Humanoid Soccer Shooter - Design Document

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1. **Draw a structure chart that showcases the various modules in your project and how they communicate with each other. Draw the modules as ellipses and name them accordingly, with arrows between the various modules to indicate the information that they share. Identify ROS topics and ROS services, if any. (Refer to the lecture slides on ROS communication graph. draw.io is a good flowchart designer) [20 %]**

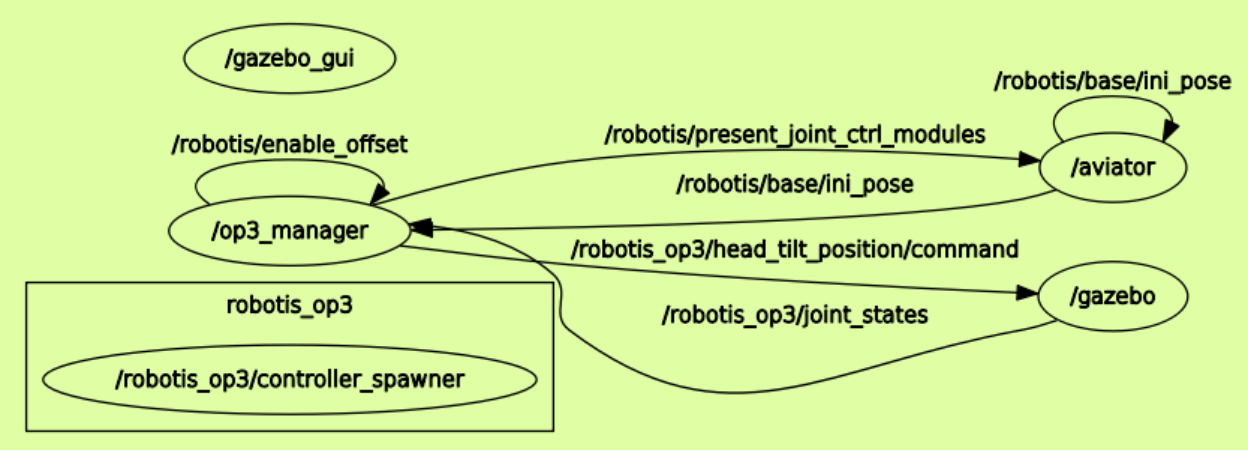

Figure 1: RQT Graph Output - Node Communication in Humanoid Soccer Shooter

2. **Identify the module(s) where you have contributed a considerable amount of new code to the project and give a brief description of what the code does. [10 %]**

    a. For the Robotis OP3, the major challenge in the project was not writing new code rather utilize the available APIs for our objective

    b. That said, we did write a new node for ourselves which in conjunction with the OP3 ball detector API tries detecting a ball in the environment and walk towards it

    c. The majority of the code written involves basic initialization of the robot to the base initialization pose, followed by a short delay to start detecting the ball and then move towards the ball

3. **Given there are various open-source implementations available for each module in your project, how did you go about selecting them? [10 %]**

a. For our case, the majority of the open-source material that is available directly comes in from Robotis as part of the SDK for the OP3, so the Robotis repositories were the obvious choices to source the implementation from.

4. Which part of the project was the most challenging and why? [20 %]

a. The most challenging part of the project was definitely the first setup of the robot development environment; which involved having to setup the plethora of pre-requisite packages for the OP3 and having to setup the simulation environment in order to develop a boilerplate code that should just work out of the box.

b. Besides the initial setup, the actual porting of the walking code from the simulator to the physical robot also was a challenging aspect. It involved some re-tuning of parameters as well as updating the source code. Updating code on the OP3 frequently required a trivial but lengthy network gimmick to have the OP3 pull files from Git.

5. Were you able to meet the various milestones as stated in your project proposal? If not, why? [20 %]

Since the roadmap milestones were not explicitly linear in nature we were able to (fully or partially) achieve the below milestones:

- Setup simulator, ROS packages and the development environment: Contrary to intuitive thinking, for this project the setup proved to be the most tedious and lengthy task because of the complex nature of software components involved, viz. ROS, Gazebo (the simulator), and OP3 ROS packages/nodes
- We were also able to deploy almost all of the written code to the physical robot which in hindsight proved to be an easier task than we estimated at the beginning of the project.

Due to the constrained timeline and the underestimated complexity of the setup, we were not able to fully implement the below features from our roadmap:

- Detection of the goal post
    - While the ball is being correctly detected by the robot, the goal post detection is not currently implemented
- Kicking of the ball:
    - Since being short on time, we were unable to implement the kicking of the ball by the robot completely

6. If you had more time, how would you extend this project? [10 %]

Considering if it were a longer term (possibly a semester long project) this could be extended by adding the following cool features:

- Implement a more robust and more “smart” ball and goal detection as well as more realistic kicking of the ball by the robot
- Have 2 or more robots play together to score a goal (kind of like particle swarms) by passing the ball to one another

7. **Can you think of any ethical impacts future iterations of this project may have? If so how would you address them? [10 %]**

    - As such this project is meant to only be a fun and hobbyist application of the available humanoid robot platform OP3 and does not pose any major ethical considerations, at least at this point of time.

    - If in the future the project is indeed converted into something like a group of robots playing soccer (together or against), then the robots will need to have be adherent to ethical/moral/sportsmanship guidelines that international soccer players follow as well. E.g.: not being violent and hurting other players, obeying the decisions from the referee (who would probably also be automated by this time), being judicious towards achieving victory without falling prey to biases that resemble match-fixing, etc.

Survey Questions:

1. **Do you have any specific comments on how we can modify the project portion of the course for future course offerings?**
    a. Either have early access (introductory hands-on perhaps as an assignment in itself) to students so that the physical robot setup does not consume a major task for most people in the final project, and they are actually comfortable handling the physical robots; this would also help in improving the quality of the projects on display for the final project
    b. OR have a slightly longer window open for the project/have a mandatory physical robot session for the students (possibly counting for grade as well)
2. **Do you have any comments for future students who take the course?**

    a. Engage in Futurama for more meaningful sci-fi discussions in the class!

References:

- http://emanual.robotis.com/docs/en/platform/op3/simulation/#gazebo-installation
- http://emanual.robotis.com/docs/en/platform/op3/recovery/#installing-robotis-ros-packages
- http://wiki.ros.org/humanoid_navigation
- http://wiki.ros.org/humanoid_planner_2d?distro=kinetic