

Orientation with Lidar: Task 3

This objective of this task was to use the output of the ransac node and calculate the centroid of the object. To calculate the centroid of the object we used the compute3DCentroid, provided by PointCloudLibrary. The result of this computation gives us the distance of the centroid of the object from the perspective of the lidar. To ensure we have the compute3DCentroid function works we compare our calculated value, to the actual distance from the lidar to the object's center.

Conclusion:

During testing, the y-axis is given by the axis which cuts the lidar scan in half vertically from the perspective of the back of the lidar. The x-axis is given by the axis which cuts the lidar scan in half horizontally from the perspective of the back of the lidar. The back of the lidar is given by the notch that is on the lidar.

It was noticeable that when we placed an object to the left of the lidar, on the negative x-axis, the compute3DCentroid function returned a positive x value. Meanwhile, when we placed an object to the right of the lidar, on the positive x-axis, the compute3DCentroid function returned a negative x value. Therefore it seems that these values are mirrored and will be handled in software.

When it came to the actual calculation of the distance from the centroid of the object, the return value was very accurate. There were minute discrepancies in the calculation but they were rather minimal. Below are a summary of the test cases:

	Test Case 1	Test Case 2	Test Case 3	Test Case 4	Test Case 5	Test Case 6	Test Case 7
Actual Y distance	1.811 m	1.07362 m	0.7112 m	0.9398 m	0.92075 m	1.4986 m	0.6985 m
Computed Y distance error	+/- 0.01 m	+/- 0.01 m	+/- 0.04 m	+/- 0.03	+/- 0.04 m	+/- 0.04 m	+/- 0.06 m
Actual X distance	0.0381 m	0.4064 m	0.7779 m	0.4 m	0.6731 m	0.39689 m	0.8128 m
Computed X distance error	+/- 0.04 m	+/- 0.03 m	+/- 0.05 m	+/- 0.07	+/- 0.06 m	+/- 0.09 m	+/- 0.05 m

As we can tell on average, the error is greater on the x-axis than on the y-axis. Although the differences in measurements in general are minuscule.

While testing it was noticeable that the object size did not affect the computation of the centroid of an object. Although, we should not forget that when extracting an object from a cluster the object size did matter and we came to the conclusion that it should be an object of at least 0.6858 m. Despite our previous conclusion during these test cases, it was noticed that an object of 0.5334 m also allows us to extract an object consistently and accurately. Therefore, it would be ideal to use an object size of at least 0.5334 m. The other object sizes were used to ensure that if we needed to use an object smaller we were still capable of computing the centroid.

Test Case 1:

Object Size: 0.3556 m length by 0.3556 m wide

Distance from lidar: 1.811 m to the front and 0.0381 m to the left

Calculated distance from lidar to the centroid of the object:

X: 0.072528, Y: 1.190295, Z: 0.000000
X: 0.063030, Y: 1.189885, Z: 0.000000
X: 0.056344, Y: 1.190589, Z: 0.000000
X: 0.052688, Y: 1.192473, Z: 0.000000
X: 0.039308, Y: 1.191347, Z: 0.000000
X: 0.040287, Y: 1.188159, Z: 0.000000
X: 0.017561, Y: 1.188979, Z: 0.000000
X: 0.041014, Y: 1.189315, Z: 0.000000
X: 0.049747, Y: 1.190438, Z: 0.000000
X: 0.076995, Y: 1.189588, Z: 0.000000
X: 0.021813, Y: 1.190604, Z: 0.000000
X: 0.061051, Y: 1.188150, Z: 0.000000
X: 0.048784, Y: 1.193037, Z: 0.000000
X: 0.027476, Y: 1.192754, Z: 0.000000
X: 0.091347, Y: 1.190234, Z: 0.000000
X: 0.060771, Y: 1.191384, Z: 0.000000
X: 0.093983, Y: 1.189236, Z: 0.000000
X: 0.091297, Y: 1.188463, Z: 0.000000
X: 0.103145, Y: 1.187911, Z: 0.000000
X: 0.084402, Y: 1.190833, Z: 0.000000
X: 0.085257, Y: 1.190749, Z: 0.000000
X: 0.047364, Y: 1.184307, Z: 0.000000
X: 0.053983, Y: 1.189392, Z: 0.000000
X: 0.072902, Y: 1.191762, Z: 0.000000
X: 0.033426, Y: 1.190234, Z: 0.000000
X: 0.086090, Y: 1.190256, Z: 0.000000
X: 0.143808, Y: 1.189898, Z: 0.000000
X: 0.079168, Y: 1.191642, Z: 0.000000
X: 0.069520, Y: 1.191453, Z: 0.000000

The distance from the centroid of the object to the lidar, on the y-axis, is precise. On average we are withing +/- 0.01 meters from the actual distance. With respect to the x-axis we the values vary but on average are the calculation is within +/- 0.04 meters.

Test Case 2:

Object Size: 0.3556 m length by 0.3556 m wide

Distance from lidar: 1.07362 m to the front and 0.4064 m to the left

Calculated distance from lidar to the centroid of the object:

X: 0.339094, Y: 1.088541, Z: 0.000000
X: 0.343762, Y: 1.090086, Z: 0.000000
X: 0.399084, Y: 1.094096, Z: 0.000000
X: 0.392460, Y: 1.092198, Z: 0.000000
X: 0.388770, Y: 1.090900, Z: 0.000000
X: 0.366444, Y: 1.088719, Z: 0.000000
X: 0.388386, Y: 1.094510, Z: 0.000000
X: 0.409729, Y: 1.094898, Z: 0.000000
X: 0.363051, Y: 1.090225, Z: 0.000000
X: 0.359866, Y: 1.089676, Z: 0.000000
X: 0.361098, Y: 1.089631, Z: 0.000000
X: 0.358139, Y: 1.090736, Z: 0.000000
X: 0.354477, Y: 1.092592, Z: 0.000000
X: 0.343024, Y: 1.090238, Z: 0.000000
X: 0.344304, Y: 1.090985, Z: 0.000000
X: 0.370481, Y: 1.088390, Z: 0.000000
X: 0.355031, Y: 1.089353, Z: 0.000000
X: 0.377556, Y: 1.091943, Z: 0.000000
X: 0.353675, Y: 1.091714, Z: 0.000000
X: 0.401556, Y: 1.092878, Z: 0.000000
X: 0.401746, Y: 1.091478, Z: 0.000000
X: 0.376364, Y: 1.091152, Z: 0.000000
X: 0.390370, Y: 1.093235, Z: 0.000000
X: 0.385383, Y: 1.091513, Z: 0.000000
X: 0.438907, Y: 1.095621, Z: 0.000000
X: 0.362771, Y: 1.088762, Z: 0.000000
X: 0.377584, Y: 1.091668, Z: 0.000000
X: 0.352762, Y: 1.091796, Z: 0.000000
X: 0.348188, Y: 1.090236, Z: 0.000000
X: 0.401491, Y: 1.093331, Z: 0.000000

The y-axis calculation from the perspective of the lidar is represented accurately. On average the calculated distance was within +/- 0.01 meters of the actual distance. On the x-axis we are a bit less accurate where we are on average +/- 0.03 meters from the actual distances.

Test Case 3:

Object Size: 0.3556 m length by 0.3556 m wide

Distance from lidar: 0.7112 m to the front and 0.7779 m to the right

Calculated distance from lidar to the centroid of the object:

X: -0.759891, Y: 0.752398, Z: 0.000000
X: -0.720736, Y: 0.752144, Z: 0.000000
X: -0.734009, Y: 0.750299, Z: 0.000000
X: -0.743021, Y: 0.749192, Z: 0.000000
X: -0.765938, Y: 0.757512, Z: 0.000000
X: -0.731515, Y: 0.753761, Z: 0.000000
X: -0.729154, Y: 0.750984, Z: 0.000000
X: -0.747116, Y: 0.752129, Z: 0.000000
X: -0.746040, Y: 0.752486, Z: 0.000000
X: -0.763195, Y: 0.750659, Z: 0.000000
X: -0.708620, Y: 0.749436, Z: 0.000000
X: -0.774551, Y: 0.755652, Z: 0.000000
X: -0.724268, Y: 0.755004, Z: 0.000000
X: -0.695988, Y: 0.750312, Z: 0.000000
X: -0.701422, Y: 0.750230, Z: 0.000000
X: -0.772501, Y: 0.755011, Z: 0.000000
X: -0.749668, Y: 0.753723, Z: 0.000000
X: -0.721211, Y: 0.747684, Z: 0.000000
X: -0.737358, Y: 0.751022, Z: 0.000000
X: -0.747649, Y: 0.751659, Z: 0.000000
X: -0.720858, Y: 0.754054, Z: 0.000000
X: -0.752980, Y: 0.750249, Z: 0.000000
X: -0.713239, Y: 0.750641, Z: 0.000000
X: -0.708538, Y: 0.750415, Z: 0.000000
X: -0.733360, Y: 0.752599, Z: 0.000000
X: -0.731527, Y: 0.750975, Z: 0.000000
X: -0.741899, Y: 0.751382, Z: 0.000000
X: -0.711232, Y: 0.749458, Z: 0.000000
X: -0.774584, Y: 0.754897, Z: 0.000000
X: -0.725528, Y: 0.749127, Z: 0.000000
X: -0.755528, Y: 0.752804, Z: 0.000000
X: -0.704026, Y: 0.751001, Z: 0.000000
X: -0.765804, Y: 0.750460, Z: 0.000000
X: -0.715661, Y: 0.752523, Z: 0.000000
X: -0.676330, Y: 0.746539, Z: 0.000000

On the y-axis calculation we are on average +/- 0.04 meters off from the actual distance, from the perspective of the lidar. On the x-axis, we are on average +/- 0.05 meters off from the actual distance. In addition, the distance to right is calculated as negative.

Test Case 4:

Object Size: 0.4064 m length by 0.0508 m wide

Distance from lidar: 0.9398 m to the front and 0.4 m to the left

Calculated distance from lidar to the centroid of the object:

X: 0.457511, Y: 0.951583, Z: 0.000000
X: 0.510788, Y: 0.904101, Z: 0.000000
X: 0.468706, Y: 0.941815, Z: 0.000000
X: 0.468641, Y: 0.937125, Z: 0.000000
X: 0.461971, Y: 0.952219, Z: 0.000000
X: 0.501319, Y: 0.912373, Z: 0.000000
X: 0.478216, Y: 0.930205, Z: 0.000000
X: 0.465163, Y: 0.944269, Z: 0.000000
X: 0.442952, Y: 0.966521, Z: 0.000000
X: 0.451947, Y: 0.958398, Z: 0.000000
X: 0.506494, Y: 0.911621, Z: 0.000000
X: 0.506239, Y: 0.906585, Z: 0.000000
X: 0.475775, Y: 0.937725, Z: 0.000000
X: 0.480609, Y: 0.931228, Z: 0.000000
X: 0.482696, Y: 0.924127, Z: 0.000000
X: 0.469468, Y: 0.942132, Z: 0.000000
X: 0.490888, Y: 0.914540, Z: 0.000000
X: 0.455199, Y: 0.952300, Z: 0.000000
X: 0.473617, Y: 0.933934, Z: 0.000000
X: 0.491799, Y: 0.920251, Z: 0.000000
X: 0.440414, Y: 0.973879, Z: 0.000000
X: 0.459241, Y: 0.952058, Z: 0.000000
X: 0.451883, Y: 0.961406, Z: 0.000000
X: 0.458274, Y: 0.955168, Z: 0.000000
X: 0.466851, Y: 0.946802, Z: 0.000000
X: 0.489251, Y: 0.925185, Z: 0.000000
X: 0.466497, Y: 0.940009, Z: 0.000000
X: 0.483108, Y: 0.931096, Z: 0.000000
X: 0.465790, Y: 0.944703, Z: 0.000000
X: 0.490899, Y: 0.922560, Z: 0.000000
X: 0.487485, Y: 0.925138, Z: 0.000000
X: 0.469967, Y: 0.941031, Z: 0.000000
X: 0.480795, Y: 0.934241, Z: 0.000000
X: 0.457695, Y: 0.950998, Z: 0.000000
X: 0.439979, Y: 0.973920, Z: 0.000000

On the y-axis, the calculated distance of the object to the lidar is on average +/- 0.03 meters off the actual distance. On the x-axis, the calculated distance is on average +/- 0.07 meters off the actual distance.

Test Case 5:

Object Size: 0.4064 m length by 0.0508 m wide

Distance from lidar: 0.92075 m to the front and 0.6731 to the right

Calculated distance from the lidar to the object:

X: -0.652166, Y: 0.927671, Z: 0.000000
X: -0.611228, Y: 0.971095, Z: 0.000000
X: -0.632995, Y: 0.948488, Z: 0.000000
X: -0.665088, Y: 0.916293, Z: 0.000000
X: -0.643645, Y: 0.935808, Z: 0.000000
X: -0.650154, Y: 0.935092, Z: 0.000000
X: -0.655895, Y: 0.931128, Z: 0.000000
X: -0.645837, Y: 0.937064, Z: 0.000000
X: -0.653035, Y: 0.927149, Z: 0.000000
X: -0.626083, Y: 0.955246, Z: 0.000000
X: -0.620474, Y: 0.960059, Z: 0.000000
X: -0.640198, Y: 0.947357, Z: 0.000000
X: -0.637900, Y: 0.949140, Z: 0.000000
X: -0.650903, Y: 0.935740, Z: 0.000000
X: -0.654865, Y: 0.928399, Z: 0.000000
X: -0.674811, Y: 0.904576, Z: 0.000000
X: -0.642177, Y: 0.940134, Z: 0.000000
X: -0.655082, Y: 0.928197, Z: 0.000000
X: -0.642492, Y: 0.942318, Z: 0.000000
X: -0.598168, Y: 0.983054, Z: 0.000000
X: -0.623455, Y: 0.959799, Z: 0.000000
X: -0.580720, Y: 0.999236, Z: 0.000000
X: -0.633130, Y: 0.949975, Z: 0.000000
X: -0.621096, Y: 0.961991, Z: 0.000000
X: -0.636999, Y: 0.946755, Z: 0.000000
X: -0.658915, Y: 0.922267, Z: 0.000000
X: -0.646589, Y: 0.937836, Z: 0.000000
X: -0.668626, Y: 0.915940, Z: 0.000000
X: -0.621175, Y: 0.960440, Z: 0.000000
X: -0.624640, Y: 0.962532, Z: 0.000000
X: -0.614820, Y: 0.967743, Z: 0.000000
X: -0.640634, Y: 0.940066, Z: 0.000000
X: -0.633959, Y: 0.954611, Z: 0.000000
X: -0.645867, Y: 0.944953, Z: 0.000000
X: -0.634637, Y: 0.949656, Z: 0.000000
X: -0.632268, Y: 0.954386, Z: 0.000000

On the y-axis the calculated distance is on average +/- 0.04 meters off the actual distance between the lidar and the centroid of the object. On the x-axis we are on average +/- 0.06 meters off the actual distance. In addition, we see that the values for the x-axis are negative, when the object is placed on the right.

Test Case 6:

Object Size: 0.5334 m length by 0.254 m wide

Distance from lidar: 1.4986 m to the front and 0.3969 m to the right

Calculated distance from the lidar to the object:

X: -0.383319, Y: 1.536091, Z: 0.000000
X: -0.344504, Y: 1.537422, Z: 0.000000
X: -0.357458, Y: 1.540076, Z: 0.000000
X: -0.339306, Y: 1.537459, Z: 0.000000
X: -0.333720, Y: 1.534021, Z: 0.000000
X: -0.339366, Y: 1.534705, Z: 0.000000
X: -0.312379, Y: 1.532783, Z: 0.000000
X: -0.378192, Y: 1.537306, Z: 0.000000
X: -0.282725, Y: 1.530142, Z: 0.000000
X: -0.366457, Y: 1.538762, Z: 0.000000
X: -0.322868, Y: 1.533104, Z: 0.000000
X: -0.303030, Y: 1.529275, Z: 0.000000
X: -0.329181, Y: 1.535454, Z: 0.000000
X: -0.378459, Y: 1.538172, Z: 0.000000
X: -0.305420, Y: 1.531270, Z: 0.000000
X: -0.321806, Y: 1.534658, Z: 0.000000
X: -0.309038, Y: 1.527437, Z: 0.000000
X: -0.320716, Y: 1.531776, Z: 0.000000
X: -0.372112, Y: 1.533769, Z: 0.000000
X: -0.279161, Y: 1.530992, Z: 0.000000
X: -0.260677, Y: 1.525531, Z: 0.000000
X: -0.295116, Y: 1.530003, Z: 0.000000
X: -0.301852, Y: 1.533653, Z: 0.000000
X: -0.267736, Y: 1.527646, Z: 0.000000
X: -0.309148, Y: 1.533380, Z: 0.000000
X: -0.341507, Y: 1.536064, Z: 0.000000
X: -0.298690, Y: 1.530967, Z: 0.000000
X: -0.309338, Y: 1.532507, Z: 0.000000
X: -0.369930, Y: 1.561767, Z: 0.000000
X: -0.329855, Y: 1.536434, Z: 0.000000
X: -0.250074, Y: 1.526523, Z: 0.000000
X: -0.300861, Y: 1.531827, Z: 0.000000
X: -0.318427, Y: 1.532138, Z: 0.000000
X: -0.403145, Y: 1.540171, Z: 0.000000
X: -0.346759, Y: 1.536479, Z: 0.000000
X: -0.355768, Y: 1.535490, Z: 0.000000

On the y-axis the calculated distance is on average +/- 0.04 meters off the actual distance from the lidar to the centroid of the object. On the x-axis we are on average +/- 0.09 meters off the actual distance. In addition, we see that the values for the x-axis are negative, the object is placed on the right of the lidar.

Test Case 7:

Object Size: 0.5334 m length by 0.254 m wide

Distance from object: 0.6985 m to the front and 0.8128 m to the right

Calculated distance from the lidar to the object:

X: -0.801283, Y: 0.722391, Z: 0.000000
X: -0.812461, Y: 0.709179, Z: 0.000000
X: -0.771596, Y: 0.781548, Z: 0.000000
X: -0.799282, Y: 0.730789, Z: 0.000000
X: -0.816104, Y: 0.703926, Z: 0.000000
X: -0.814636, Y: 0.703450, Z: 0.000000
X: -0.776615, Y: 0.775451, Z: 0.000000
X: -0.810920, Y: 0.711767, Z: 0.000000
X: -0.790907, Y: 0.743037, Z: 0.000000
X: -0.788570, Y: 0.756704, Z: 0.000000
X: -0.760438, Y: 0.812046, Z: 0.000000
X: -0.795831, Y: 0.742398, Z: 0.000000
X: -0.779789, Y: 0.778733, Z: 0.000000
X: -0.803086, Y: 0.723830, Z: 0.000000
X: -0.813874, Y: 0.707629, Z: 0.000000
X: -0.820688, Y: 0.689012, Z: 0.000000
X: -0.803850, Y: 0.726052, Z: 0.000000
X: -0.817112, Y: 0.701177, Z: 0.000000
X: -0.820831, Y: 0.693236, Z: 0.000000
X: -0.803005, Y: 0.728548, Z: 0.000000
X: -0.803312, Y: 0.727542, Z: 0.000000
X: -0.795119, Y: 0.740658, Z: 0.000000
X: -0.812062, Y: 0.705679, Z: 0.000000
X: -0.818130, Y: 0.699454, Z: 0.000000
X: -0.794612, Y: 0.740032, Z: 0.000000
X: -0.841338, Y: 0.658185, Z: 0.000000
X: -0.829205, Y: 0.679434, Z: 0.000000
X: -0.814768, Y: 0.704988, Z: 0.000000
X: -0.783983, Y: 0.761615, Z: 0.000000
X: -0.764952, Y: 0.800919, Z: 0.000000
X: -0.810727, Y: 0.716124, Z: 0.000000
X: -0.787702, Y: 0.754891, Z: 0.000000
X: -0.778695, Y: 0.774680, Z: 0.000000
X: -0.803135, Y: 0.724608, Z: 0.000000
X: -0.780205, Y: 0.767640, Z: 0.000000
X: -0.798012, Y: 0.737350, Z: 0.000000

On the y-axis the calculated distance is on average +/- 0.06 meters off the actual distance. On the x-axis the calculated distance is on average +/- 0.05 meters off the actual distance. In addition, the x-axis calculation is negative, since the object is on the right.