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Summary

For preparing the Mid-term presentation, specific architecture is decided in our project. Also, the research about the RGB-D camera proceed in this week, as the RGB-D camera is selected for using in the SLAM and obstacle avoidance. Moreover, defining the limitation and de-limitation of our project.

What FarmVroong completed this week:

- RGB-D SLAM [3]

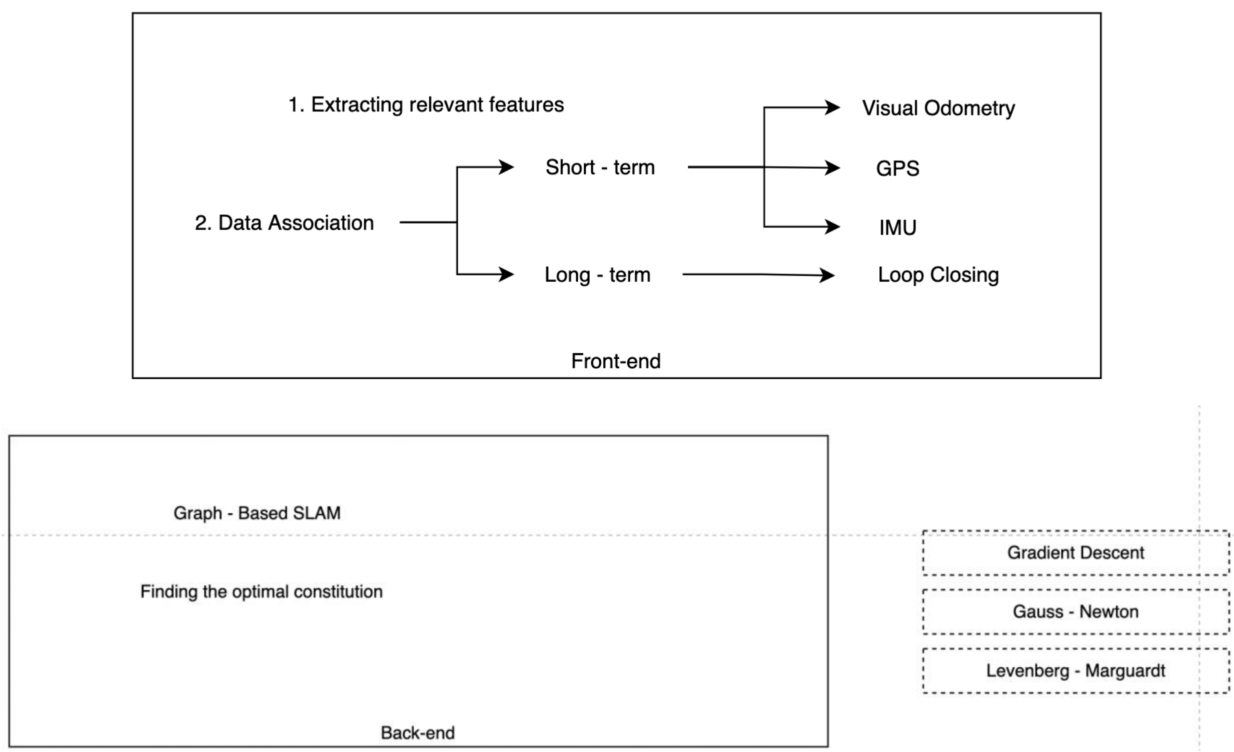

Fig. 1. The architecture of the SLAM in our project. top: Front-End part and bottom: Back-End part.

Our SLAM algorithm divided in two parts: front-end, back-end.

At the front-end, the relevant features are extracted from the camera at first. Next, data-association is conducted. Data-association is divided to short-term and long-term. Short-term data-association traces the features between two continuous measurement value. In this step, we are going to combine Visual Odometry, GPS, and IMU and correct the accumulated error which the car makes riding the unknown maps. At the Long-term data-association, the loop closing is conducted, which searches whether the car revisits the location that it previously visited, and at that moment the error is corrected. Global data-association searches whether the car revisits the location that it previously visited, which is loop closing. Likewise, Back-end part conducts the process of finding the optimal constitution which maximizes the consistency of all observation. Maximum A Posteriori (MAP) is the prime problem of it.

Back-end part, Graph-based algorithm realizes the pose-constraint map. Each node of the graph means the pose and location of the car, and the edge which connects nodes means the space constraint (movement and rotation). Based on the construction of the graph and data-association conducted at the front-end, maximum likelihood estimation is conducted at the back-end. Maximum likelihood estimation is solved by gradient descent method (GD), Gauss-Newton, or Levenberg-Marguardt. So we are going to research each algorithms and choose one to use.

- Path Planning

As sample-based planning selected for our project in last time, it is important to choose the algorithm which is more suitable in our project. In Sample-based planning, RRT-Connect [2] and BIT* [1] are the robust and powerful methods than other. Figure 2 shows that RRT-Connect and BIT* are not much different between best and worst instance. Comparing the RRT-Connect and BIT*, RRT-Connect is a greedy tree connection so it is not asymptotically optimal planners. BIT* is the heuristic search and reuse the previous information. For this reason, we select the BIT* Algorithm.

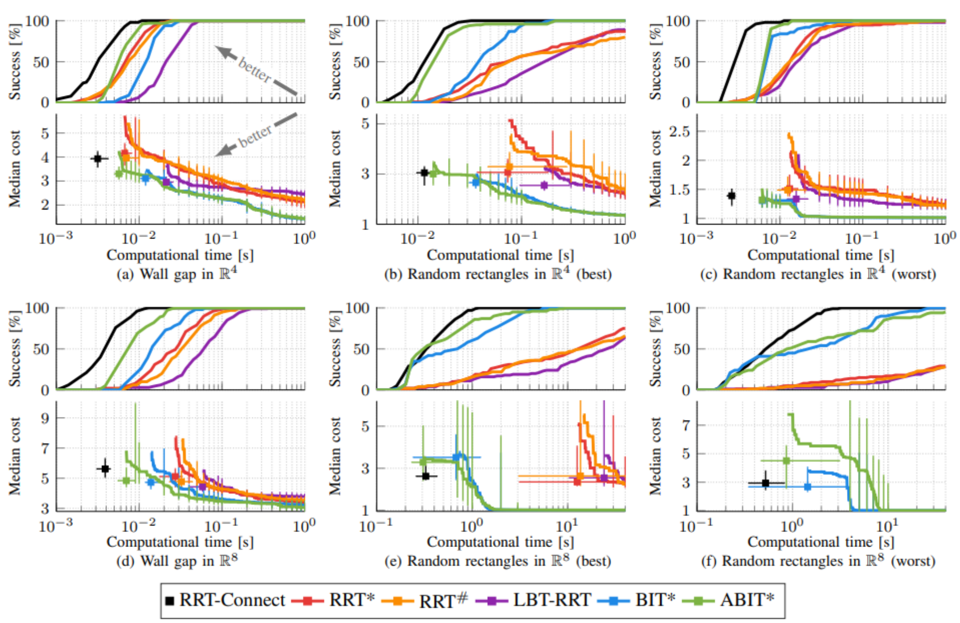

Fig. 2. Results from the experiments

- Obstacle avoidance

Using the depth camera to get the depth information for obstacle avoidance.

- De-limitation, limitation

limitation: The performance of depth camera and sensor
Delimitation: Defining the obstacle which is taller than half of the wheel. (It is hard to detect the object which can be pass through or not.), Clouding system.

Things to do by next week

- Prepare the Mid-term presentation.
- Simulate the Path planning with iRobot.
- Choose the front-end and back-end data association.

Problems or challenges:

- Establishing specific experiment plan in outdoor.

References

[1] J. D. Gammell, T. D. Barfoot, and S. S. Srinivasa, "Batch Informed Trees (BIT*): Informed asymptotically optimal anytime search," *The International Journal of Robotics Research* , vol. 39, no. 5, pp. 543–567, Jan. 2020

[2] J. Kuffner and S. LaValle, "RRT-Connect: An efficient approach to single-query path planning," in *Proceedings of the International Conference on Robotics and Automation (ICRA)*, vol. 2, 2000, pp. 995–1001

[3] S. Zhang, L. Zheng, and W. Tao, "Survey and evaluation of RGB-D Slam," *IEEE Access*, vol. 9, pp. 21367–21387, 2021.