Environment Configuration in Project Starwar

Author: Jinze Chen
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This report is mainly about the environment configuration and instructions about the usage of already deployed environment.

Part 1: Overview

Hardware and software requirement specification

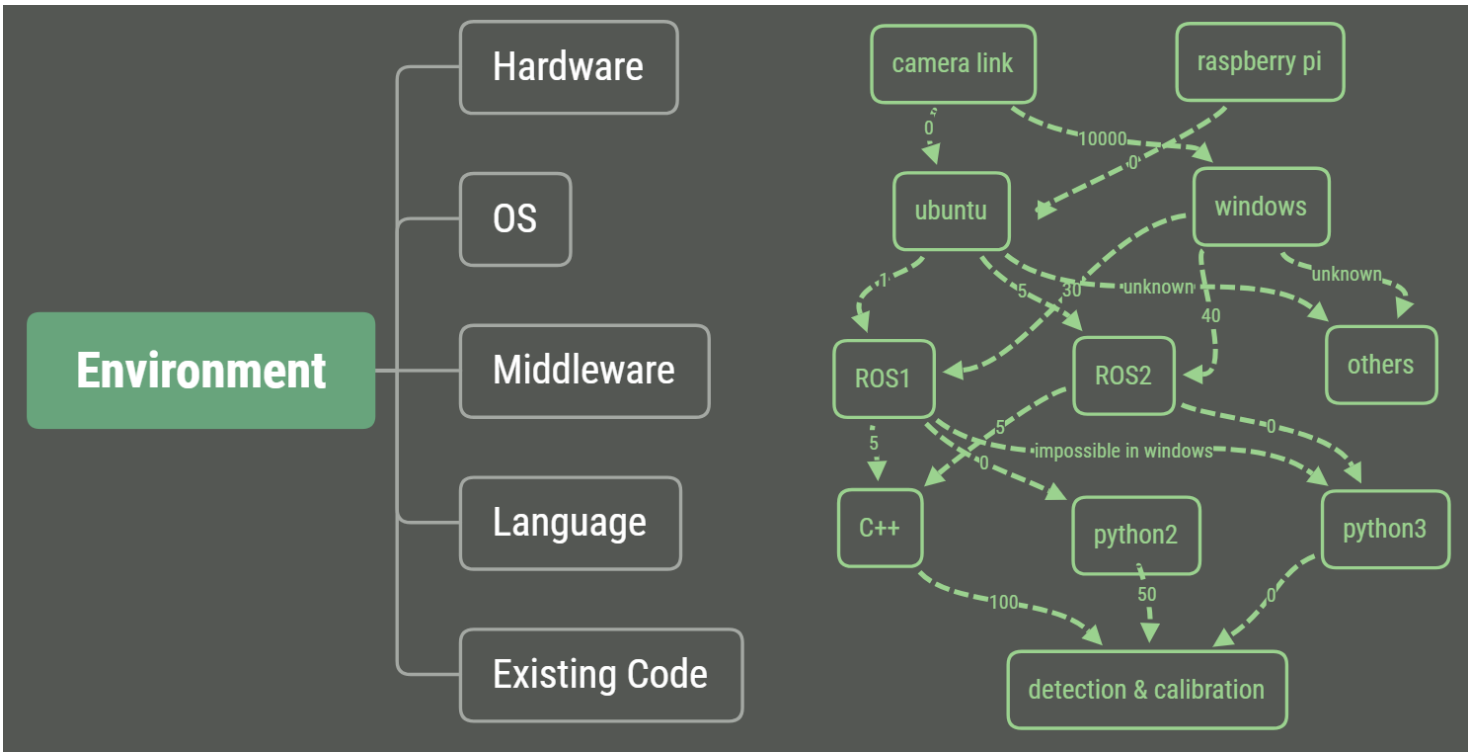
The purpose of this project is to build a robust yet scalable robot so that we can conduct some promising research like robot localization, AI based approach for control tasks and so on.

In stage 1, we are using 3 cameras to locate the robot and then apply some control algorithms to navigate the robot to its destination. The hardware we are using are 3 cameras, 1 rapberry pi, 1 Arduino Uno and 1 dev-box with 4 Titan Xp.

For scalability and fast development, I decided to use ROS (Robot Operating System) as the middleware to operate on. There are 2 distributions called ROS1 and ROS2. Details can be found on https://en.wikipedia.org/wiki/Robot_Operating_System.

View based localization method is not part of my work currently, but I also built a docker environment for them to train their neural networks. The instructions to train a model on our dev-box is explained in Part 2.

The dependencies about the hardware, OS, middleware, programming environment and code can be shown as a graph listed below. The number represents the difficulty for deployment in my opinion. We need to find a path from top to bottom with least cost.



There are something to note though:

- The manufacturer doesn't provide driver for camlink on linux, and it doesn't work with default driver.
- ROS1 has more packages but doesn't support python3 officially. The build tool in python3 is based on linux specific libraries so it doesn't work on windows.
- ROS2 has support for low latency communication, but is unstable yet.
- ROS1 can communicate with ROS2 in C++.

- It's possible for C++ to call python modules. I have tested on simple scripts but it may cause trouble if it becomes big.
- Different language can communicate with each other with no problem in ROS. Members of the ROS 2 community have also created additional client libraries like C# and Node.js to build ros2 packages. Details can be found in https://index.ros.org//doc/ros2/Concepts/ROS-2-Client-Libraries/.

The current plan for the environment is camlink+windows-desktop+ROS2-dashing+python3+algorithm communicate with pi+ubuntu-mate1804+ROS2-dashing

Something about pyrobot https://pyrobot.org/

In my opinion, the ambition of pyrobot is to share their algorithms and networks between researchers with the prerequisite that they use the same robot. So it's of no use in the early stage of our project. Pyrobot is also based on ROS1, so we can implement the interface in the future. And I failed to build the pyrobot environment.

Some useful links about reinforcement learning frameworks in robotics

https://github.com/AcutronicRobotics/ros2learn

Part 2: Instructions to use dev-box to train your model

A brief introduction to docker

You can treat docker as a lightweight virtual machine. I use docker to provide better isolation and resource management for training. It's also possible to use docker to build a cloud server in the future. Here I only describe the development environment in our dev-box. Here is the tutorial I used to learn docker http://www.runoob.com/docker/docker-tutorial.html.

How to build a docker server

1. Install docker
2. Install gpu driver
3. Install nvidia-docker for gpu support (ubuntu only, because windows version doesn't support gpu)
4. Create your own images
5. Use it

* Administrators shouldn't let users use docker commands directly for security concerns. Instead, administrators should provide a script with right privileges for them to use.

Some useful docker commands

```
docker images #list installed images
docker ps -a #list all containers (including stopped ones)
docker rm -f <container_id> #force the removal of certain container
```

```
 docker run
             --rm #remove container automatically after it exits
              -it #connect the container to the terminal
 --runtime=nvidia #enable the use of gpu
 -e NVIDIA_VISIBLE_DEVICES=0,1 #only allow usage of gpu0 and gpu1
       --cpus=1.5 #limit available cpu resources
       --name web #name the container
       -p 5000:80 #expose port 5000 externally and map to port 80
   -v ~/dev:/code #create a host mapped volume inside the container
       alpin3:3.4 #the image from which the container is instantiated
          /bin/sh #the command to run inside the container
```

More can be found in https://docs.docker.com/get-started/.

Existing images in dev-box

```
$ docker images
starwar pytorch0.4.1-cuda9.2-cudnn7-ubuntu1604-opencv4.1-sshd aee7e2fe8506 8 days ago 3.28GB
ros-kinetic-cuda full 90a6d9aa2c8c 9 days ago 4.54GB
starwar-ros2 cuda10.1-cudnn7-ubuntu18.04-anaconda3-pytorch1.1-opencv4.1 01167b982f8c 9 days ago 4.26GB
starwar-ros2 latest 01167b982f8c 9 days ago 4.26GB
starwar pytorch0.4.1-cuda9.2-cudnn7-ubuntu1604-opencv4.1 bb1fd4e913b5 9 days ago 3.23GB
ros-kinetic-cuda latest b304d84d4606 9 days ago 2.1GB
osrf/ros2 nightly 6d95d76bcdcb 9 days ago 3.53GB
starwar latest 84a4f835a255 9 days ago 7.94GB
cuda10.2-anaconda3 latest 535ba039b4e9 10 days ago 6.24GB
nvidia/cuda 10.1-cudnn7-runtime-ubuntu18.04 31f34f1664ab 12 days ago 1.59GB
nvidia/cuda 9.2-cudnn7-runtime-ubuntu16.04 aac1a925b48a 12 days ago 1.3GB
nvidia/cuda latest 010a71dc59db 12 days ago 2.81GB
ros kinetic-ros-base-xenial 7d6ef5f3e9b5 3 weeks ago 1.19GB
continuumio/anaconda3 latest cb34e4508fdc 7 weeks ago 3.72GB
hello-world latest fce289e99eb9 6 months ago 1.84kB
pytorch/pytorch 0.4.1-cuda9-cudnn7-runtime 7b329a33d981 11 months ago 2.91GB
```

How to build an image

Use a dockerfile or commit from containers (not recommended).

Advanced usage of docker

To connect pycharm from an extranet to a docker environment in dev-box (not recommended)

Use ssh forwarding capability to make it possible https://docs.docker.com/engine/examples/running_ssh_service/.

Example commands in dev-box:

```
docker run -d --name train_sshd --runtime=nvidia -p 2200:22 --rm -v /home/wuw:/home/wuw -e NVIDIA_VISIBLE_DEVICES=2,3 starwar:pytorch0.4.1-cuda9.2-
```

Part 3: ROS environment

Features of ROS

1. Based on internet to communicate among different machines
2. Use publish-subscribe logic to exchange information between nodes, also support for service and actions (only in ROS2)
3. ROS2 may support embedded MCUs in the future
4. Many good algorithms and visualization tools has been built in ROS
5. Support for playback so we can change the parameters offline

Installation

It's hard to build ros in a virtual environment. If you are installing ROS2 on windows, you'd better prepare a freshly installed one, or the python environment configuration can make you crazy.

On ubuntu

https://index.ros.org/doc/ros2/Installation/

On windows

I failed to build ROS2 from source on windows. The prebuilt one also has some problems about the default FastRTPS implementation. I used openslice as the DDS implementation and it works.

Programming guild on ROS2

Coming soon...