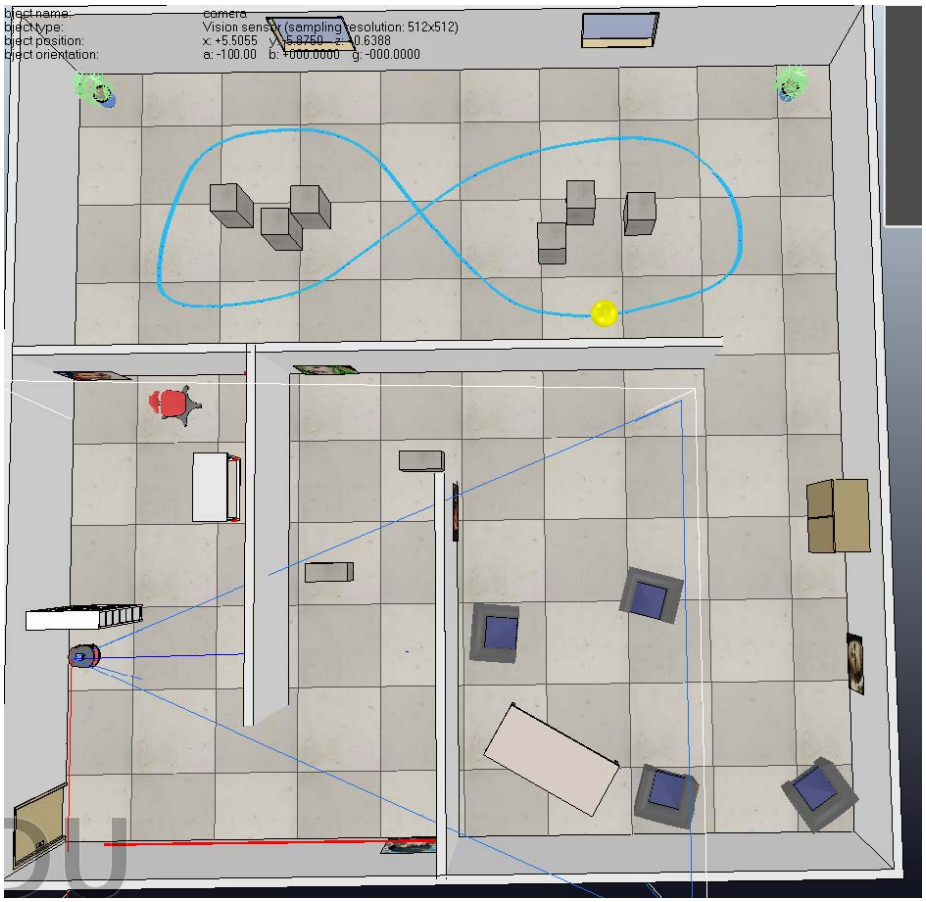


Figure 3: Overview of Simulation Environment

1 • Name: /vrep/image
  - Type: sensor msgs/Image
  - Pub/Sub: Publish
  - Comment: The image captured by vision sensor on mobile robot. Refer section

2 • Name: /vrep/scan

- Type: sensor msgs/LaserScan
- Pub/Sub: Publish
- Comment: The laser scan data

3
- Name: /vrep/cmd_vel
- Type: geometry msgs/Twist
- Pub/Sub: Subscribe
- Comment: The velocity command to mobile robot

4
- Name: /vrep/laser_switch
- Type: std msgs/Bool
- Pub/Sub: Subscribe
- Comment: Enable/Disable the /vrep/scan, disable it can speed up the simulation, you only need publish this topic once. Default: Enable

5
- Name: /vrep/camera_switch
- Type: std msgs/Bool
- Pub/Sub: Subscribe
- Comment: Enable/Disable the /vrep/image, disable it can speed up the simulation, you only need publish this topic once. Default: Enable

And we also publish two transform by ros tf. If you don't know tf or tf2 of ros please refer to the (tutorial). We define the frame id of mobile robot, laser, vision sensor are base link, laser link, camera link respectively. By listening to the tf you can get the transformation of these objects, which is critical for task 2&3.

4.1 Image Problem

There is one problem of V-REP vision sensor which you have to solve. The image you get at ros node side is left-right reversed, as shown in Fig. 4. We mount the camera with conventional coordi- nate, x-axis(right), y-axis(down), z-axis(forward). In Fig. 4(a) we see 5 the picture of Avril Lavigne is at left side but it's at right side of Fig.4(b).

It's easy to solve this problem by OpenCV CV::flip function [3]. Hence, in your node implementation, please call the cv::flip to reverse the image and then do later processing.

[3]Link CV:filp

4.2 Prior Knowledge & Hints

1 The size of all five target images in simulation environment is 1x1 (meter).

2 We choose the perspective-type vision sensor for simulation and the model is shown in Fig. and more detail at link [4]. The parameters are listed in Table. 1.

Table 1: Vision Sensor Parameters

Near clipping plane (m)	0.01
Far clipping plane (m)	10
Perspective angle(degree)	45
Resolution X (pixel)	512
Resolution Y (pixel)	512

3 The color of ball is RGB:#FFFF00 which could be used to sim- plify the tracking task. Don't forget to reverse the image.

4 Refer rviz/DisplayTypes/Marker [5] and learn how to show marker in rviz.

5 Hint: publish data to /vrep/laser switch to disable the laser to speed up the simulation when switch to auto-tracking mode.

5 Evaluation

The evaluation is based on the all tasks.
The demonstration process :

1 Use your launch file launch ros and ros nodes (including rviz), start V-REP simulation

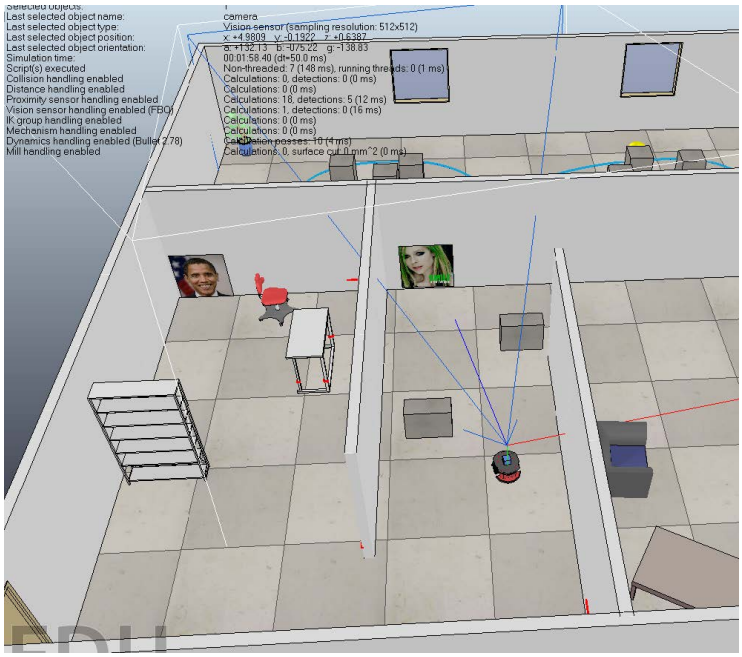
2 control the mobile robot move in the environment by keyboard

3 at same time, the grid map should be shown in rviz. Fig.2.

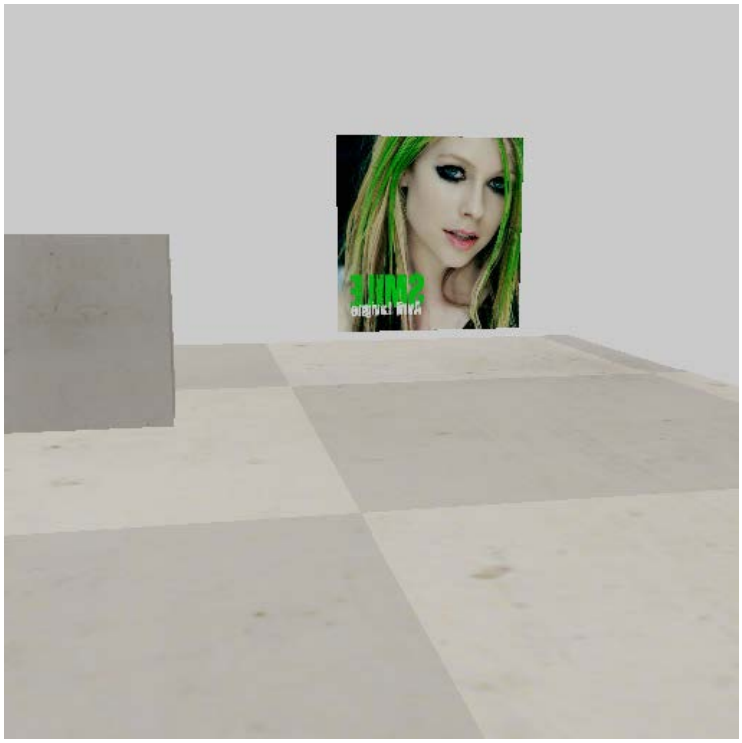
4 at same time, if the target images occurs in the field of view of vision sensor, its location should be estimated and marker should be shown in rviz

5 move robot to upper room and switch to auto-tracking mode. The robot should automatically track and follow the yellow ball without keyboard control

[4] http://www.coppeliarobotics.com/helpFiles/en/visionSensorPropertiesDialog.htm
[5] http://wiki.ros.org/rviz/DisplayTypes/Marker



(a) V-REP side



(b) ROS side

Figure 4: Two Subfigures

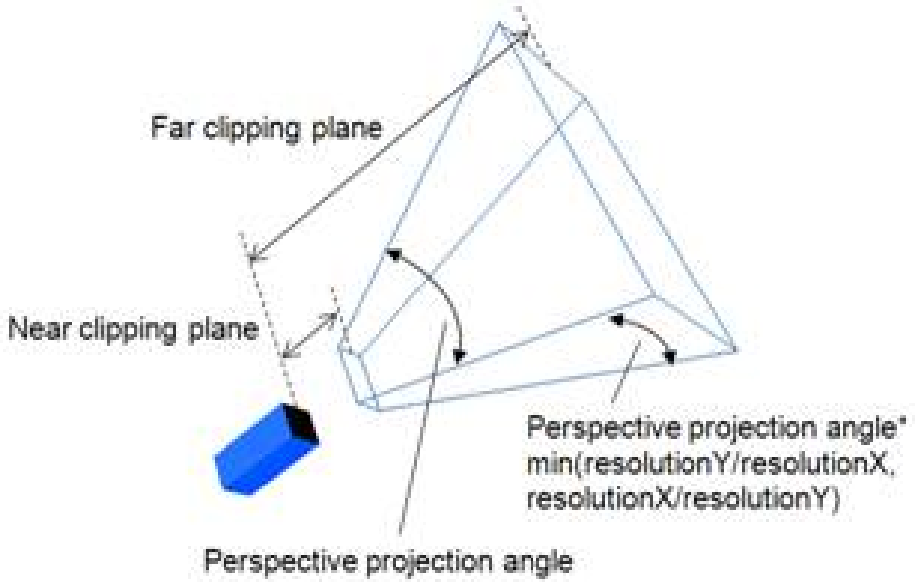


Figure 5: Vison sensor model of V-REP

6 Possible Add-up points

- Besides detection, you can also recognize the faces on the wall.
- Automatic exploration of the environment.
- Controller performance evaluation for the tracking problem.
- Any further contributions not included in the standard tasks and specifications.

You can also setup your own research environment, such as exploration with human existence, multi robots collaboration, path planning, etc. Innovation is encouraged. The points will be counted according to the complexity and novelty of your work.

7 Notices

1 NO PLAGIARISM. It's much easier to analyse code than words.

2 Late demonstration is NOT accepted. The penalty policy is 10% points off per day.

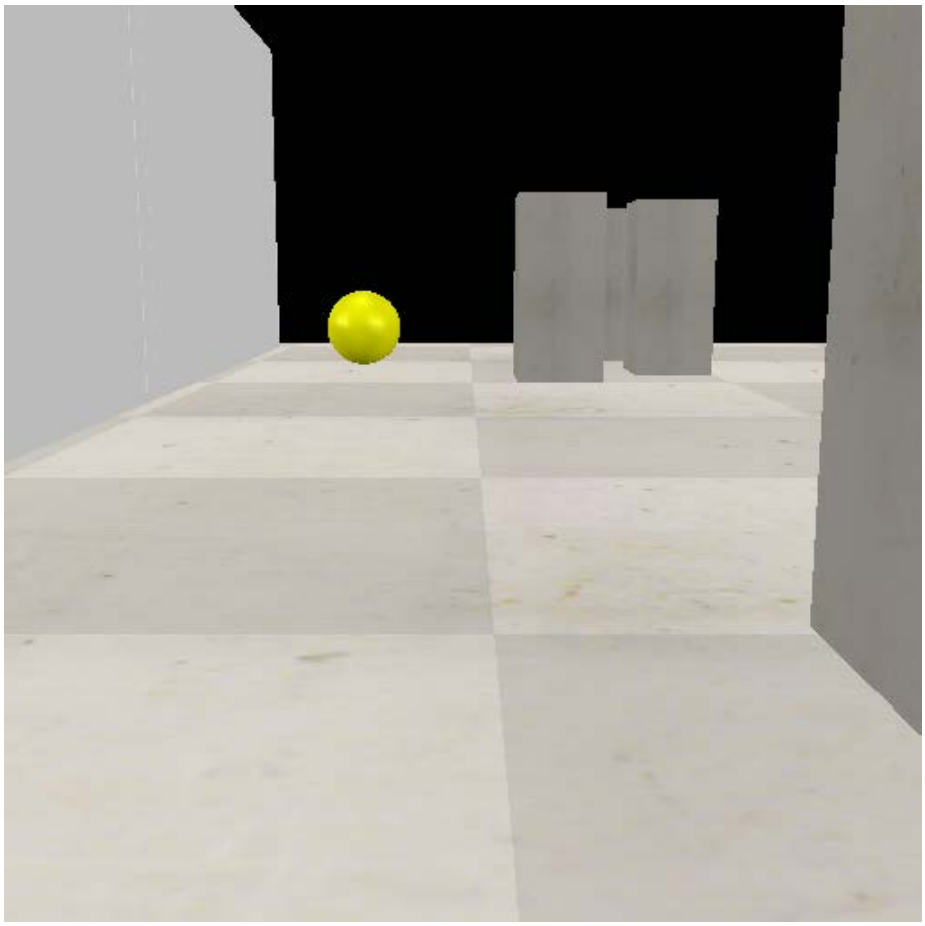


Figure 6: Yellow ball to follow