Individual Lab Report
Weekly Progress

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Team B: Team Space Jockey
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1. Individual Progress

My first priority for this progress review was to revise and complete the magnetic feet for the robot. In testing, we discovered that the torque of the end segment's pitch motor was sufficient to lift the feet, without the aid of an additional detach servo, so these were removed in both end segments, reducing weight and complexity. Additionally, the magnet configuration was changed to line them up along the end segment's pitch joint, so that maximum leverage could be applied to detach the foot (See Figure 1). Finally, I designed and fabricated mount for the camera which was integrated directly into the structure of the front end segment (See Figure 2).

In addition, the center foot was modified as well based on our observations of earlier tests during which it tended to slide. The foot now has a much larger surface area to increase friction, and the magnets are spread radially around its edge (See Figure 3). The center foot will retain its detachment servo, since it can't be "levered" in the same way as the end segments. The center foot, as well as the new end segment feet, now have a total capacity of 24 magnets. I also added high-friction tape to each surface.

After completing the feet and gluing the magnets in, I integrated the feet into the chassis, as well as the rest of the new chassis parts that I'd printed over the past weeks (See Figure 4). I disassembled and reassembled the entire robot with this new hardware, except for the center joint, and reorganized the cables and wires to avoid tangles that we'd recently been experiencing. I also had to fashion connectors for the camera power supply and IMU, and finally calibrate all of the servo motors for the new configuration.

2. Challenges/Issues

Some coordination issues arose while preparing the front end segment's camera mount. We only have a single camera, while Songjie, Dipta, and I all need it for distinct purposes. As a result, progress was slowed at different points when the camera was unavailable. Since these modules are each still under development, we're planning to buy a second camera soon to mitigate this bottleneck.

While I've become quite adept at integrating magnets into segment feet, the use of high friction tape presented some new difficulties. In particular, the tape seems to rely in part on being

somewhat double-sided, in that some adhesive is present on both sides. While this certainly accomplishes the goal of creating more friction, it does so at the expense of leaving residue on surfaces, and making detachment more difficult. The goal of using such tape was simply to reduce sliding motion and not pull-off, so this further complicates the issue of detachment and attachment.

Once the robot was fully integrated, a host of issues made themselves apparent. First, one of our linear actuators failed as the motor driving it burned out, requiring that I modify one of our spare motors so it could turn continuously and also interface with our potentiometer. Secondly, the planning software jerked the front segment so violently toward the table that the camera was thrown from its mount. This jerking motion also made it nearly impossible for the robot to stay attached to the wall, as each downward motion by one joint caused equal and opposite upward motions by the other two.

3. Team Work

Nathaniel completed the final iterations of the linear actuator segments and passed them off to me for fabrication and assembly, as well as taught me the processes of servo calibration and modification for linear actuators, and contributed to the design concept for the feet. He also continued work on his path planner and integrated the solidworks model of the robot in RViz. The software he's developing will take the place of my GUI from last year and ultimately include localization as well.

Localization has been primarily the task of Dipta this period, as he continues work with AR tags and integration of that functionality into our ROS environment. The camera is now operable within ROS and can output imagery as well as transforms for identified AR tags. We've been able to place these transforms in RViz and are very close to achieving localization to a world frame.

Songjie has been continuing work on building a map and detecting changes, which will allow us to identify and locate defects in the surface. His module is now able to warp images to a world frame and superimpose them on a map of the workspace, as well as cluster points of difference between two images and so identify distinct "defects", their bounding box, and centroid.

4. Future Work

A few more hardware modifications will be necessary before the final demo which I'll be handling. The camera mount must be improved so the camera doesn't so easily pop out of it. The existing feet should probably have their remaining magnets integrated so they can attach to surfaces with full force. I may even print a set of backup feet that can hold even more magnets in the event that it becomes necessary. Through experimentation, I'll need to find the ideal balance between friction tape and magnets to achieve the strength of attachment and ease of detachment that we desire.

The majority of remaining work to be done is in the realm of software. Localization, path planning, and image comparison are all partially completed and are not yet integrated with one another. I plan to work with each of Nathaniel, Songjie, and Dipta with their respective modules as well as their integration, wherever I'm most needed.

5. Figures

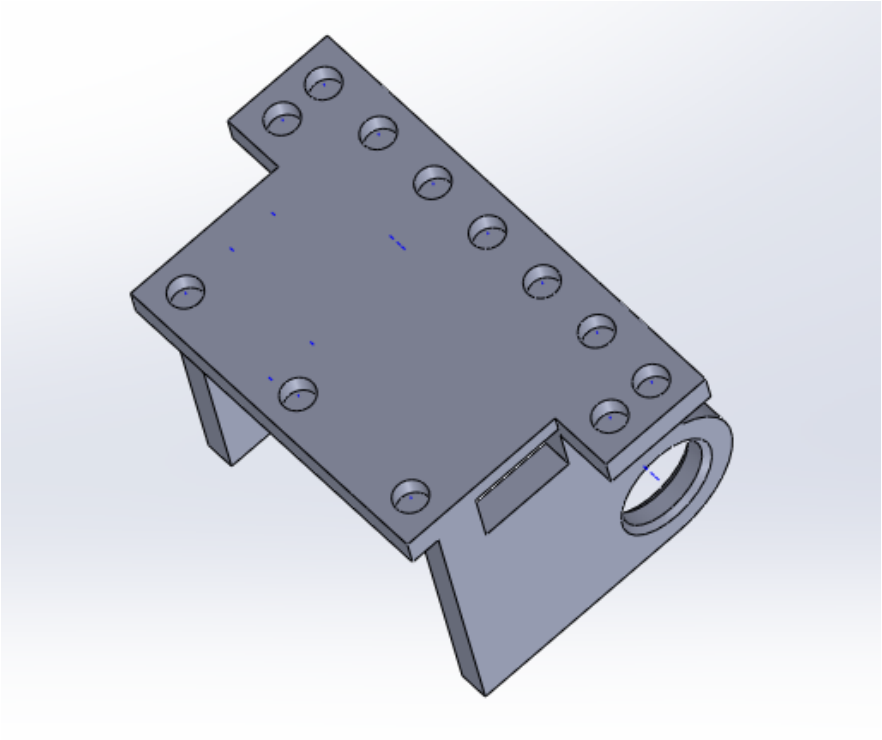

Figure 1: New end segment magnet configuration

Figure 2: Front segment camera mount with camera

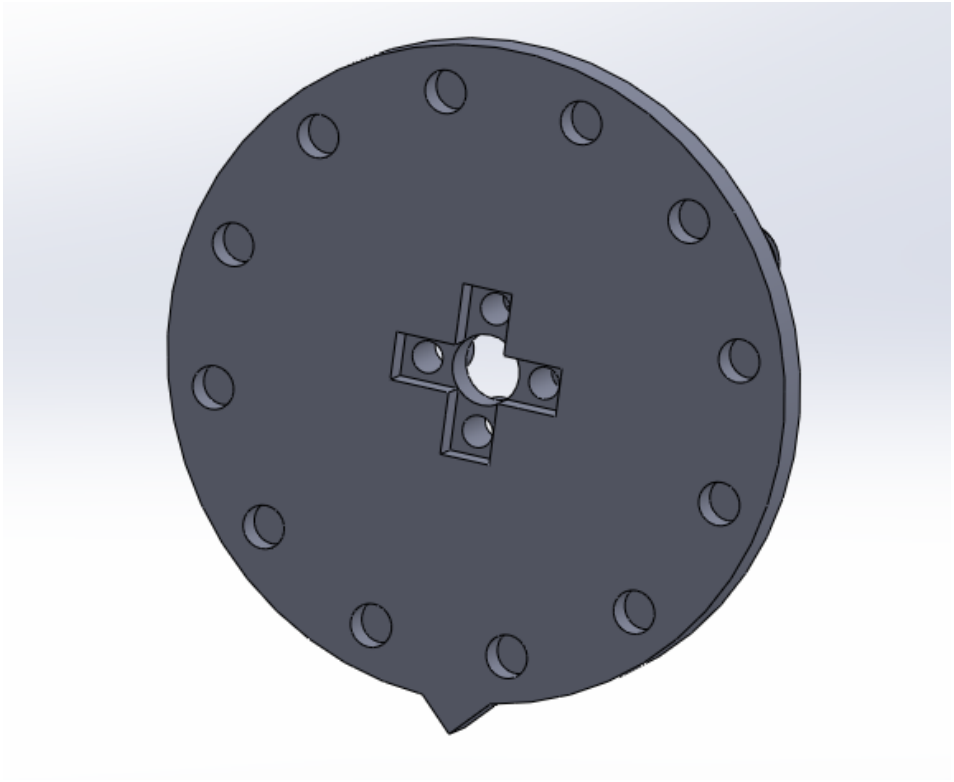

Figure 3: New center foot magnet radial configuration and increased footprint

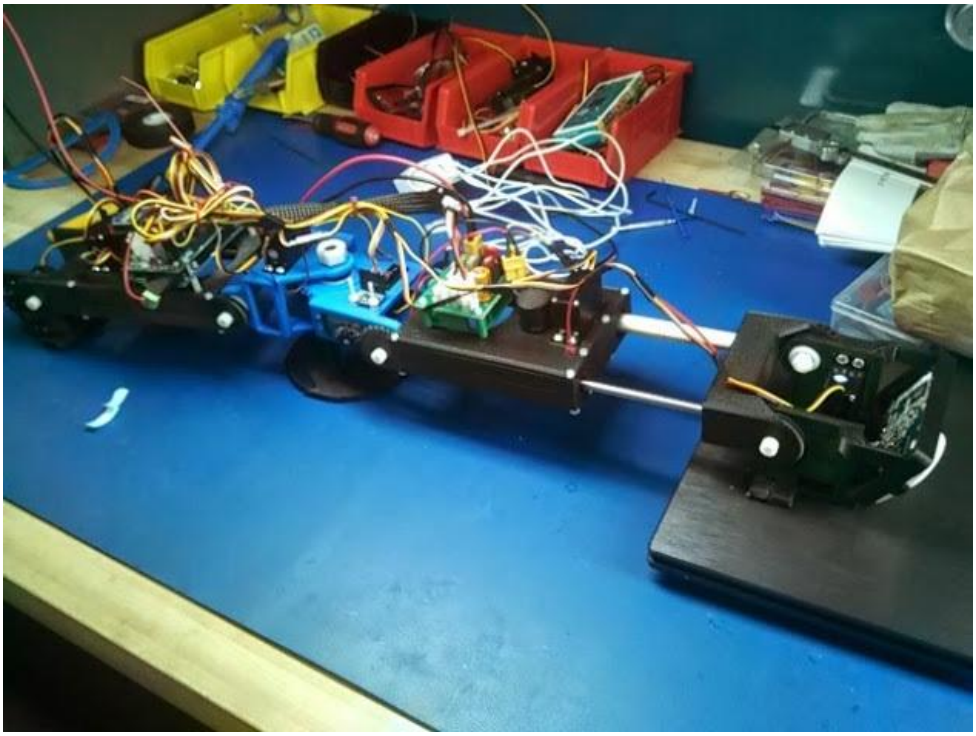

Figure 4: New chassis, newest segments printed with black ABS