ILR #10: Progress Review 11

Harry Golash – Team A

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1. Individual Progress:

1.1 Tasks:

For this progress review our team had the following tasks accomplish:

1. Integrated stereo vision system (detection + tracking of multiple objects)
2. Data filtering and clustering for the radar
3. Meaningful integration of camera and radar data
4. Initial sensor fusion and data visualization

The tasks I was partially responsible for were the second, third, and fourth ones in the list above. We planned to use ROS for the purposes of sensor fusion and system integration. Unfortunately, we did not accomplish sensor fusion or integration of the camera and radar data, since the ROS setup for stereo vision ended up being more technically challenging that previously anticipated. We were however able to setup the radar in the ROS environment, and visualize the detection-level data in real time using rviz. Right now, we are working on clustering the detection-level data to assist with the stereo vision tracking.

Additionally, I improved the power setup for the radar and camera such that they can now draw power from a single 12-15 V DC source (car battery), with in-line voltage regulation circuits for 24 V for the radar and 12 V for the cameras (DC).

1.2 Implementation:

1.2.1 Data filtering and clustering for the radar:

Unfortunately, we were not able to get to the clustering of our detection-level data for the radar. Our sponsor let us know that they had an in-house filtering and clustering algorithm that they are willing to share with us, so we put off working on it ourselves. We are currently working on clustering for tracking purposes.

Since our last progress review, we were able to visualize the radar data using rviz in real time, which allows us to view all the objects detected in a spatial grid (see Fig 1.). The grid is created such that the radar is at the center of the grid and detected objects are displayed around the radar at their detected distance in meters – each increment on the grid represents a distance of 1 m. This allows us to now do real-world testing to determine the accuracy of the radar's object and boundary detection capabilities (the figure below was obtained during indoor testing). To determine the radar accuracy, we plan to use a laser distance measure for ground truth, as we did with our stereo vision system.

In order to visualize our data, we used rviz in ROS (see the ROS setup description below). We used ROS since we as a team decided to use ROS for our system integration and sensor fusion. The data was obtained at 20 Hz, which is sufficient for real-time perception for our purposes.

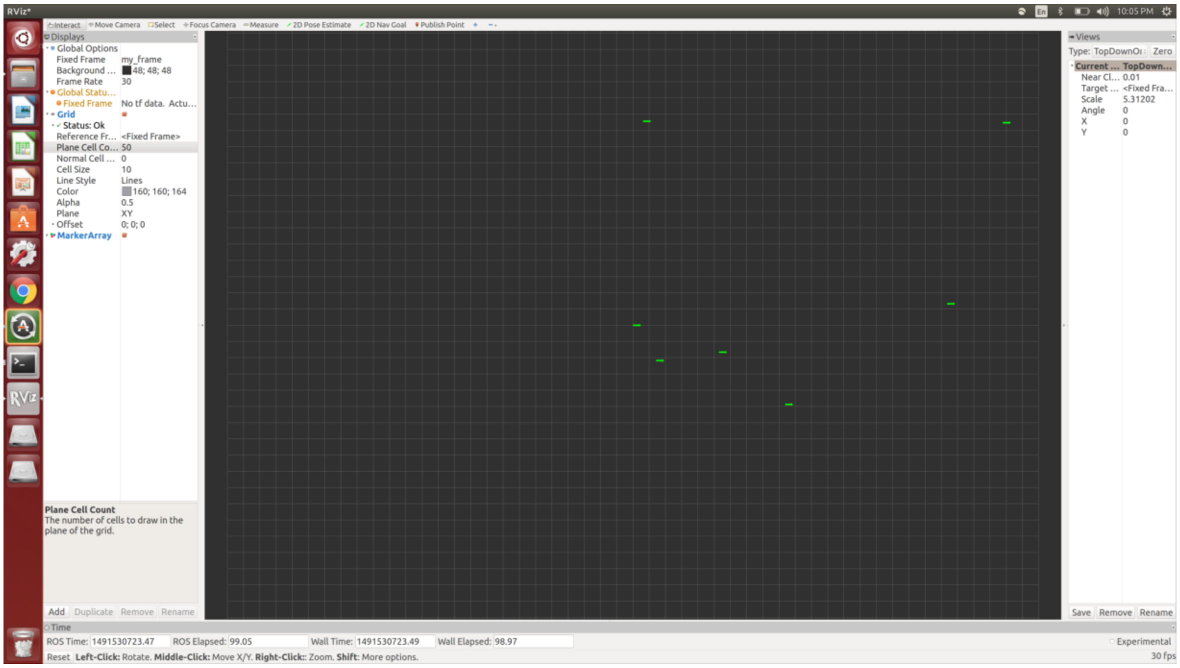

Fig. 1: Radar object detection visualization in rviz

1.2.2 <u>Integration and sensor fusion:</u>

Our team decided to use ROS for sensor fusion. To enable the radar to work in ROS (and to visualize the data in real-time), we created a node to publish the integer-arrays generated by the radar to a topic. Another node subscribes to the topic and received this position and angle data, de-codes it, and then converts it from polar to Cartesian coordinates. This converted data is then visualized in rviz using a third node (see Fig. 2. for ROS setup screenshots in terminal).

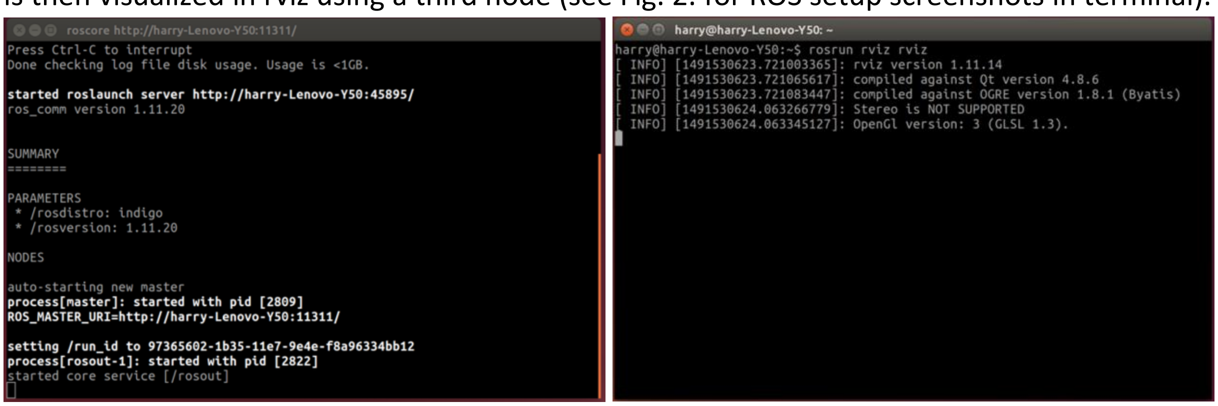

Fig. 2: Setting up the radar to work in ROS

1.2.3 Improving the power setup:

Until the last PR, we used the large DC power generator to power the radar, for lack of a better option (our PDS PCB had failed spectacularly). For the cameras, we used either USB power or a 12 V DC power supply that had to be plugged into a US mains socket. In order to consolidate the power supplies for our sensors, and to allow for overvoltage protection, I rewired our setup such that a single 12-15 V DC power source can power all the sensors (we currently use a 4S LiPo battery, but we will switch to a car battery once we reinstall the sensors on our test vehicle). I used HXT 4mm connectors to ensure that the setup is robust. For the radar, I used a regulated DC-to-DC step-up module (see Fig. 3) and for the cameras I made a small in-line voltage regulation circuit.

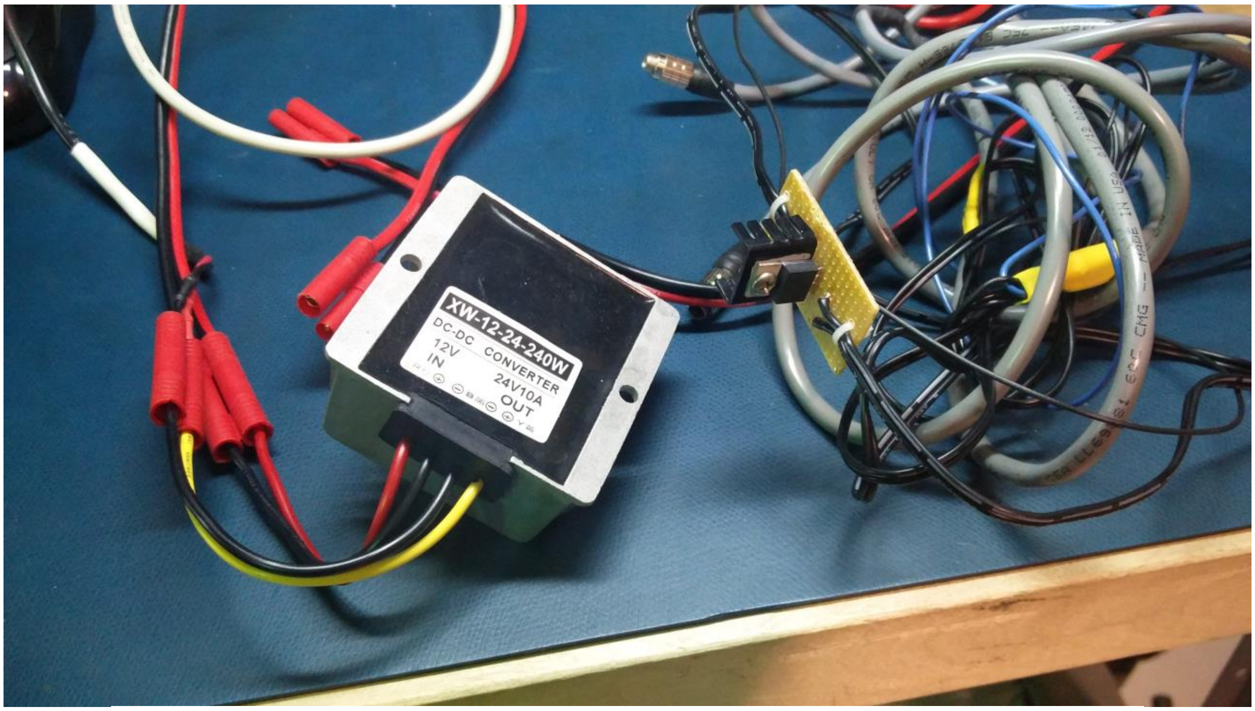

Fig. 3: New and improved power supply setup for the sensors

2. Challenges:

Unfortunately, we underestimated the difficulty of setting up the stereo vision system in ROS, and so we were unable to do initial sensor fusion as planned. On the radar front, we were told that we would be given a clustering algorithm from our sponsor, and so we did not work very hard to create our own.

During testing, our test vehicle met with an accident with a small animal, which left the car un-drivable (the radiator was cracked). The car is currently in repair, and should be fixed shortly (a few days max). One of the LiPo batteries that we used while testing our new power supply circuit puffed up and is now unusable. Fortunately, we had a few spare batteries.

3. Teamwork:

There is a large amount of work that needs to be done by the next PR. We will need to closely and effectively manage our progress in the days to come. We have distributed the workload among teammates and assigned specific tasks and internal deadlines, which we will review and update daily.

Amit and I will work on the radar data-filtering, data-clustering, and real-world testing. Zihao and Yihao and Menghan will complete the ROS setup of the stereo vision system so that we can achieve sensor fusion between the cameras and the radar. By the next PR, we hope to demonstrate sensor fusion in real time using ROS. We also hope to use the radar data to meaningfully complement and bolster the performance of the stereo vision system. We will determine the best use of the radar by conducting real-world testing using our test vehicle. Our next PR should be a rehearsal of the SVE.

Personally, I feel there is a fundamental misunderstanding in our team of the dynamics and requirements of the MRSD project. While I was project manager last semester and Amit is project manager this semester, I don't think either of us understood that we were supposed to essentially spoon-feed and babysit the rest of our teammates. Given the feedback received, I will try to exercise better leadership; for what it is worth, I think it would actually be a better use of my time to just do all the remaining tasks singlehandedly. For example, last semester, two of my teammates reported that they were working on "familiarizing themselves with the PointGrey API" – a process that apparently they could not complete in the 5 weeks they worked on it. By contrast, it took me 4 hours to write code and a GUI that triggered both cameras simultaneously and received and saved the images in a useable format. This pattern does not seem to have improved in the months since, and once again certain teammates were unable to complete a ROS setup in the two weeks they had to do it. From what I have learned, I was out of line to critique their performance, which was largely a result of my poor leadership anyway.

4. Future Plans:

By the next progress review, we hope to accomplish the following:

1. Sensor fusion of stereo vision and radar
2. Tracking from the clustered radar data
3. Improvements to real-time performance of the integrated system

I will be working on all of the tasks above, as will the test of the team.