MTRX5700

Experimental Robotics

Assignment 2

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Due: March 25, 2015

1 Question 1

1.a

1.b

1.c

Code Listing

See Appendix A [9.1]

2 Question 2

2.a Validity Check

2.a.i R_1

2.a.ii R_2

2.a.iii R_3

2.a.iv R_4

2.b Roll/Pitch/Yaw Angles

2.c Angle Estimation

Code Listing

See Appendix A [9.2]

3 Question 3

The Iterated Closed Loop Algorithm

By modifying the given code pieces, we will implement an Iterated Closed Loop algorithm to estimate the position of a vehicle as it moves through its surroundings.
All code pieces, original and modified, can be found in the Appendix.

3..i Part A - Implementing the ICP

By modifying the given showICP.m file, we will exam the resultant ICP features generated for a single data set. The set in question is frame 500, and we will use frame 520 as our initial 'guess'.
Firstly, using the default variables of a grid size of 0.005, and a maximum iterative loop of 40, we can generate the following graph:

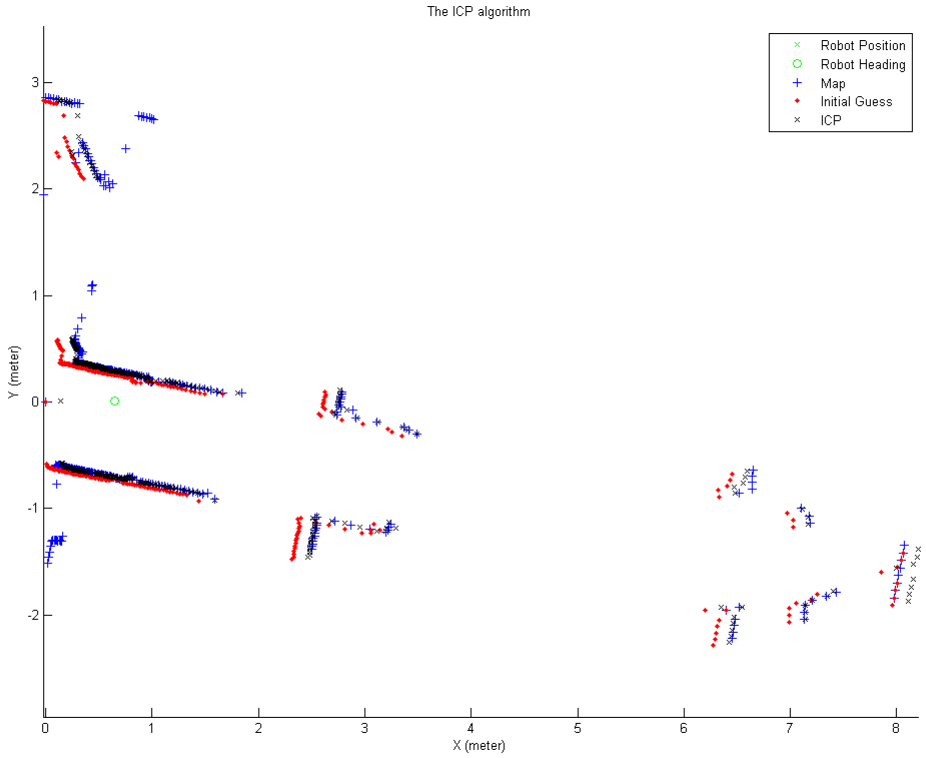

Figure 1: ICP estimate for maximum iterations of 40 and grid size of 0.005

We will now examine the effect of modifying some of the variables of the ICPv4.m algorithm.
Firstly we will look at changing the grid size. For a smaller grid size of 0.001 we obtain the following graph:

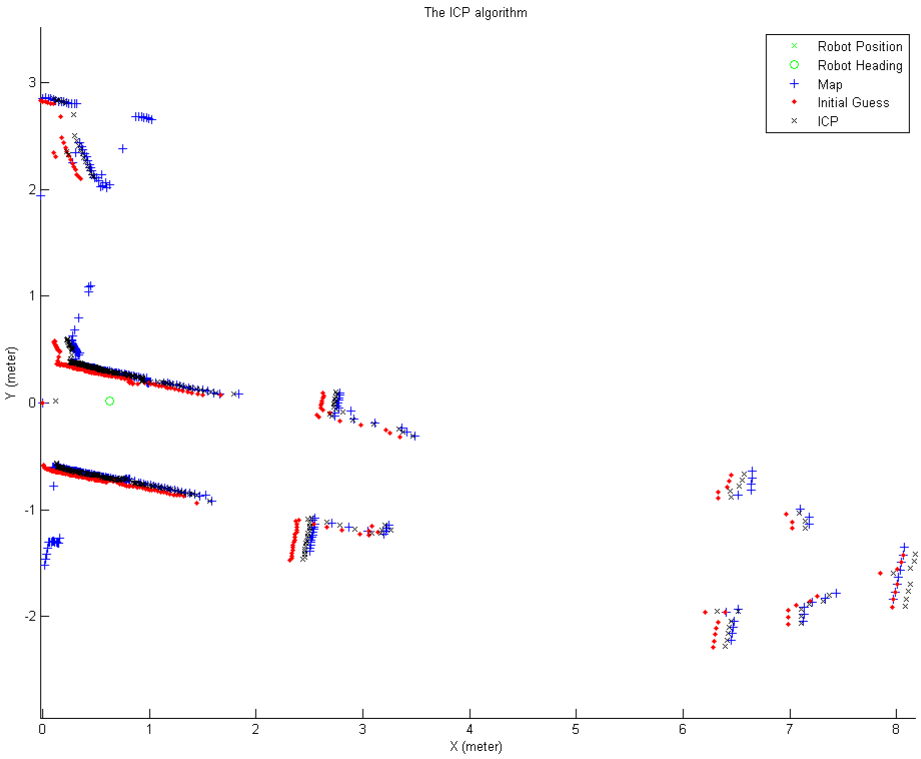

Figure 2: ICP estimate for maximum iterations of 40 and grid size of 0.001

Next, for a grid size of 0.1:

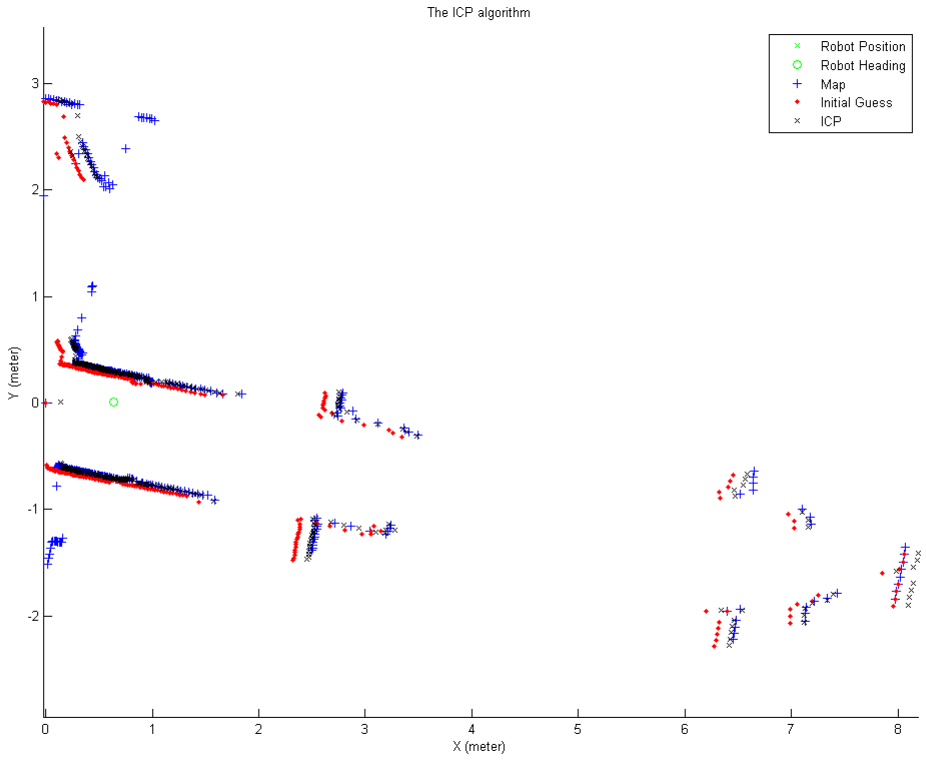

Figure 3: ICP estimate for maximum iterations of 40 and grid size of 0.005

As can be seen, changing the grid size has little effect on the overall ICP .
It does, however, have an affect on the number of collision points detected. For a grid size of 0.005, 188 points collide. For 0.001, 32 points collide, and for 0.01, 252 points collide. This is expected - an increase in in the grid size means a large sample section, with a greater likelihood of multiple points landing in a grid.

Checking for matching pairs reveals an interesting point - for all tested values for grid size, the number of matching points is the same - 362. Also of worthy note, despite a maximum number of iterations of 40, no more than 9 iterations are used. Changing the maximum number of iterations to 10 resulted in no changes to any of the previous tests. As such, the maximum iterative size does not need to be nearly so large.

Looking at the generated deltaPose$_bar, we can get an idea of the estimated heading of the vehicle, and by looking at deltaPose_bar_c$ou
$The pose was as follows$:

$deltaPose_{bar} = [0.1360, 0.0116, 0.0004]$ where the pattern is $[x, y, \theta]$
This Is very close to the zero position, which is to be expected seeing as this ICP algorithm has only taken a single frame. Relative movement should be little

3..ii PartB

Assumption

Code Listing

See Appendix A [9.3] for all code used.

4 Question 4

4.a Modified DH Notation

5 Question 5

5.a

5.a.i Workspace

5.b Singularities

6 Question 6

6.a Inverse Kinematics

6.a.i Theoretical Method

6.a.ii Results

6.a.iii Code Listing

See Appendix A [9.5]

6.b Simulation

7 Appendix

7.1 Question 1 Code Listings

7.2 Question 2 Code Listings

7.3 Question 3 Code Listings

7.4 Question 5 Code Listings

7.4.i Workspace Plot

7.5 Question 6 Code Listings

7.6 Question 7 Code Listings

7.6.i Epson Arm Code

7.7 Question 8 Working and Code Listings

7.7.i Part a Working

7.7.ii Part b Code