Individual Lab Report 4

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Team B: Space Jockey
with Brian Boyle, Ardya Dipta Nandaviri, Songjie Zhong
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1 Introduction

At this point in the project, team B is engaged in the mad rush to get our system prototyped before the fall system demo. In the last two weeks, we have made good progress on the design front, and have ordered the bulk of the fasteners, bearings, and connectors we will need to fabricate our final design. Although we are a little bit behind schedule, I think we are still on track to present a workable fall demo.

2 Individual Progress

In the last two weeks, I have continued to work supporting my teammates, and as a "pinch hitter" adding my efforts to whatever part of the project is most pressing.

Last week, the majority of my efforts was spent working with Dipta to validate and locate components for the Power Distribution Board. In this, I focused my efforts on component sourcing, locating workable parts on Digi-key and updating our internal EAGLE library with the correct package dimensions and layouts. Once this was complete, Dipta developed the draft board layout, and I did some verification and cleanup before submitting the design. I also generated the full bill of materials for the component, complete with Digi-key part numbers for ordering.

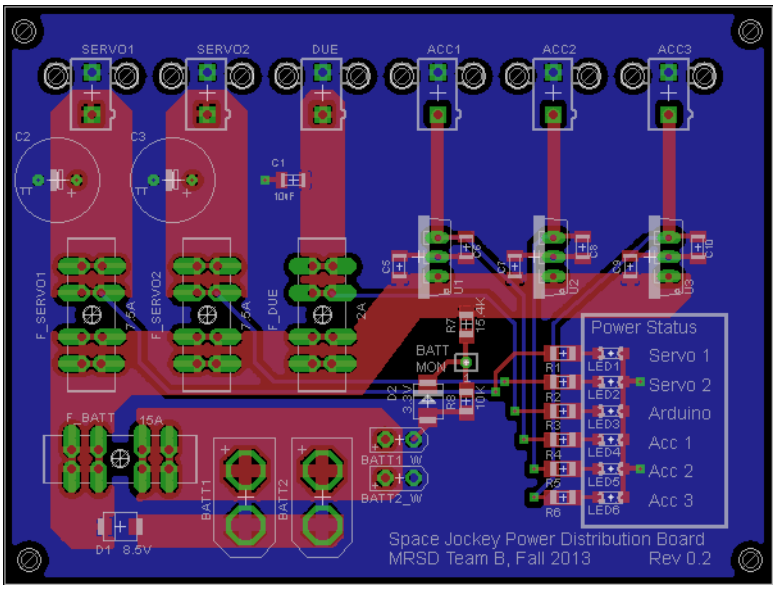

Figure 1: Team B final power distribution board layout.

Due to my efforts in this area, we were able to get our final board design (Figure 1) out for ordering, and are ready to order components from Digi-key. Our plan is to make 2 copies of our power board: one for the main robot, and the second for our bench squid, or to use as a spare on hand in case something burns up.

This week, I have focused more on the mechanical side of things, with our fall demo looming and Songjie focused more on our adhesive foot actuators. I lent my efforts to the Solidworks design of our linear actuators and chassis. As much as possible of this design is built using off-the shelf components from McMaster-Carr, requiring a minimum of machining and fabrication time. The current design of our linear actuator can be seen in Figure 2.

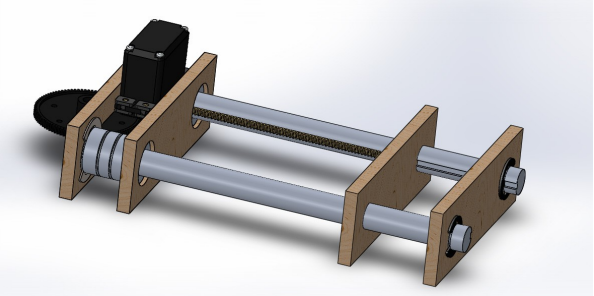

Figure 2: In-house design of a lightweight linear actuator

This design will use a modified hobby servo to drive a rack and pinion actuator mounted on a lightweight aluminum shaft. For position feedback we will use an external potentiometer mounted on a reduction gear (Figure 3), which should give us a nearly 6” actuator throw while using stock hobby servo control signals. During our lab presentation, the potential of using a string pot was also mentioned, and will be investigated as another option.

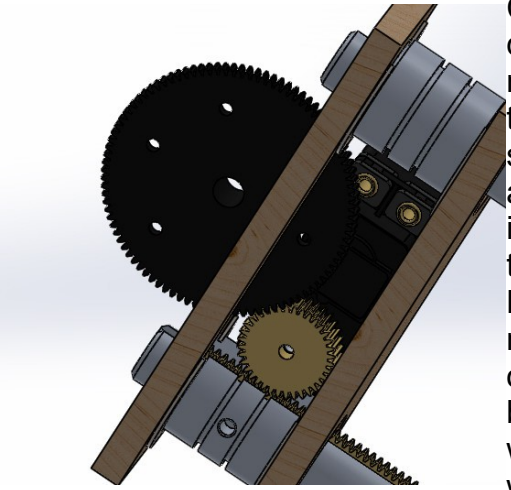

Figure 3: Detail of feedback gear reduction, the potentiometer will be mounted on the black gear, giving a reduction ration of 1:2.66.

Construction of this design should be extremely quick. All of the bulkheads and enclosures for the mechanism will be laser cut. I have received training to use the Lasersaur in the collaborative machine shop, and we have a large stock of 1/4” MDF available in the lab, so we have virtually instantaneous turnaround time on these parts. All of the other components have been ordered from McMaster-Carr and Servo City, and the only machining necessary is a relatively simple turning operation to trim and slot the shaft blanks to accept bulkhead retention clips at the proper intervals. As we continue to iterate this design over the weekend, we should be ready to begin assembly early next week as all the parts are delivered.

When selecting materials, I spent most of my time trying to minimize the weight of our robot design with my chosen components. All rotary joints on the robot will be supported with acetal backed ball bearings, for minimum weight and friction losses on the joints, aluminum components and fasteners are being used wherever possible, and the MDF material we're using is itself fairly lightweight. Our design weight for the center joint segment is <3 lbs, and we believe these components should be able to meet that specification.

3 Challenges / Issues

This week, most of our difficulties have been schedule related, with 18 days till the demo, business presentations due next week, and homework in other classes mounting, the pressure has been on to make intentional progress on our project. I have been able to help in this effort a great deal by pinch-hitting, helping out on whatever aspect of the project is in most dire need. So I feel that we are making good progress towards our fall demo goal.

One of the biggest technical challenges we're currently facing is the foot gripper design (figure 4), even with Songjie giving that portion of the project 100% of his attention, there are still many design and robustness concerns about it. With that in mind, we may need to do some additional de-scoping for our fall semester demonstration. If the foot and gripper materials are unable to meet our performance goals, we will most likely give our semester demonstration on a horizontal surface, allowing gravity to provide our 'attachment force'. This should allow us to prove that our mobility design and control architecture works, while not throwing the entire demo due to concerns with our V-10 material. Should this be the case, Songjie will be able to continue his work on the foot design, while the rest of us focus our efforts on autonomy and guidance during the software-heavy Spring semester.

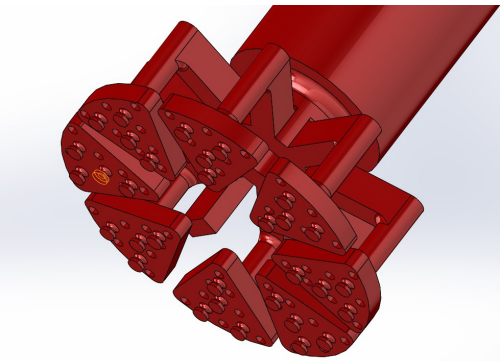

Figure 4: Current foot pad design. Image credit: Songjie Zhong

4 Efforts By Team Members

In the Past two weeks, Brian has made good progress with our software infrastructure: successfully wiring up ROS, rViz and our GUI design, so that we are almost ready to begin testing poses and gait generations in simulation. In the coming weeks, I will refocus on the embedded software elements so that we can begin to directly control the mechanical servo elements in as seamless a manner as the simulation. This should allow us to have some physical control of the robot functioning by the next progress report.

Last week, Dipta and I worked together on the power distribution board. By combining my effort with suppliers and verification together with his design efforts, I feel were we able to successfully generate a high-quality design much faster than we did on our previous assignment.

Songjie has been focusing his effort on the foot and ball-joint mechanism. Because of space constraints, the brittleness of the PVA 3D printing material, and the complexities of assembling this foot mechanism, he has been iterating the foot design in quick succession. At this point, we have several promising prototypes, and are investigating good methods of reliably casting the V-10 material to the foot pads, so that we may begin testing early next week.

5 Future Plans

In the next few weeks, we will continue with our fabrication efforts. Our goal for the November 18th progress review is to have our prototype nearly fully assembled, with just software details and minor refinements left before our final semester demo on the 25th.

I plan to have the CAD design for the laser cut panels all complete by Monday or Tuesday of next week. Along with this, our order from McMaster-Carr has already been delivered, and our Servo City order is on its way, so we should be able to complete our first draft prototype by the middle of next week. I will then shift my efforts to the Software components with Brian, while Songjie and Dipta make iterative improvements on the Chassis structure and complete the foot mechanisms.

With the bulk of the electrical design and implementation behind us, Dipta will be leading the charge in developing and implementing our foot test plan, and will be testing and verifying other components as they are completed.

Songjie will continue to work on the foot actuator, and is looking into different methods of 3D printing a compliant ball joint at the “ankle” of our robot, to allow gripping on uneven or curved surfaces.

Brian is fine tuning the GUI and finishing his simulation efforts in the early part of next week, as well as leading and organizing the presentation for our business class. Once the draft chassis is built, I will be shifting over to work with him, and we will complete the necessary control structures to achieve our semester end goals.

In short: we're busy, but I think we're still on track, these next two weeks should show some great leaps as we transition rapidly from simulation and Solidworks to physical construction and prototyping, and set us in good stead for our demo.