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Team D – CuBi
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Individual progress

For this progress review I worked on the global planner static obstacle avoidance module and integration on Cubi.

CuBi Technical

I made a lot of changes to the global planner: added the ability to go from one point to another while avoiding obstacles, inflated obstacles, improved the visualization and performed an initial integration on Cubi. Paulo had created an algorithm in which given a map, he created a path that would minimize turns and avoid cells with obstacles. I integrated his section of code with my map and global planner module. When defining our initial interface, we had not accounted for the direction Cubi was pointing towards when going from one point to another. I had accounted for it in the map frame (x,y, yaw) and he accounted for it as a cardinal direction ("North", "South", "East", or "West"). I created a mapping from the map frame direction to his cardinal direction.

I then made it possible for the global planner to have three modes: exploration, going home, and going from one point to another. When returning home, we only go through visited cells. I also wrote a function to determine where cubi was in the occupancy grid and whether it had arrived to the center of the cell in the decomposed cell map. Therefore, given the mode Cubi was in and where it was in the map frame, I could publish the new desired waypoint.

We were also experiencing issues during our last PR where Cubi would crash into walls when exploring. As mentioned in my last ILR, we cannot make the decomposed cells large enough to assure that Cubi will not crash, but also will not crash into walls. To solve this issue, I made the decomposed cells a little larger (from 0.5m to 0.7m) and then created a 25cm inflation of obstacles. This should assure never crashing because cubi has a rotation radius of 0.6m and the smallest possible distance the centroid of a decomposed cell and a wall is 0.6m (half of a cell 0.35m + inflation 0.25m). The only case where we have seen this fail is that it tries to search under the table as the table is higher than the LiDar. It then can crash into the legs of the table which are not perceivable by the LiDar.

I also changed the exploration policy because the previous one was too slow. It would explore and when it saw a toy it would pick it up and drop it off at the box. Once it completed this, it would return to the point where it saw the toy. Now, from the box, it searches for the closest unvisited cell and continues right following. This saves valuable time.

Furthermore, I changed the visualizations in simulation making it easier to see where Cubi is and how it is exploring. In this way, we can visualize what Cubi does when picking up a toy and how it returns through visited paths. This has made debugging when testing on Cubi much easier as we know exactly where Cubi should be going to in all moments. The visualization can be seen in figure 1 in the Appendix.

Finally, I created a preliminary integration between the global planner and Cubi's state machine. The state machine can receive new waypoints and go to them. However, there is a bug causing the global planner to think that Cubi has never reached the waypoints. As of now, we have just pasted all the waypoints the global planner outputted into the state machine.

I also worked on the integration with Bobby. This will be discussed in the Challenges section of the report.

CuBi Project Management

Every week, I keep our task manager up to date. I scheduled many group meetings to ensure at least two people were working in the lab on integration multiple times throughout the day. This is necessary because problems are very complex to debug and we need people to bring in the knowledge of their subsection.

Challenges

Technical

Bobby and I have been doing great part of the integration work together. We've faced many issues to get a successful run. Initially, we had problems where we would always miss the toy. One of the reasons was because the controller did not require Cubi to be within a small enough angular threshold. We decreased this and it solved some of the problems. Another issue we had was that Cubi would sometimes miss the toy because it would rotate and go towards the toy all at once. If Cubi was too close to the toy, it would not have enough time to rotate, so it would finish rotating at the end. To solve this, we created the idea of an approach point. Cubi would go some distance between itself and the toy and face the toy. Then it would go and pick up the toy. Finally, Cubi would sometimes crash because it would pick up a toy, lift up the tray and then rotate. With a fully extended arm, Cubi has even larger turning radius causing it to crash into a wall if the toy was placed close to a wall. I made Cubi pick up the toy, rotate and then lift up the tray before going to the box. We have faced many more issues when performing integration, but the main ones were mentioned.

Team Work

Nithin: I worked with Nithin on deciding how to align with the box and go towards it.

Paulo: I wrote a global planner which performed the exploration and had an empty function in which given a map and two points, found a trajectory between the two points. He wrote that portion of the global planner algorithm.

Laavanye: I worked with him to ensure that the parameters he tuned for vision matched the assumptions I had made for the global planner.

Bobby: I worked with him a lot on integration. We worked together and sometimes with others to integrate the different subsystems.

Plans

There is one week left for us to finish the first version of the FVD. I will finish integration exploration and fix the stop and go issue. Currently, Cubi stops at the center of each cell before continuing to the next. A lot of time is wasted when doing this. I will also work with Bobby and the rest of the team to fix the following issues: hitting the box when dropping a toy, missing the toy, offset problem in our controls, and reduce height of should when dropping.

Appendix

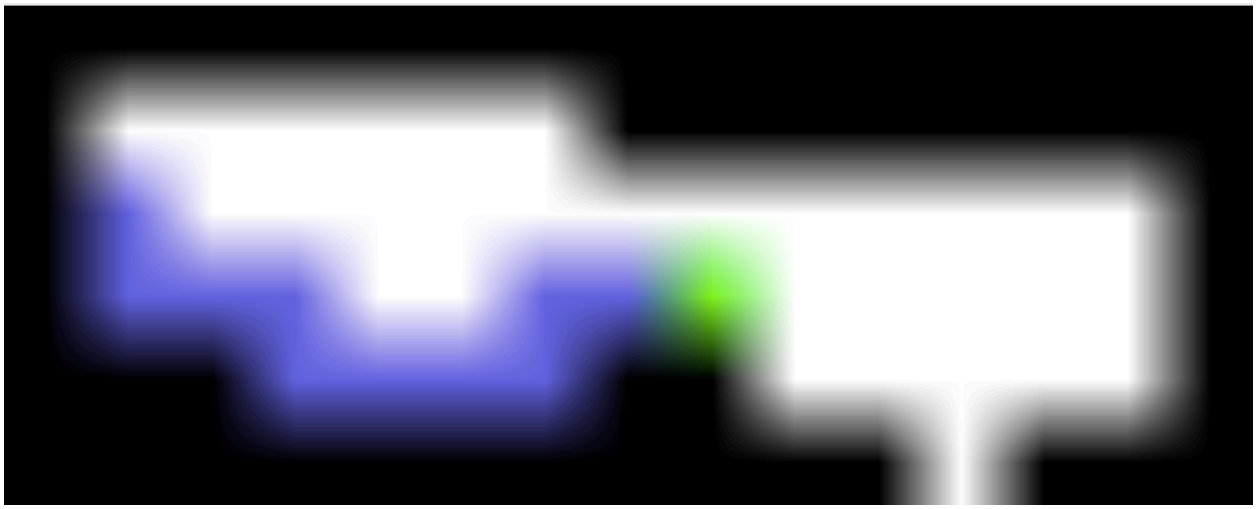

Figure 1. The white shows unexplored territory, the green shows where Cubi is at and the black shows obstacles.