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Team D – CuBi

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Individual progress

For this progress review I worked on setting up and mapping the room with Bobby and Nithin, exploration on my own, grasp fail-safe with Paulo, and grasp validation with Laavanye.

CuBi Technical

Our project requirements indicate we need to explore a 20m^2 room. In previous weeks, we were testing in the 4th floor common area. The couches are constantly moved making the environment very dynamic. To test, we would neep to re-map the room. On average the amount of time it took me to set up Cubi every time and start running experiments was 20 minutes. The dynamic environment also made the debugging process very difficult.

We added several large obstacles in the room and made it not a perfect rectangle. We then mapped the walls and large objects. The room will give us enough flexibility, so that if we have time, we can test more complex algorithms and potentially even search for toys in different lighting conditions (ex: under tables). The distance between Cubi's center of rotation and the tray is 55cm. This is a huge turning radius which will make our exploration and obstacle avoidance more complicated.

I then worked on creating a map with Nithin and Bobby. It took us two attempts to create a good map. We would drive Cubi around be especially careful to not turn quickly. We also tried to not only translate as this could cause issues when performing the reconstruction. It took around 1 minute to map. We drove Cubi around with the controller and made it loop through the room three times.
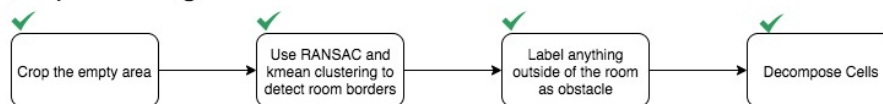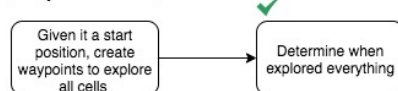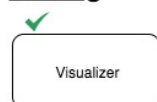

Figure 1. Exploration Pipeline and Status

For exploration, I created the pipeline that I included in figure 1. My goal was to create a pipeline which was as flexible as possible. I wanted it to be robust to different room shapes and sizes. The major assumption I made is that a room has 4 main sides that define it.

The exploration module reads in the map and the meta data from the file. The occupancy grid image is very large and room takes up approximately 5% of it. To speed up exploration analysis, I cropped it to the size of the room. I have a way to then map back to the exact cell in the original occupancy grid map. I then use RANSAC to find major lines created by the borders of a room. Once the lines are found, I cluster them into two categories using Kmeans. I get the two largest lines in each of the groups to define the borders of the room. I then find the edges of the lines to create a convex hull. Finally, I set all points outside of this occupancy grid as obstacles. This border prevents Cubi from exiting the room through the small holes we have around the map. As you can see, the process of refining and pre-processing the map is general and automatic.

Figure 2. The grey lines represent the obstacles that Cubi labeled as being at the border of the room.

Other tasks I worked on were:
- Creating a function to have Cubi lift up the manipulator to a place where the camera could see if it was full and perform grasping validation.

CuBi Project Management
Every week, I keep our task manager up to date. I am realizing we are having issues as everyone's tasks are not granular enough, so I am trying to help the team do so. This will improve accountability and track how much progress we have actually made.

Challenges

Technical

I integrated the fail-safe code Paulo and Bobby created. I did this with Paulo and it was great because the team then realized that a task might take 2 hours to finish and it will take another two hours to integrate it. The grasp-fail detection only worked in the last PR because of the three second sleep. If you changed the three second sleep to a seven second, it would break. The reason that this happened was that when the manipulator would get stuck, it sent a command to the state machine. Since it got stuck for a prolonged amount of time, it would send multiple commands to the state machine, causing it to toggle many times. I debugged the issue with Paulo and finally integrated the fail-safe mechanism.

Team Work

Nithin: I worked with Nithin on creating the map. I also helped him design the obstacle detection pipeline.

Paulo: I worked with him to integrate to integrate the fail-safe mechanism. This was one of the biggest issues we had when grasping.

Laavanye: I added some pre-defined manipulator positions, so that grasping validation could be done.

Bobby: Worked with him to create the map. We had to research packages so that we could then save the map and make it accessible in future runs.

Nithin, Bobby, and I also set up the environment we used to test. This was a long process as we need to create one that was stable and flexible enough for us to test our different modules. We also all worked together to test Cubi in the new environment and saw that Cubi had many different false positives in object detection.

Plans

- Given a start position, create a set of waypoints to explore the entire room
- Integrate Exploration into our system
- Obstacle detection design a proof of concept
- Obstacle avoidance design a proof of concept.