Sphero-ROS Interaction Documentation

I.   INTRODUCTION

This program uses Python OpenCV to detect a robot and a target through a USB webcam. It currently uses color detection for the robot and target, but if needed can be changed so that the target is tracked using different methods. From the video frames, the centers of the robot and target are calculated then the distance and bearing between the two are calculated. From that, a desired heading and velocity is sent to the robot commanding it to track the target around its environment.

This program also has a manual teleoperation mode which allows the user to control the robot with a joystick or directional-pad or change the color of the LED on the robot. Manual teleoperation mode can be switched on or off using the GUI that has been developed.

II.   PREREQUISITES

This ROS package was developed in Linux Ubuntu 20.04 using ROS Noetic. To successfully run this program, the following need to downloaded and configured. Below each package is a link to a tutorial on how to do this.

- Linux Ubuntu 20.04
  - o   https://phoenixnap.com/kb/install-ubuntu-20-04
- ROS Noetic
  - o   http://wiki.ros.org/noetic/Installation/Ubuntu
- Python3
  - o   https://iohk.zendesk.com/hc/en-us/articles/16724475448473-Install-Python-3-11-on-ubuntu
- Pip
  - o   https://linuxize.com/post/how-to-install-pip-on-ubuntu-20.04/
- Tkinter
  - o   https://www.pythonguis.com/installation/install-tkinter-linux/
- Python OpenCV
  - o   https://data-flair.training/blogs/install-opencv-on-ubuntu/
- VS Code
  - o   https://linuxize.com/post/how-to-install-visual-studio-code-on-ubuntu-20-04/
- usb_cam node
  - o   https://answers.ros.org/question/197651/how-to-install-a-driver-like-usb_cam/

III.   INSTALLING THE PACKAGE

Open your terminal window and navigate to the source directory of your workspace for ROS packages, usually called catkin_ws/src and type the following

- *roscd catkin_ws/src*

Clone the repository here https://github.com/TaiLe2435/sphero_ros_interaction

- *git clone https://github.com/TaiLe2435/sphero_ros_interaction*

Navigate to the packages home directory, and make your package, then source your files

- *roscd sphero_mini*
- *catkin_make*
- *roscd sphero_mini/devel*
- *source setup.bash*

Now the package is installed. To configure the system, you need to find the launch file for the webcam and sphero-mini as well as the source code called startup_menu.py. To find and configure the webcam launch file, plug the web camera into the PC/laptop and type the following in the terminal window

- *ls /dev/video**

and take note of what video outputs are present. Then do the following

- *roscd usb_cam/launch*
- *code usb_cam-test.launch*

and locate the part that says

- *<param name="video_device" value="dev/video#" />*

where # is a number

Then change the # to one of the video outputs detected in the previous step. To test to make sure that the video output is correctly selected, run the following in the terminal

- *rosrun usb_cam usb_cam_node*

and look to see which camera lights up. Keep changing the number until you find the correct one.

Now we are going to configure the sphero_mini launch file. To do this type the following in the terminal

- *roscd sphero_mini/launch*
- *code sphero_mini.launch*

and locate the line that says

- *<arg name="mac_address" default="XX:XX:XX:XX:XX:XX" />*

where the X's are a MAC address of the Sphero-Mini.

Change the X's to the MAC address of the Sphero-Mini, which can be found by using the Sphero-Mini app and checking at the bottom of the "advanced settings" page.

Finally, if interaction between two robots is still going to be used, navigate to the start_menu.py file

- *roscd sphero_mini/src/sphero_mini*
- *code start_menu.py*

and change the MAC address found on line 10 to the MAC address of the other Sphero-Mini

- *launch_cmd2 = 'roslaunch sphero_mini sphero_mini.launch mac_address:=XX:XX …*

IV.   RUNNING THE SYSTEM

To run the system using a blue and red robot, first open the blue robot and make sure that the USB port of the inner mechanism is pointing parallel to the vertical axis of the environment, open two terminal windows and run the following codes in the two separate windows

- rosrun sphero_mini start_menu.py
- rosrun sphero_mini tracker.py

Then select the robot that you want to select from the pop-up menu
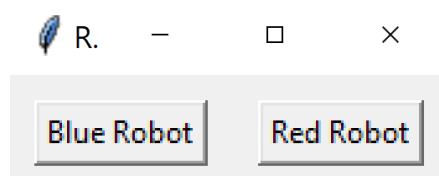
After selecting the robot the following window should pop up
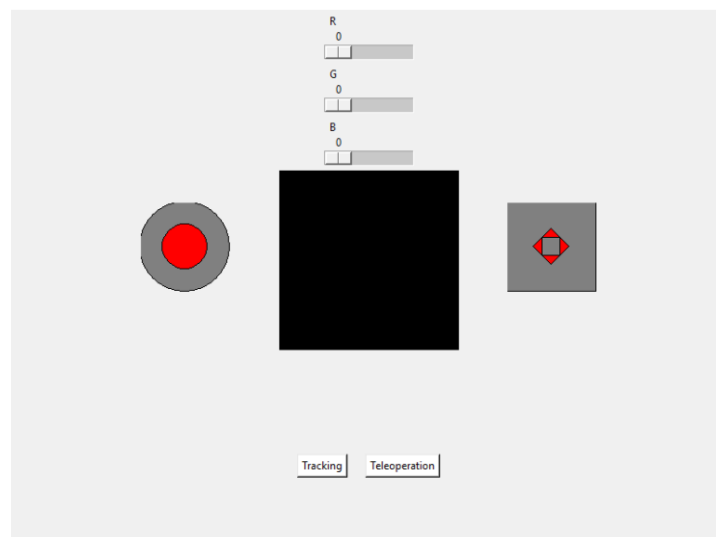
To start the tracking of the target, click the tracking button at the bottom of the window. To switch back to teleoperation mode click the teleoperation button at the bottom of the window. By default the system starts in teleoperation mode. In teleoperation mode you can click and drag the joystick on the left, click the arrows of the d-pad on the right, or us WASD move the robot.

V.   DEBUGGING

Cannot connect to the robot

- Click activities in the top left corner, and search for "System Monitor"
- In the System Monitor app, search for any processes called "roslaunch" or "rosmaster" and end those processes
- Restart the program using the steps above

If that does not fix the problem, or there are no processes running, plug the robot into the provided usb plug to reset the robot.

VI.   POSSIBLE FUTURE WORK
- For different object tracking, the file "Tracker.py" needs to be edited to compensate for either the different color ranges or different tracking methods.
- Depending on the speed of the target, the gain values for the control law of the robot need to be tuned for either faster, or slower control.