Individual Lab Report 9

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Team B: Space Jockey

With Brian Boyle, Ardya Dipta Nandaviri, Songjie Zhong

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1 Introduction

For the last two weeks, my focus has been in completing the mechanical design of the new chassis, implementing the waypoint planner prototype, and developing our ROS platform to foster the continuing development of our planning, localization, and flaw-detection features.

2 Individual Progress

One of the biggest tasks I took on in the last two weeks was the design of the center segment of the robot. Due to the size constraints, number of actuators, and strength concerns, this task actually proved to be quite challenging, with 4 or 5 prototypes necessary to reach a working design. This was one of the first parts I've designed where the assembly process had to be taken into account, because I had several prototypes that worked as an assembly in SolidWorks, but the servos were impossible to insert into their positions in the real world. However, I was able to change the layout of the servos, and add access cuts to make assembly easier. In addition, I encountered some issues with layer separation and cracking on the 3D printed parts and developed a custom slicer profile to try and resolve these issues. After several design iterations, I was eventually able to print a rigid and buildable center segment, which was able to support the rest of the chassis. Once the robot was fully assembled and calibrated, we were able to re-run our Fall Validation Experiment as planned for our progress review. The final weight of our robot has been brought down to around 1.3 Kg, which is within the capabilities of our magnetic feet to support. The current design state may be seen in Figure 1.

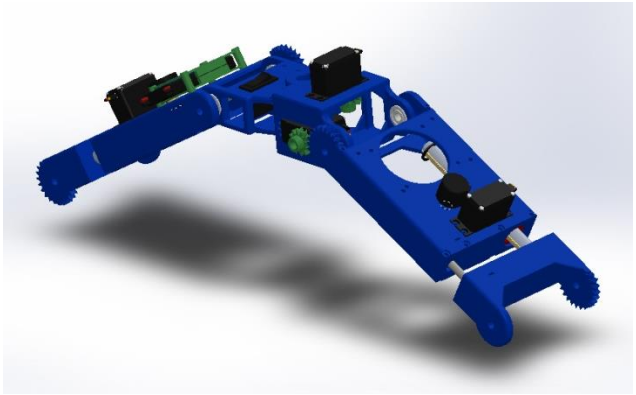

FIGURE 1 - COMPLETED CHASSIS REDESIGN, EXCLUDING FOOT SEGMENTS.

My other major task for the week was assembling a basic waypoint path planner for our system. This planner takes a set of target waypoints from the user (either movement targets, or inspection targets, and then generates a set of 2D foot placement commands to reach all the targets, while respecting joint limits and robot capabilities. Currently this runs with a very basic Tkinter GUI, but will be rolled into our main GUI as Brian continues to develop this. On the back end, it outputs the generated movement coordinates to a ROS topic, which will be parsed by individual motion sub-planners and our IK engine to control the full robot motion.

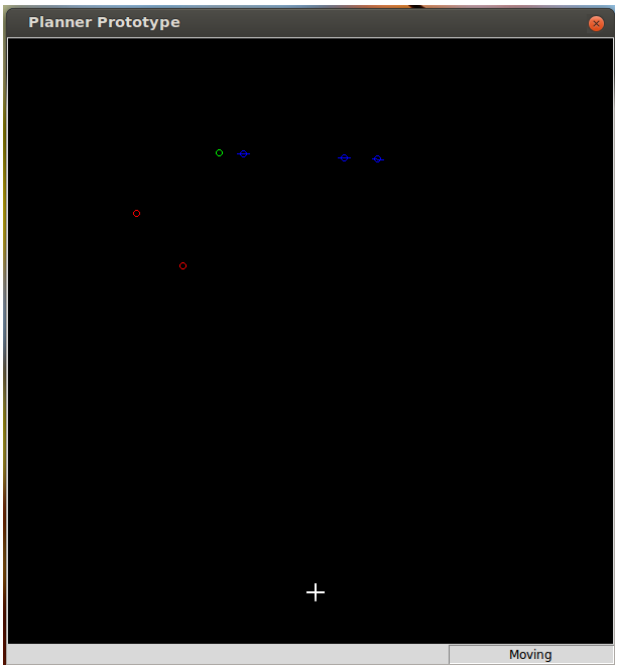

FIGURE 2 – PLANNER SCREENSHOT, SHOWING FOOT LOCATIONS (BLUE), MOVEMENT WAYPOINTS (GREEN), AND INSPECTION WAYPOINTS (RED).

Finally, In preparation for the rest of the control system pipeline, I have also been working on cleaning up and incorporating our ROS codebase, including setting up the Parameter Server, configuration files, launch files, and custom message types. Working together with Brian, we've sketched out the whole planning path for our forward control loop, and are ready to begin developing our software very aggressively.

3 Challenges / Issues

As mentioned in the previous section, the main challenges I had to overcome this time around were the spacing and strength constraints of the center segment. What was originally planned to be a single-day design task ended up taking me the majority of Spring Break to develop and fabricate successfully. However, the custom Makerbot print profile I developed has been checked into our repository, and should allow us to build stronger parts faster and with less waste (due to modifications in the support material settings). Also, the lessons learned about assembly clearances and processes should help me think better about future design projects.

4 Efforts by Team Members

In the last two weeks, Brian has been focused on designing and testing our magnetic foot prototype, as well as refining the URDF model of our robot so that we can use ROS's built in transform and kinematics packages to control our joint positions. Songjie has been developing our image transformation and comparison code, and Dipta has been working on integrating the Arduino IMU and Camera data into our ROS ecosystem.

5 Future Plans

For our next progress review, we are focused on gearing up our software system towards reaching our spring validation goals. Brian and I will have the magnetic foot design and camera system integrated with our robot chassis, which is the last hardware task remaining. We will all be working on developing our ROS code. Songjie and Dipta will be focused on getting our sensing and localization (feedback) system working, developing the internal inspection map service, and getting all of our sensing nodes operating with ros topics (Camera input, and Open CV integration). Brian and I will be focused on getting our feed forward control system fleshed out, including the kinematic calculations, gear lash compensation (Jacobian analysis based on IMU data), and our scheduling and state estimation code. For our next review, we would like to have the robot navigating on a vertical surface, accepting commands from our waypoint planner GUI and executing them in the real world.