MRSD Project 1

Individual Lab Report #04

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PhoeniX
Teammates:
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Individual Progress

My main assigned task was to get figure out what kind of manipulator-arm we would be using and how would we attach extinguisher to it. Initial idea was to get some simple arm with 2-3 degrees of freedom so that we can point extinguisher to the detected fire. But after talking with the sponsors, we realize that they need the ground vehicle for different MBZ challenge to pick cubes as well which requires more degrees of freedom in the arm. Sponsors agreed to provide UR5 arm from their lab. With this updated situation, my goal was to figure out a way to attach extinguisher to the arm.

I started with looking at UR5 design specifically its end factor design. I came to know that UR5 provides multiple end-factors for various applications which means that end-factors are detachable. I decided to custom design and 3D print end-factor that is compatible with UR5 design. I procured the CAD model of the UR5 and keeping the attachment mechanism in mind, designed the part. Experience gained while doing CAD assignment of MRSD helped a lot in quickly moving forward with the design process. I ended with a simple two-part design as shown in figure 1.

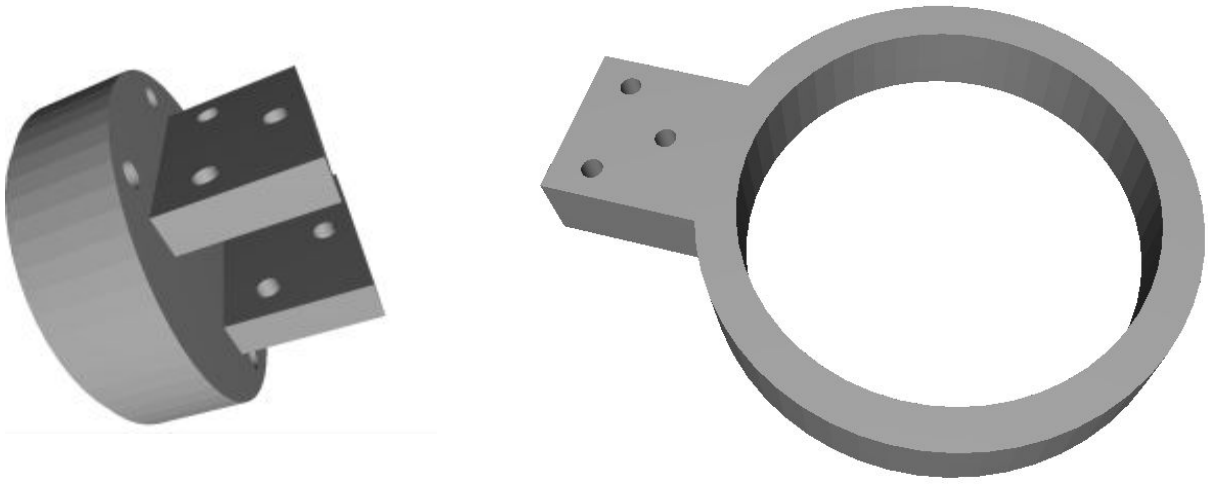

Figure 1: Designed parts to attach extinguisher to UR5 arm

Once the design was completed, I 3D printed both the parts. 3D printing was not as smooth as I was expecting but after a couple of attempts, I got parts that I needed to attach the extinguisher. The final result can be seen in figure 2.

Figure 2: Extinguisher attached with UR5 arm

Another task was to integrate SLAM with our framework. Last time, we had a SLAM system running independently and now we wanted to use that information to control the system. While ORB-SLAM2 provides ROS wrapper, that wrapper is limited to subscribing to image topics. ORB-SLAM2 doesn't publish any trajectory or map information back to ROS topics. I had to dig into ORB-SLAM2 code and find relevant trajectory information, convert transformations to compatible form and publish them to tf tree. I also had to write tf subscriber inside our ROS motion server framework to get that trajectory information. Finally, I along with Shubham wrote a simple state machine to demonstrate a simple mission that uses SLAM information and executes the mission.

We also built a new hexacopter. Details about which can be found in teamwork section.

Challenges

There were some technical problems with the 3D printers. In the first attempt, only partial part was printed. But by looking at the partial part, I noticed possible problems even when print was complete specifically regarding assembly of both the parts and how much extra space should be kept between them. I also found one difference

between the UR5 CAD model and actual UR5 that might cause an issue. After fixing those issues in my design, I reprinted the parts.

UR5 arm was there in the Manipulation Lab and I didn't have access to the same. Also, I had no experience using the UR5 arm. I had to collaborate with students in manipulation lab. They were helpful in providing me suggestions and CAD models of UR5 arm.

Since we wanted to do mission in husky without any wires connected, I had to modify the code to turn off any GUI viewer which doesn't work when SSH mechanism is used. That also meant that we won't be able to visualize the map and trajectory live. We faced this problem when doing a mission in the corridor instead of the lab. We had to record the run and later visualize the same to figure out the issue. Lack of features in the scene was causing the problem. Shubham and I tried to solve the problem but as of now, we are still trying to find ways to overcome the same.

Teamwork

We did an outdoor flight test as well as an indoor flight test. Akshit, Steve and I participated in the outdoor flight test. Shubham, Akshit and I participated in the indoor flight test. We also faced issue while landing in outdoor test and hexacopter got damaged a bit. We also made a new hexacopter. Based on our learning from building it last time, we made modification specifically in hexacopter arms' length and work distribution in building the drone. Some parts haven't arrived yet but other than that we are almost done building a new drone. Everyone in the team worked together to build the new hexacopter as efficiently as possible.

Figure 3: Newly built tilted hexacopter

Future Plans

I would be working on the simulation aspect of the system. Simulation is required for MBZ project report as well as proof of concept for Spring Validation Experiment. Akshit will collaborate with me regarding the hexacopter part of the simulation. I will also be working with Shubham in debugging problems in ORB-SLAM2 in feature sparse environment and how to improve it.