Individual Lab Report

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Team B – Auto Pirates
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ILR07

February 11, 2016

1 Individual Progress

As we have started the integration of the system since last progress review, we went to test how the systems works during the last field test. We have some good progress such as replanning and integrating the bridge pylons into the path planner, but we still found some new problems. One big problem is the path we generated is not so smooth and sometimes the path planner choose a kind of dangerous path. We have to fix this by mainly two approaches - 1. Modify the costmap, so that the cost near the shores and pylons will be increased and the planner won't choose the path that is too close to either the shores or the pylons. 2. Tune the motion primitives, so that the motion of the boat can be better described and controlled.

1.1 Generate Motion Primitives

The SBPL Lattice Planner uses combined motion primitives to generate a path to the destination. And the motion primitives are predefined motion that a robot can take given the state.

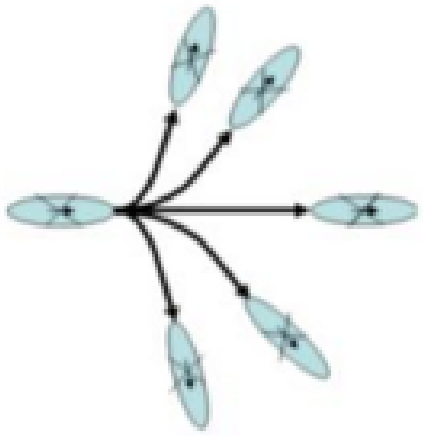

Figure 1: Motion Primitives

Figure 1 shows an example of motion primitives. This motion primitives tells that the robot can take a path forward, backward and sideways (indicated by the arrow).

In our case, we divide the 2D space (360 degree) into 16 angles, which means our boat can choose a direction from one of the angles. For each angle, there are corresponding motion primitives similar to figure 1. And we can use the matlab tool by SBPL lab to generate and tune the motion primitives.

1.2 Tune Motion Primitives

Let's look at the motion primitives before as figure 2 shows. Figure 2 shows the motion primitives for 0, 22.5, 45, 67.5 degree respectively. And the motion primitives for other angles will be just symmetric as these. We can see here the problem is that no matter which angle, the motion primitive takes a relatively longer straight distance until diverge.

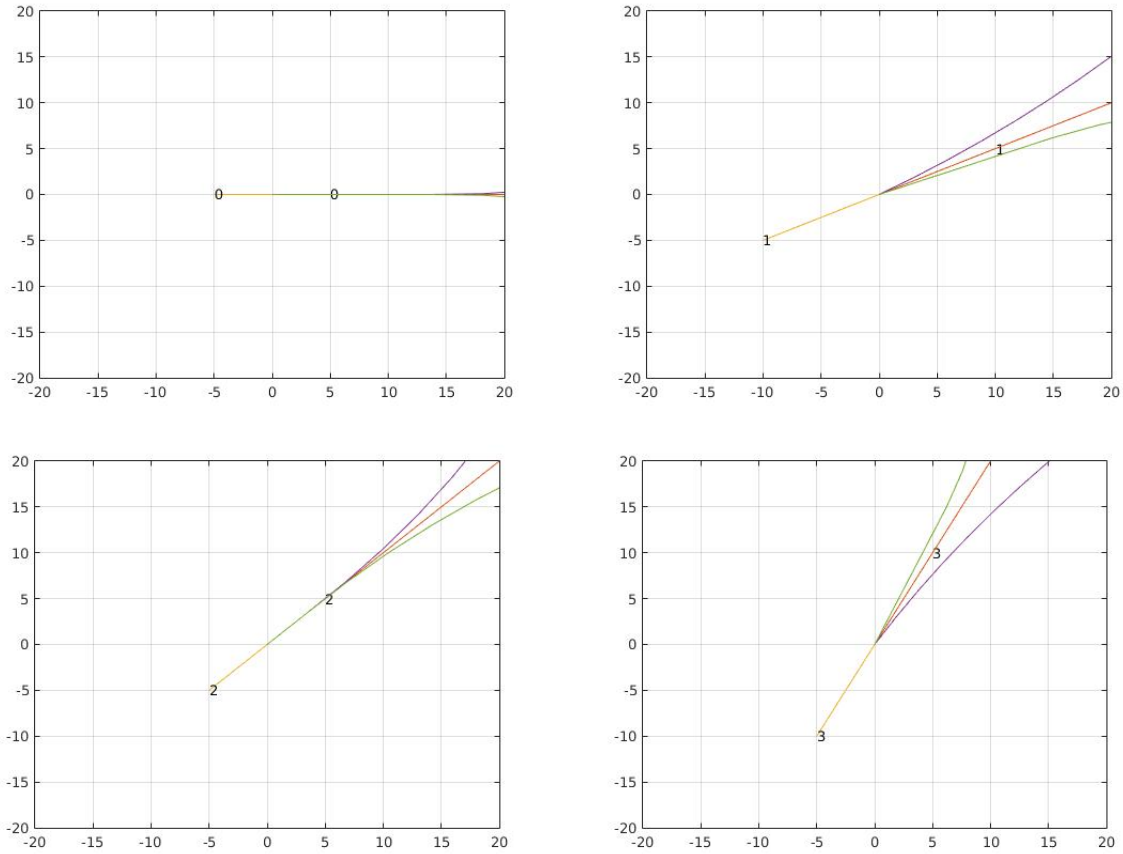

Figure 2: Motion Primitives before tuning

This default setting is reasonable as for the purpose of saving computational power, because we want to plan the path using less waypoints and avoid changing waypoints so frequently. But this will cause the problem when turning as stated before.

1.3 Tuning Result

Therefore, I tuned the motion primitives to give each of them a shorter length. And after tuning using the matlab script, the motion primitives are shown as figure 3.

We can see that the length of the motion primitives is decreased and then we can get smoother path. And we'll test different settings of motion primitives in next field test.

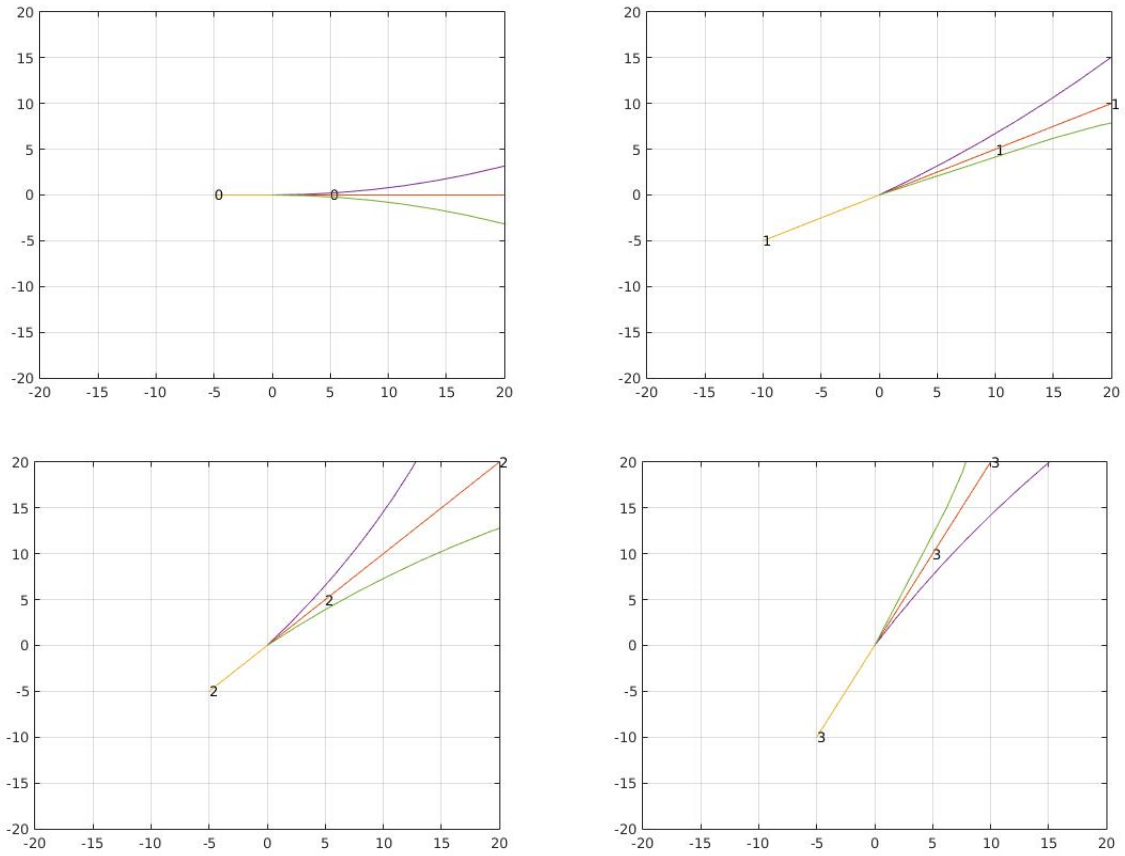

Figure 3: Motion Primitives after tuning

2 Challenges

The main challenge is to understand the concept of motion primitives and the matlab script given by the SBPL laboratory. I'm still not fully understand the whole script so I'll keep working on this in the next week. The difficult part is that the script defines the motion primitives in the first 90 degrees and symmetrize it to the rest of 270 degree. But things becomes more complicated if I want to add different cost for left and right side.

The other challenge is when we failed to integrate radar data with path planner because the radar is too noisy. After the field test, I tried to improve the binomial radar filter we implemented before to remove more noise. I played with the parameters and the result showed that if I make the filter too strong, it will lose some of the obstacles, mostly the buoys in the river and also it will be more difficult to match and remove the bridges in the radar image. So we are trying to develop other ros package (OctoMap package suggested by William) to improve the filtering.

3 Teamwork

- Tushar worked on the replanning of the path planning subsystem. He was able to do the replanning without deleting the environment, which makes the incremental path planning possible.
- Tae-Hyung worked on to develop the path planner to follow the roads of the road. He also proposed to use an extra GPS device to test the ros localization package.
- William worked with me to try to improve the radar filter. He also worked on implementing the rules of the road planning by manipulating the costmap.
- Bikram worked on improving the simulator and add dynamic obstacles with random trajectory in the river in rviz.

4 Future Plan

My future plan will be continue working on the motion primitives. This includes:

- Tune motion primitives, save different settings of parameters.
- Give the motion primitives different cost for left and right sides. This means making the boat have different motion primitives on different sides and let it prefer to turn on the right so that it follows the rules of the road.
- Test them on next field test.