

MRSD Project 2

Individual Lab Report #06

Parv Parkhiya

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Team H:

PhoeniX

Teammates:

Shubham Garg

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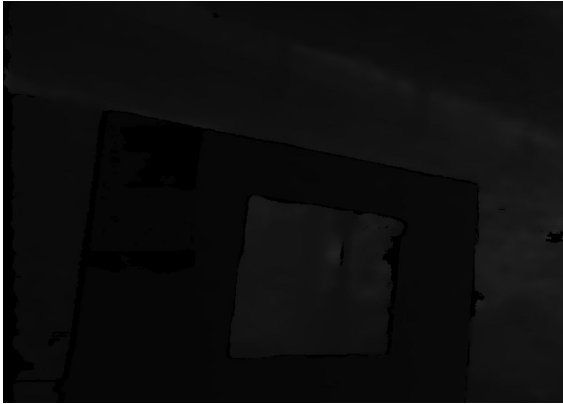
Zhihao (Steve) Zhu

Individual Progress

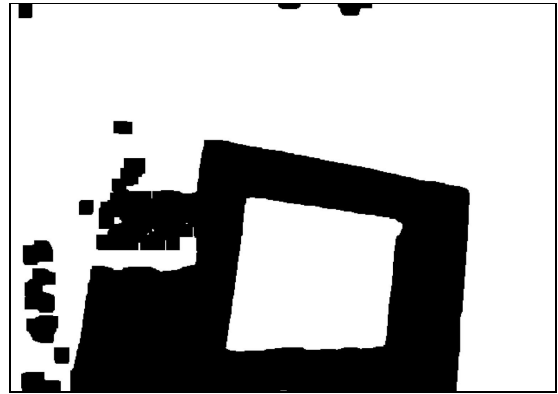
I worked mainly on the opening detection part of our project before this progress review. Stereo disparity images are input to our system and we want to detect the opening through the window and door through which UAV and AGV can fly and drive through respectively. We wanted high performance for opening detection module, so we decided to implement the system on C++ instead of python. We used the OpenCV library to perform various image processing operations. Given an image, first, we converted the gray-scale image into a binary image by thresholding. To filter out the noise in the form of small clusters in the image, I used morphological operation such as “closing”. On the filtered image, contour detection is run to get the contour of various blobs in the filtered binary image. Contours with the unreasonably large or small areas are rejected. Valid contour with the largest area is chosen to be the best guess of the opening. The minimum area rectangle that encloses the contour and largest free space circle inside it are computed and outputted. Grayscale of the output image is rescaled for better visualization. Result at various stages in the pipeline can be seen in figure 1. Finally, I wrote the output part of the ROS wrapper around our Opening Detection class that can publish images to the ROS channel.

I also set up the IDE named CLion (for C++) and Pycharm for (Python) code for efficient restructuring and debugging of the code. Working with IDE was far more productive than writing code on a text editor. Experience of writing C++ code during the internship was really helpful and was influential in improving the quality of the code.

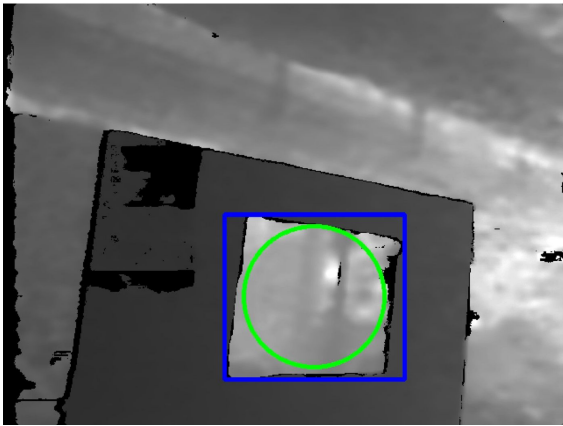
Another major task was scheduling and attending various meetings with sponsors and other team members since some of the team members arrived back to Pittsburgh a bit late. There was a major shift in terms of the UAV platform which is changed from custom Hexacopter to DJI Quadcopter.



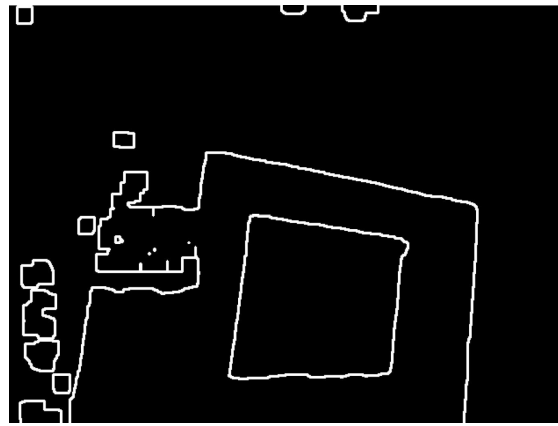
Input disparity image



Filtered thresholded image



*Output Image
Detected Opening on Normalized Image*



Contour detection

Figure 1: Opening Detection Pipeline

Challenges

Image conversion from ROS format to OpenCV format turned out to be trickier than I initially imagined. Stereo disparity images in ROS are in the 16-bit format whereas the OpenCV module we wrote works with the 8-bit format. Also, when we use ROS “rqt” to view a grayscale image, internally it normalizes to make the darker image brighter. I had to figure out how to replicate that effect in OpenCV. The functionality of the same can be seen in figure 1 where the output image is much brighter than the original input image. Writing OpenCV in C++ was also new for me and took some time to get used to. While in python everything just works, in C++, there are many small details that need to be specified. But there is a significant performance boost in using C++ instead of Python.

The decision of changing the platform came from our sponsors. But we didn’t want to spend time in figuring out operation and interface with new DJI drone since that would put us back in our development of new functionality. We had to convince our sponsors in a way that would allow us to keep working on high-level functionality.

Teamwork

Akshit and I worked on the Opening Detection part of the system. We went back and forth in terms of writing various functions in the code and followed proper git workflow. We also worked together in fine-tuning the parameters so that our opening detection can work appropriately on the recorded bag of the stereo disparity image stream. Our code is easily able to keep up with 30 fps stream provided by the camera.

I also went to Gascola (test location roughly 30 minutes away from CMU) with half a dozen MBZIRC team members on the last Sunday. We had to pack (and unpack after returning) various stuff from additional propellers to screwdrivers in the AirLab Ambulance that might be needed at test sight. Together, we set up the test environment and conducted multiple flights with the new DJI platform for testing flight stability and data collection.



Figure 2: Flight Test with new DJI platform at Gascola

Future Plans

The future plan is to use the opening detection output and align UAV with respect to the opening and finally fly through. For this, we would need special visual servoing capability that can orient UAV's front perpendicularly to the wall and can go through the opening. I would work on getting the 3D transform between UAV and the opening. For husky, we would have to plan trajectory with keeping its motion constraints in mind. We also want husky to plan a trajectory around obstacles. I will look into creating a 3D occupancy grid map from the disparity image that can be used by local planner being set up by Shubham. We might receive a new UAV platform this week. Together as a team, we might spend some time learning basic things about the DJI drone.