Individual Lab Report #10

Progress Review #11

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Pit Navigator

Team G: The Pit Crew: Awadhut Thube, Justin Morris, Alex Withers

Individual Progress

Pit Navigator

FVD Dry Run at Gascola

Thanks to the progress made during PR 10, we were able to perform a successful dry run of our final validation demonstration on hardware. We poured a lot of resources and manpower into getting our robot ready for this test. We visited Gascola twice since the last PR. As the test director, I was responsible for coming up with this test plan and figuring out how we can measure and validate the requirements of the test and gather respectable videos and pictures to show on the website. I decided that our overall objective of these tests was to do validation of system level requirements, create visualisations, and to determine the weak points of the system that still needed work.

Our test consisted of starting the rover 3 to 4 meters behind the brink that we wanted it to traverse, then it would travel 2 meters forward via global and local planning. Once the robot's goal is reached, orient radially to the brink and perform the brinksmanship control algorithm. During this stage the robot will inch forward to the brink until the algorithm tells it to stop. Where it will take a panorama at 3 different tilt angles, then back away from the pit at double the speed and half the time to return to the first goal point. The rover will then use its global and local planner to travel 2 meters to the left and set that as the new goal point for brinkmanship and runs the algorithm again. This process is completed a 3rd time before the rover decides that it has enough data and must return to the "lander" to drop off data and complete the test. To simulate this the rover then navigates back to where the rover started the test and stops moving. This test would validate five of our seven performance requirements. With this test we could measure how close the brink was in comparison to where the rover thought it was, find a plan within 20 seconds, capture images that cover 20 degrees of the pit without distortion, capture more than 3MB of usable data at each vantage point, and determine if we operated in a way that would be less risky than a 5 to 1 safe to failure ratio.

To create good visualisations, I wanted a shot of the brink that we were near so we could get videos of how close the rover got to the edge. I wanted an overall shot from a human perspective, rover view, and a bird's eye view. Overall it seemed that we needed four video cameras and an additional camera to record the behind the scenes footage. While I had access to 2 video phones that we could use, and the realsense on the rover, we could not find a way to capture a bird's eye view without access to a drone. The bird's eye view was quickly dropped as a human perspective can also give a complete sense of what is going on. For the edge view, we needed a camera on a tripod, but for the first test did not have access to a tripod. I was able to

resolve this by bringing coffee mugs to lean the phones on. The coffee mugs were sturdy enough to hold their position while the camera was leaned against it. This was sufficient for the first test, but the view was very close to the ground, so I made sure to pack a tripod during the second test. Getting the rover's view was simple enough, we needed to create a rosbag that captured the video, even if the rosbag took up a lot of space on the rover's computer. The human's perspective was also fairly simple, putting a camera in my hands and recording the robot doing the test. Making sure that people/ equipment / cars and motorbikes were not in the shot was more difficult and we failed to have a truly perfect video for that during either trip to Gascola. The video related to figure 1 is the best video that we created from our tests:

Figure 1: Still from the video edit that shows off this final validation demonstration dry run. https://youtu.be/1bscJiN1qrg

We cannot validate our requirements and create storytelling videos during the same test. In order to validate requirements we need to lay measuring tapes down along each of the brinksmanship paths. These measuring tapes are marked every other inch with black tape, so that the distance from the edge is easily visible from a 3rd person recording, and if the camera is pointed in the right way, from the rover's camera as well. These measuring tapes are an eyesore for storytelling, as they are so visible to the cameras. The rest of the validation criteria is not reliant on camera videos, but post analysis. We will look at each of our panoramas and determine if the data contained within the image is not unusable, then add the size of the image to the total gathered at that point. We will also be looking at the panoramas for determining how much of the opposite side that we captured at each waypoint. The center 20 degrees is the most important, and if that portion is captured, then the minimum requirements have been met. We will look at roslogs to determine how long it took to plan to each new goal and find an

average planning time. Lastly we will run the test many times to determine if we are operating in a 5 to 1 risk ratio during each approach to the pit, then during three approaches to the pit. Initial tests show that we have a 11 to 1 risk ratio upon approaching a single brink, but that may change as we optimize and test different parameters for the FVD.

FVD Dry Run In Simulation

Along with doing work on the rover, our other portion of the FVD is to run an entire mission simulation on our simulation computer. We poured all of our resources into getting the hardware test working nearly perfect, and used the simulation as almost an afterthought. While the algorithms that we developed work in both the simulation and demonstration, we took for granted how different they would be in practice. While running the simulation I realized there were a number of tweaks that we made in the field that was detrimental to the simulation, and made efforts to fix those as quickly as we could. In particular we had made changes to the local planner that altered the max roving speed and turning capabilities, that proved to not match the rover in simulation and caused crashes with obstacles. They have different configuration files for each rover now, but the rover in the simulation is not the same as it was. I will need to do more digging into what happened in the next week as we prepare for both the simulation and hardware FVDs. The simulation has the code to be complete other than that one issue and the navigation goals need to be altered to take full advantage of the brinksmanship code, but is well on its way to being ready for demonstration next week.

Challenges

Pit Navigator

Waypoint Navigation with Rover Hardware

Overall we met with many challenges during our hardware testing. Like our portable monitor did not come in time for the first gascola test and we needed to bring a regular monitor and power it with my car's battery. The car needed to idle for the entire time that we were doing the tests and was not desirable for the environment, or for our team. Upon arriving at gascola, it was clear that our code was not as plug and play ready as we expected and spent several of the first hours that we were there debugging code before we could test. This gave me plenty of time to set up all the cameras and rulers that were needed for testing. We came across errors like glare creating points in free space, very high slope values that would trigger the brinksmanship early due to slope in the roll direction, navigational drift due to the rover moving on sloped terrain, and the rover not turning fast enough to move the motors. Thankfully we solved most of these, and were able to get a decent result for this week's dry run.

Teamwork

Pit Navigator

Individual	Main	Sub	Description
Alex W.	Testing director	Planning nav debugger, film crew, simulation crew	I was responsible for making sure that the testing went smoothly, and was in charge of filming each test. I debugged the navigation code and helped Awadhut create visuals with the simulation.
Awadhut T.	Perception debugger	Simulation crew, documentation specialist	Awadhut majorly debugged the perception system and brinksmanship code to work on the rover, he also helped create visualizations to show of the simulation. He also took candid images of Justin and I working on the tests.
Justin M.	Technical assistant/Jack of all trades	Rover anchor	Justin helped the debuggers, particularly brinksmanship, work through the troubles they were having and held the rover and prevented it from falling off the edge

Plans

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FVD Testing

In preparation for our FVD, we would like to do system optimization tests in the field. The only place we can really test the entire system is at Gascola. I have been the point of contact for making sure that the testing site is available on the dates that we need, and am responsible for making the test plan and making sure the tests run smoothly. In the coming time before the testing in the field, I will be making as many preparations as possible so that it can run smoothly. I will ensure that we have access, have the necessary equipment, extra batteries, vegetation clearing tools, lunch, PPE, rope, robot, portable monitor, hotspot, remote access to the rover, extra cables, chairs, and water. I will also make sure that we know which tests are

useful and which we want to run so that we can most effectively prepare for the livestreamed FVD.