Individual Lab Report 2

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Team B: Space Jockey
with Brian Boyle, Ardya Dipta Nandaviri, Songjie Zhong
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1. Individual Progress

During the last week, I have focused primarily on concept development and ordering components for testing and prototype assembly.

I worked closely with Dipta on the Power distribution concept. Through this process, we were able to spec out the basic components of our system. We have chosen to implement our system around an Arduino Due (for the additional processing power and IO pins it offers). Because the Arduino has an on board regulator that can accept 7-12 volts, we chose to design using a 7.4 V LiPo battery, which allows us to connect the Arduino directly to the battery (with OV/RV protection) and gives us better power efficiency over chained linear regulators.

Figure 1: Hitec HS-5496MH Servo (www.servocity.com)

Once this decision was made, and Dipta did a trade study on available servos. We chose to use hi-voltage servos because they could also run unregulated off of our chosen battery voltage, and offered better torque relative to their 6V counterparts of similar cost. I ordered several standard-size metal gear servos to begin testing and development, and hope to receive them in the next week.

However, the use of higher voltage servos added difficulty in selecting a servo driver board for the project, as most were only rated for 6V operation. However, through close inspection of data sheets and the PCB layout of the Adafruit I2C servo driver, I found that it should be possible to modify the board by cutting the motor power trace and soldering a new 7.4V connector into an unpopulated filter capacitor plug on board. This will allow us to run all of our servo control electronics off of the built in Arduino 5V regulator and have a completely separate power channel for the servos, giving us a nice buffer between our electronics and our actuators.

I also did a quick supplier survey on available cameras for our project, although we will not be integrating these until spring semester. After looking at both wifi and machine vision cameras online, I found that there are many that will accept voltages in the 5-6V range, which can easily be sourced from our batteries. Taking into account the fact that most linear regulators and TVS diodes come in pin-compatible families of different voltages. I decided that we should add 3 unpopulated 5A regulated power distribution channels to our board, which will allow us to delay making a final decision on cameras until we're ready to integrate them, but still use the same power board.

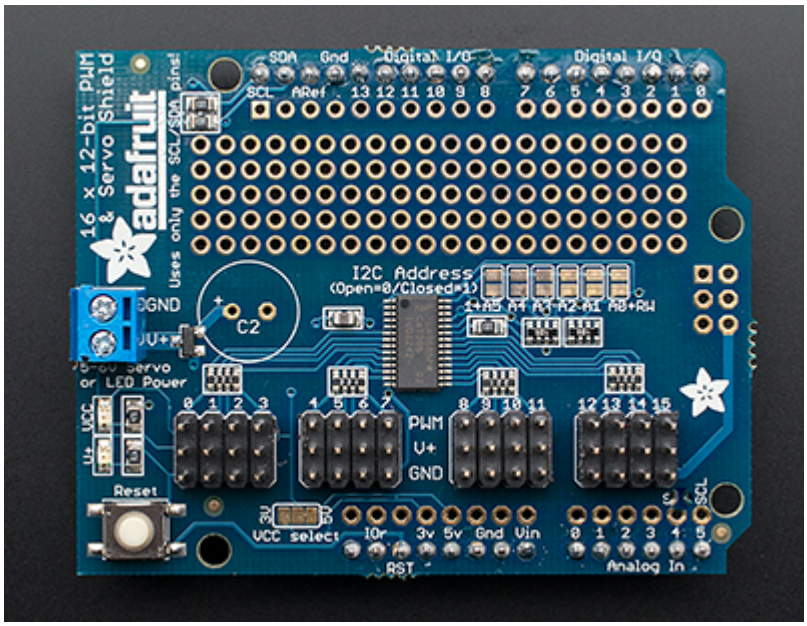

Figure 2: The Adafruit I2C Servo driver board. Note the unpopulated C2 footprint where we can mount our 7.4V supply lines. (www.adafruit.com)

Finally, my team met with Dimi Apostolopoulos this week to try and settle on the number and arrangement of legs for our robot. After the Conceptual Design Review, we were leaning towards a design resembling the Lemur IIb[1] developed by the JPL. However, after some discussion about wrist kinematics and trying to figure out how to execute plane-change maneuvers between surfaces, we realized that we didn't need as many degrees of freedom, and should be able to accomplish our task with a much simpler “inchworm” style robot. After our initial meeting, I did some brainstorming and sketched out a basic idea for a 7 DoF robot that should be able to implement the ideas we were discussing. We had another meeting with Dimi today and he thought it was definitely a design worth pursuing, and may be novel enough that we should consider publishing a paper and/or putting together a NASA SBIR proposal in December.

2 Challenges / Issues

There were not many technical challenges presented this week. After the communications challenges our team was dealing with last week, I have worked with my teammates to try and adjust the task allocation for these upcoming weeks so we can collaborate between our different roles better. It will be interesting to see how these efforts pan out in the long term.

For me personally, time management also proved to be a sizable issue on account of

1 Kennedy, Brett, et al. "Lemur IIb: a robotic system for steep terrain access."Industrial Robot: An International Journal 33.4 (2006): 265-269.

our critical design review in mobile robotics this week.

3 Efforts By Team Members

As mentioned previously, Dipta and I collaborated fairly closely on the power board conceptual design and servo selection this week. Songjie did some Solidworks mockups of potential leg designs for our robot. Even though we are moving in a different direction, his effort in this area really helped clarify our thought processes and start the conversations with Dimi. Also this week, based on the software lectures in class we decided that we are going to be moving from our custom made “channel” architecture previously described to ROS's more robust implementation of the anonymous publish/subscribe architecture. With this in mind, Brian has been porting our previous GUI work to the Qt framework and fleshing out ideas for our final operator interface.

4 Future Plans

Our first priority this upcoming week is to expand on the new “inchworm” robot concept we've been exploring with Dimi. Songjie and I will be working together next week to develop some kinematic mockups of the design, and start working towards a practical mechanical design.

Another immediate priority is to cast and begin testing the Gecko dry adhesive material we plan to use in our project. We received the casting medium in the mail today, and Dipta and Songjie will continue working with Metin Sitti to acquire the molds and begin fabricating material.

Dipta will continue to working on the power distribution schematic and I will be assisting him with design verification and parts sourcing as we develop a realistic bill of materials.

Finally, Brian will be updating the GUI for the new design direction, and designating ROS versions and build environments so that we can begin writing compatible software. Once they are delivered, he an I will also work to assemble and test the servo driver boards with the Arduino Due.

Note that for all of these tasks, we have one person leading and another assisting. This is the change we are implementing in hopes of improving our communication and understanding as a team.