ILR #7: Progress Review 8

Zihao (Theo) Zhang- Team A

February 15th, 2017

Teammates: Amit Agarwal, Harry Golash, Yihao Qian, Menghan Zhang

Individual Progress

After discussing with the team during last week, I decided to switch my focus from the radar to the stereo vision subsystem as a way to better contribute my skills to the project for the rest of this semester.

Since the shift of my role last week, I have been working hard to catch up with the current progress on the vision subsystem. As the calibration of stereo vision was almost completed, I have been working with Yihao to generate the disparity map of images from the stereo camera.

The core algorithm that we are currently applying for the stereo vision is called the Semi-Global Block Matching (SGBM), which is built based on resources from OpenCV and is implemented in C++. To gain the basic familiarity with the algorithm as the first step, I studied and reviewed several popular algorithms including Block Matching (BM), SGBM, and AD-Census through various research papers and open-source code. This learning process helped me better understand how each algorithm worked and the tradeoffs between one and another so that I could make more reasonable analysis on the results later.

To test the software, I collected image data with Yihao from the outdoor parking lot on campus in order to get similar lighting conditions and objects of interest in the real object detection and tracking. We took images that contain "larger" targets (vehicles) within the short range (< 10 m), as well as "smaller" targets (vehicles) within the mid-range (20 – 60 m), as shown in the pictures below:

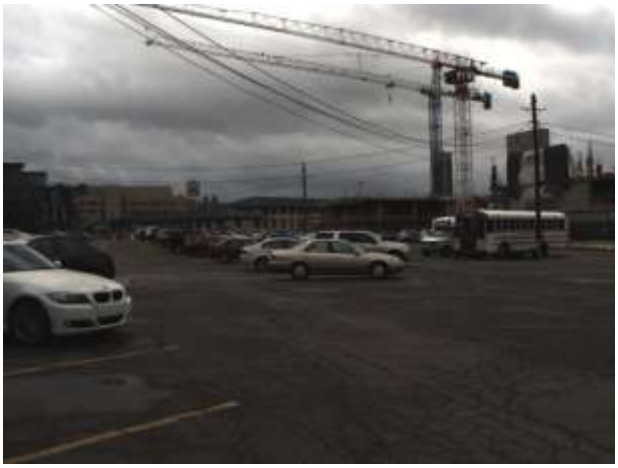

Figure 1. Image with mid-range objects

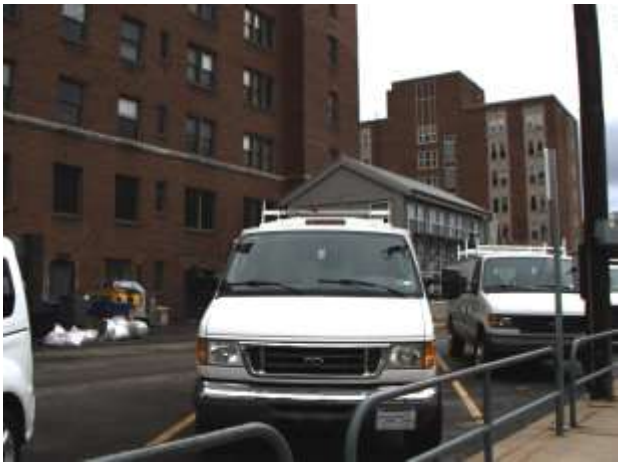

Figure 2. Image with short-range objects

We successfully complied the code for generating the disparity map and tried different combinations of parameters such as the window size and maximum disparity in order to achieve better quality for each disparity map.

Figure 3. Disparity map of scene from figure 1

Figure 4. Disparity map of scene from figure 2

In comparison, the disparity map on the left has a better quality on depth estimation, as the general shape of most mid-range vehicle objects can be easily observed from the map. The disparity values across the same object are mostly consistent as well. The disparity map on the right, however, cannot render even the general shape of the vehicle object (van) in the short range. The disparity values are mostly invalid across the object.

Through literature review, I realized the two factors that have the most significant effects on performance of the stereo vision algorithm, namely the existence of un-texture regions and photometric variation. These two factors can be used to well explain the difference existed between the two disparity maps above: as the object becomes closer to the camera (larger in the image), the same un-textured region (for example, the hood of the van) also becomes larger. Given the same window size, errors are much more likely to take place in this region because the increasing number of pixels in the same region. The subtly different lighting conditions between images from the two cameras also added difficulty to the feature matching process to some extents.

Challenges

The abrupt shift of my focus from the radar to stereo vision initially brought me some challenge in catching up with the current progress in stereo vision. The limited time between my shift and this progress review required me to adapt myself with a fast pace and be able to make progress on my new work during the short period of time.

Fortunately, the computer vision course I took last semester allowed me to take advantage of my prior knowledge and build new knowledge on top of it. It gave me a jump start while reviewing the theory and algorithms. Moreover, Yihao (who has been mainly working on the stereo vision)

also provided a great environment for collaboration and open discussion. This also helped us work toward the same direction and facilitate the progress together.

Teamwork

Amit Agarwal:

Amit has been working with Harry on setting up connection between the radar and computer through Ethernet. There was minimal update about the radar during the past week.

Harry Golash:

Harry has been working with Amit on setting up connection between the radar and computer through Ethernet. There was minimal update about the radar during the past week.

Yihao Qian:

Yihao finished the calibration of our stereo vision subsystem and was able to generate disparity map from images using C++ and OpenCV. He has been searching other algorithms to make further improvement on our current algorithm.

Menghan Zhang:

Menghan worked on integrating depth information from the stereo vision with the object detection result. Specifically, the depth value of each detected object can be now displayed on each bounding box in the image.

Plans

Before the next ILR/ progress review, our team would like to achieve the following goals on our project of developing the perception system using Stereo Vision and radar:

1. Improve current stereo vision algorithm for depth estimation
2. Quantitatively evaluate the accuracy of the stereo vision
3. Research on data visualization
4. Write and parse data to file
5. Understand detection level data

In term of individual work, I will be mainly involved in tasks related to stereo vision (Task 1-2). Specifically, I will also work on developing a software program using Point Grey API to send captured image to stereo vision and object detection programs continuously.

I have also ordered a GPS module (used with Arduino) to help with the object tracking and ego-motion estimation (the next steps of the project). I'll start to work on it once the module is received.