CS 3630 Project 6

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1. What data was given to you to complete this project? How did you use it?

The data given to me is a dataset composed of 180 Lidar scans captured by Argo AI, a self-driving car company based in Pittsburgh, PA. These scans were captured over 18 seconds by one of their cars in Miami. The car starts at an offset T-intersection and makes a left turn onto NW 2nd Ave and traveling down the street. I applied ICP implementation on the dataset, populate the factor graph and visualize the dataset to see how the vehicle moves.

2. If you used LIDAR information from just one frame to create a map, what would the map be missing that make it not-so-helpful?

If we just use one frame to create a map, we cannot evaluate the transformation from one frame to another frame over time. By evaluating the transformation and compare some stationary objects in the frames, we can guess where the vehicle is in the graph and plot its movement, velocity and direction.

3. What is the Iterative Closest Point (ICP) algorithm? Explain briefly.

ICP algorithm has five steps.

1. Initialize transformation
2. Assign each point in set 1 to its nearest neighbor in set 2
3. Estimate transformation parameters using least squares
4. Transform the points in set 1 using estimated parameters
5. Repeat steps 2-4 until change is very small

The goal of ICP algorithm is to estimate transform between two dense set of points.

4. How did you use the ICP algorithm in this project?

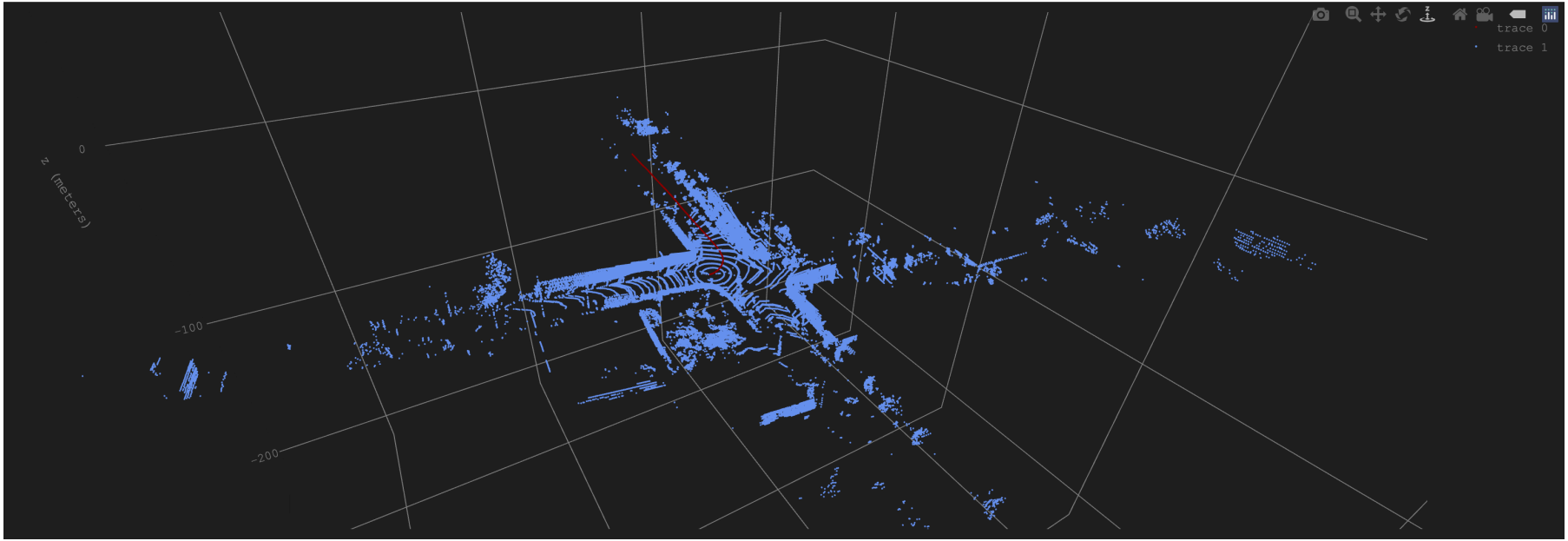
I use the ICP algorithm to estimate transformation between frames in the cloud of data we have. We could see how the stationary objects or points converge to each other over time. By viewing the relative positions of the stationary points in each frame, we could estimate the viewpoint of the vehicle and its relative movement. With these transformation, we then create a factor graph representing the transform between the pose variables.

5. What is a factor graph? How was it used in this project?

A factor graph is a bipartite graph representing the factorization of a function.

In this project, a factor graph is used to estimate or localize the poses of the vehicle using the transformation between frames given by the ICP algorithm. Those transforms becomes the factors in the factor graph. GTSAM is used to construct the factor graph in this project. The poses could then be used to form a map of the street from the point clouds.

6. Paste a screenshot of the vehicle poses being given as output from the factor graph.



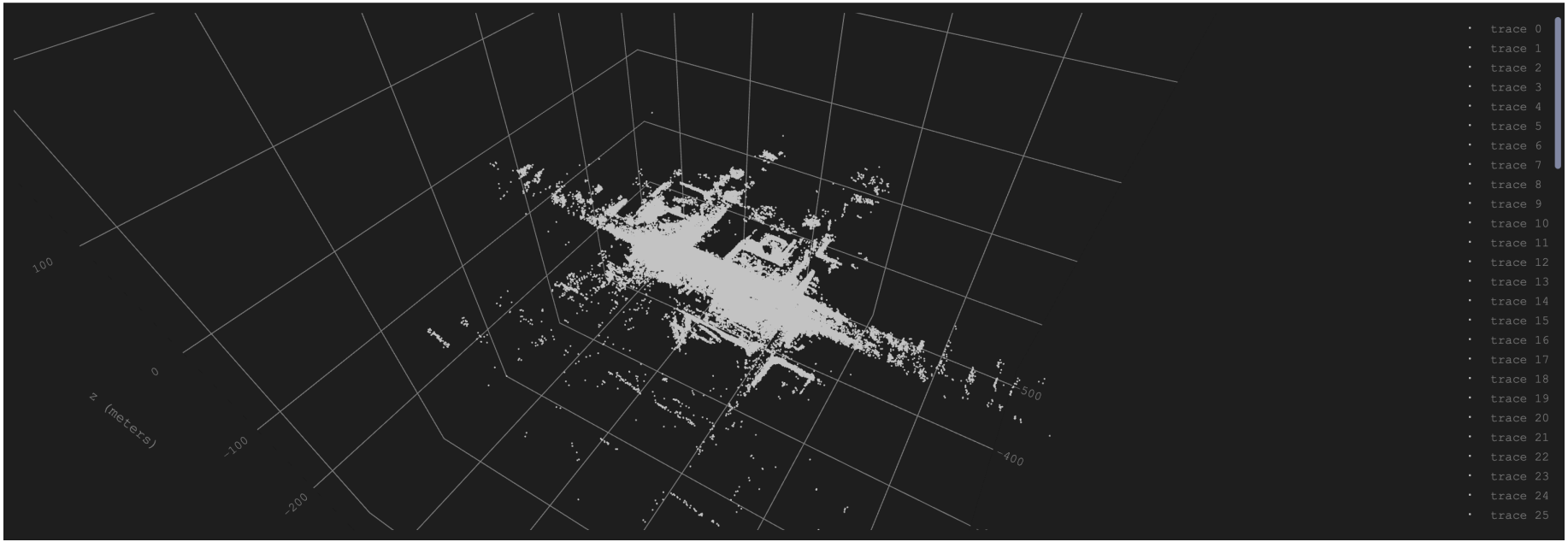
7. In the generated map, what happened to the people and other cars moving around the car collecting LIDAR data?

The three people that are relatively stationary on the map at the T-intersection at the beginning are represented as people-like figures. But the points corresponding to the moving people and cars are filtered out because there are so many different maps and they changes location on each.

8. What did you learn about mapping in autonomous driving in this project?

Through this project, I learned that mapping in autonomous driving is through converging frames according to their stationary points or objects. Through these transformations, the change in the relative position of our moving vehicle in world coordinates could be detected and shown. I also learned that the running time of ICP in mapping is important and if one run takes you a long time, it would affect the efficiency of your algorithm hugely.

9. Insert the cloud map visible to you after at the end of the project.



10. What do you think you could add or change to make the map better?

I think currently the structure of the road and other objects are not so clear. If we could map with multiple colors, the mapping could be better. In addition, there are quite some noises in our mapping, it could be better if we could reduce the noises.

11. Do you feel confident that you can take up a challenge related to self-driving at ArgoAI?

After this project, I feel clearer about the brief process of generating map in autonomous driving. So I am confident in where to start if I were to take up a challenge related to self-driving at ArgoAI, but I am sure I must learn and explore a lot more if to complete the challenge.