JdeRobot | Robotics-Academy ROS2-RADI and Amazon warehouse exercises in web-based template

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Abstract

Robotics-Academy currently has the single robot Amazon warehouse exercise implemented for the gzweb version. I plan to accomplish the following over the summer.

- Construct a RADI for ROS2 Foxy
- Extend the warehouse exercises to the web-based template
- Explore improvements in reference solutions for the exercises

Contents

1 The Project

In this section I will detail my vision for how the exercise will look and how the code will be structured. I expect this structure to be considerably enhanced under the guidance of my mentor.

1.1 Knowledge Pre-requisites

- C++: Very proficient
- Python: Very proficient
- Experience with ROS1: Extensively worked with ROS1, very proficient
- ROS2: Lukewarm familiarity
- Git: Very proficient
- Undertaking the course at IIT Bombay *Advanced Topics in Mobile Robotics* whose second half is a theoretical and mathematical discourse into multi-agent systems and swarm robotics. There is a project component for practical application

1.2 Completed Pre-proposal Tasks

- Get accustomed with Robot Academy's codebase by attempting open issues
- Understand the high level overview of the Docker architecture and be able to render and verify modifications in the locally cloned repository (both for docs and web template exercises)
- RoboticsAcademy challenge: Solution
- C++ challenge: Solution

- Python challenge: Solution
- ROS2 challenge: Solution

1.3 Tasks

- Understand the working of the Web Template architecture's backend
- Sketch a digital flowchart of the architecture from my understanding (might help future contributors too)
- Construct a RADI for ROS2 Foxy
- Extend web based template for the single and multi robot amazon exercise [1]
- Develop reference solutions for the exercises

2 About Me

2.1 The Student

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2.2 The Institute

University Indian Institute of Technology Bombay

Degree B.Tech. with Honors in Mechanical Engineering

Minor Computer Science & Engineering

Year | **CPI** Senior | 9.32/10.00

(My application would not affect my ongoing degree)

2.3 Computing Background and Programming Experience

The description of my **daily working setup** is as follows:

- Hardware: Lenovo Legion Y540 with Intel i7-9th gen, Nvidia GeForce GTX 1650, 512 GB SSD
- OS: Ubuntu 20.04 LTS with i3
- Terminal: Alacritty + tmux + zsh
- ROS: Melodic in primary Docker environment, Kinetic in secondary Docker environment, Foxy apt-installed (all have GPU acceleration enabled)
- I have blogged a visual of my system specs & link to the config files here

I have been programming for the past 4 years with a very good grasp on design and analysis of algorithms, and data structures (received top grade in both of these courses at IIT Bombay). My **programming background** is as follows:

- I am most proficient with the languages: *Python*, *C++*, *Bash*. I enjoy discovering easter eggs in Python for fun
- My other known languages are: *C*, *Java*, *R*, *Javascript*, *x10*, *Sed*, *Awk*, *Perl*
- I am extremely proficient with the frameworks: *Git*, *Docker*, *ROS1*, *RegEx*(yeah!), *OpenCV*, *OctoMap*
- Very swift at scripting automation tasks in Python (slightly rusty in Bash scripting right now)

My experience in **Robotics and Computer Vision** is as follows:

- Won many competitions related to robotics
- Constructed and programmed a 2-wheeled self-balancing bot at home during lockdown
- Rigorous programming assignments in college courses- *Advanced Topics in Mobile Robotics*, and *Computer Vision*
- Self-projects done out of interest (listed in the My Projects section)

GSoC participation: I have not applied to GSoC before this

2.4 My Motivation

My approach towards honing robotics skills has been very unstructured during my four years of college — picking up any exciting tutorials I found, frequently fixing my local system setup to get ROS to work (thanks, Nvidia), and occasionally pursuing robotics projects out of self-interest.
The Robotics-Academy platform does a tremendous job of silencing the noise and allows the users to focus simply on honing their skills. By working towards increasing the scope of our exercises, I might facilitate future roboticists' learning experiences. For me, that is immensely satisfying to imagine.

2.5 My Projects

Autonomous Drone Exploration [2] - Capable of navigating in a complex static environment by avoiding on-field obstacle-collision and reaching the target destination after its correct detection

International Micromouse Challenge [3] - Reach from the corner square to the center of an unknown maze in the shortest time

Two-wheeled Self-Balancing Bot [4] - Demonstrates the inverted pendulum problem using a two-wheeled bot and input from gyroscope+accelerometer module

Automated Graph Reader [5] - Deployed live on Heroku server, the web-app accepts queries for y-values in simple input graphs. The solution is purely based on image processing and OCR

Panoramic Mosaicing [6] - Uses ORB feature extractor, Brute Force Matcher with Hamming Norm, and RANSAC algorithm to mosaic any number of input images

Quadruped Robot - Founding member of an institute technical team to solve the international urban search and rescue challenge- RoboCup Rescue League

More details about my projects (including others) can be found on my GitHub page.

2.6 Contributions

I started using Robotics-Academy in March and made my earliest contribution in the first week of April. I have been constantly learning from the community ever since.

Merged PR's

- 808 - Added sky and clouds in FollowLine exercise
- 840 - Added FollowTurtlebot to the Robotics-Academy splash page

Unmerged PR's

- 844 - Displays Real time factor in the FollowLine's exercise webpage

Issues/Bugs Caught

- 841 - README.md at the Project root is incomplete
- 845 - Connection established popup needs to be clicked twice

General help

- 807 - Guided a keen member of the community on how to contribute
- 814 - Collaborated on the migration of FollowLine exercise to Noetic RADI

3 Road-map

I will not be available for two separate days in May (giving GRE and TOEFL). My college semester officially ends on May 16, 2021.

From previous year trends, my job joining would be after 2 months of summer vacation. The initial month after joining would be mostly orientations and getting accustomed to the work atmosphere. I am very intent to work harder (60-70 hrs per week) during the initial month (till June) to keep it lighter at the tail. I promise to remain committed during my job's orientation phase to any remaining tasks in my project.

I recognize that this is a serious commitment, equivalent to a full-time paid summer internship or summer job. I have no other commitments during

the summer. I prefer to stay at home during weekends and public holidays. So these won't conflict with the timeline either.

3.1 Community Bonding Period

- Discuss the project with my mentor in further detail.
- Consolidate my understanding of the web-template based RADI's architecture
- Setup my system and test the existing Amazon warehouse exercises based on Gzweb (End of May)

3.2 Coding Period

- Develop the ROS2-RADI (First and second weeks of June)
  - I have already independently created the Noetic-RADI. Using that as base, we wouldn't have to worry about the Python2 to Python3 migration
  - Changes in the `Dockerfile`, `manager.py`, `exercise.py`
  - Emphasize on leveraging containerization benefits from the ROS2 architecture into RADI
- Migration of models to ROS2 branch of `CustomRobots` and tackle any compatibility issues (Third week of June)
- Extend the Follow Line exercise to ROS2-RADI(Fourth week of June)
- Implement the Single and Multi Robot Amazon warehouse exercises using the web-based template of ROS2-RADI (First and second week of July)
  - Explore improvements in the existing reference solutions based on features provided by ROS2 Navigation2
- **GSoC Checkpoint 1:** July 12, 2021
- Buffer weeks for any unexpected delays (or more enhancements) (Four weeks)
- **GSoC Checkpoint 2:** August 16, 2021

3.3 Post GSoC

Robotics-Academy is an excellent platform to hone robotics and vision skills. I would enjoy testing newer exercises just for the learning that it brings. On non-office days, I would continue contributing to enhance features and especially love to guide enthusiastic new developers that attempt to fix issues.

4 Acknowledgement

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References

[1] Gzweb single robot Amazon warehouse exercise
https://jderobot.github.io/RoboticsAcademy/exercises/MobileRobots/single_robot_amazon_warehouse/

[2] Competition, `Inter IIT Tech Meet`
https://github.com/trunc8/drdo-drone-challenge

[3] Competition, `International Micromouse Challenge`
https://trunc8.github.io/2020/12/28/comp-imc

[4] https://trunc8.github.io/2020/12/15/doc-self-balancing-bot

[5] https://github.com/trunc8/auto-graph-reader-webapp

[6] https://github.com/trunc8/panoramic-mosaicing/