Individual Lab Report
Weekly Progress

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Team B: Team Space Jockey
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1. Individual Progress

With new 3D Printing equipment in the lab, I suggested to the team that we consider switching our chassis material from MDF to ABS, so we'd be able to maintain a fairly rapid prototype turnover time but have more flexibility in designing the chassis. My main intent was to create a less boxy frame that would hopefully be more space and material efficient, ultimately making the design more compact and lighter. To this end, I printed some copies of spare chassis pieces to compare strength and weight. The prints were performed with a 10% density honeycomb pattern for solid fills. Based on the example prints I performed, the ABS chassis pieces (See Figure 1) on average weigh only half as much as their MDF equivalents, and were more difficult to break by hand. This drastic weight reduction was a welcome surprise, and there are at this time no apparent drawbacks to switching to ABS except a slightly longer fabrication turnover.

To reengage with the existing software and improve it with the semester ahead in mind, I performed a full refactor of all code taking place on the control console. This involved taking every opportunity to encapsulate, reorganize, and generalize code so it can be expanded upon in the future. I believe the fresh perspective I had on the code after a month's break was very conducive to this effort.

Additionally, I began implementing a more user-friendly pane of the GUI (See Figure 2) to be used by operators who aren't as intimately acquainted with the robot. As it stands, it is now constituted by a set of buttons with simple commands such as "Step Forward" and "Turn Left" that will correspond to macros which execute the lift/extend/ place commands already implemented. The interface also has placeholders for a map representation of the operating environment and robot, and widgets for displaying information such as the queue size, which until now had taken the form of readouts in the many consoles which host the various ROS nodes necessary to operate the robot.

Finally, I also devised a new Spring Validation test plan, which now has a clear procedure that demonstrates the inspection task we've decided to focus on. The plan also establishes that our test environment will be restricted to a vertical surface, although we may attempt plane transitions if time permits. I also took part in and sketched the results of our group brainstorming sessions to explore different design options for our attachment mechanism, which is currently our most pressing issue. We have 5 new designs that we plan to explore in the next two weeks.

2. Challenges/Issues

The main challenge during software refactoring was encapsulating the various functions and processes taking place within the gait generator. Initially, individual motions such as lifting, extending, and placing a segment took place in distinct functions with excessive duplicate code. Extracting those instances of duplication required me to analyze and generalize what was happening in them. Gait generation code was among the last of the code to be written last semester, and much was done in a hurry, so the implementation as it stood was often sloppy or inefficient. In the future, I'll try to do much more planning before implementing such a crucial portion of code so it will be written right the first time.

The process of printing old chassis parts in ABS with the new Makerbot was simpler than last semester when I was first learning the art of 3D printing, given that I now have better intuitions as to what is likely to cause problems. In particular, the pieces printed were at first prone to peeling off the heatbed, a problem I was able to resolve by raising the temperature of the bed and releveling it. After a series of iterations, the final pieces I was able to produce were nearly flawless by visual inspection, and even press-fitted with each other more tightly than their MDF counterparts had.

3. Team Work

Dipta and Nate redesigned our Power Distribution board (PDB) so we can fabricate a second iteration that saves both mass and volume. Among the changes are reductions in the number of peripheral and motor channels, and the addition of a capacitor to smooth the data we receive for battery monitoring. The next step is to resize the PDB and send the design to be fabricated. Dipta also performed a trade study on digital cameras and IMU's to be included in the robot.

Nate was responsible for the design and fabrication of a new gearing system that we hope to integrate into the robot to replace the current method of actuation which is prone to flex. By integrating gear teeth directly into the 3D printed chassis, we can hopefully achieve much tighter and more reliable actuation. Nate also established radio communication with the robot using a simple device that can be plugged into any computer running the operator interface with no additional configuration necessary.

Songjie was present and contributed some great ideas to our brainstorming sessions for attachment mechanisms, and also joined me in familiarizing with the new Makerbot.

4. Future Work

In the next few weeks, it's clear that our highest priority is the development and implementation of a functional attachment mechanism. We've given ourselves until Mid-February to make a breakthrough using dry adhesive-based designs, and if that fails we'll explore magnetic or other options. As such, further software development at this time is a secondary priority. I plan to implement more comprehensive debugging features in the existing software, particularly the software embedded on the Arduino, to help us better diagnose issues such as the one we had last year that entailed the robot apparently losing motor power midway through operation.

My primary goal will thus be to work closely with the rest of the team to compete the redesign of our chassis using printed ABS, and fabricate as much of it as possible. Simultaneously, we'll be designing, fabricating, and testing attachment mechanism options. My hope is that the chassis redesign will lead to a much more compact and lightweight prototype that will be far easier to attach using dry adhesive pads.

5. Figures

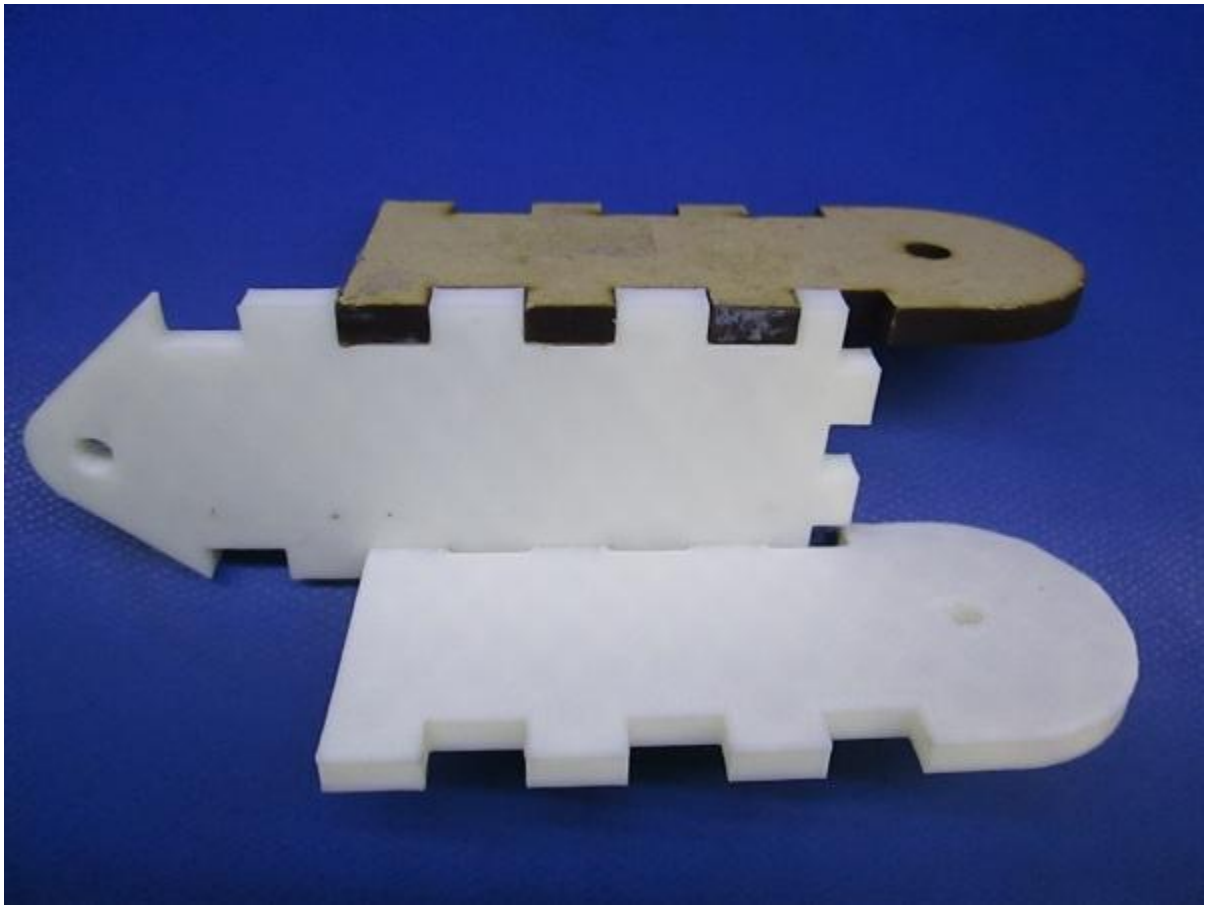

Figure 1: ABS chassis elements with equivalent MDF piece. Note the tightness of press-fitting.

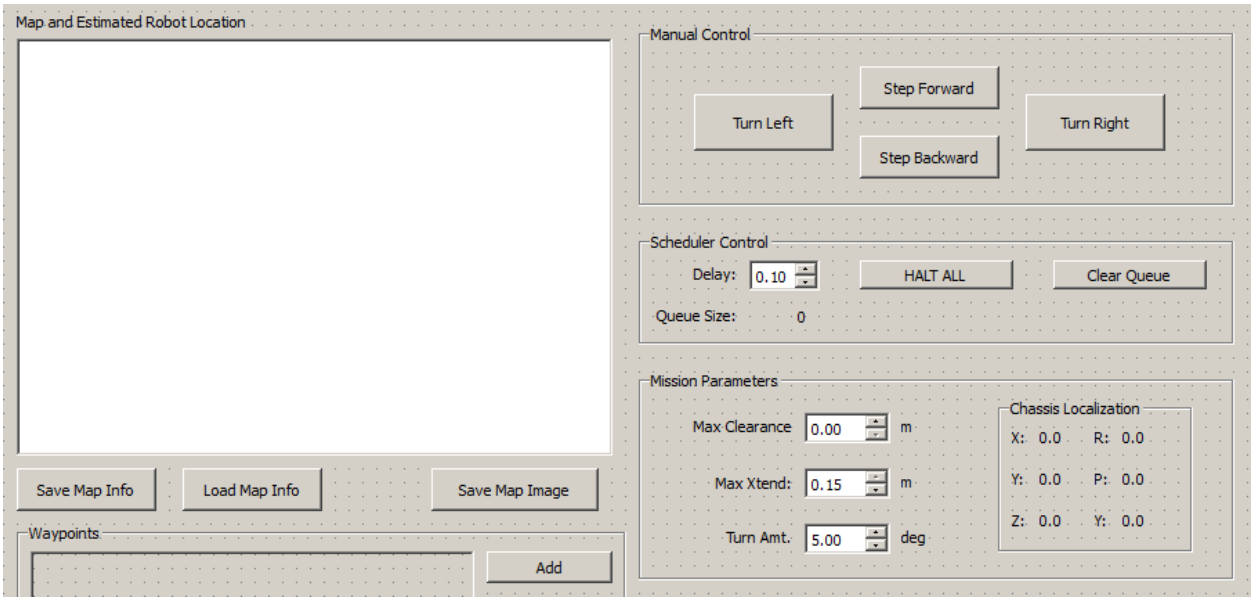

Figure 2: User-friendly operator interface, with map view and driving buttons