HOCHSCHULE
RAVENSBURG-WEINGARTEN
UNIVERSITY
OF APPLIED SCIENCES

Lidar And Radar Systems

Assignment-1

Master Mechatronics

submitted by:

Nishanth Nandakumar

Mtr.No:

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Prof. Dr.rer.nat. Stefan Elser

1 Assignment 1

1.1 Introduction

The main objective of this project is to determine the physical dimensions of the car provided the point cloud data from the two Lidar sensors Blickfeld and Velodyne as shown in the Figures from the dataset provided.

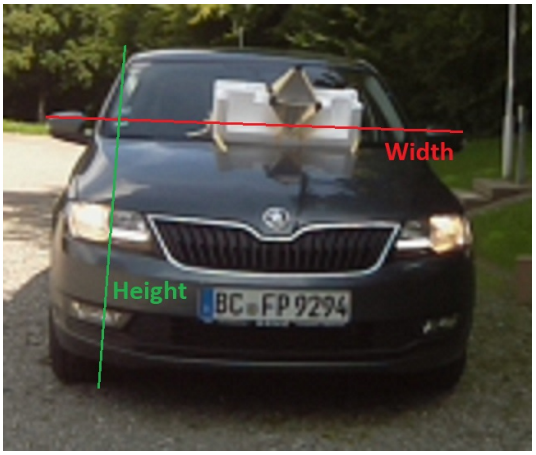

Figure 1: Height and Width of the car[Src:Dataset]

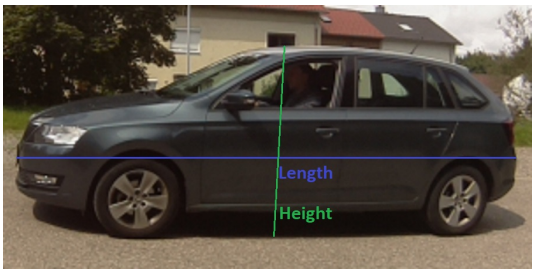

Figure 2: Height and Length of the car[Src:Dataset]

The data in the Record1 of the dataset provides the front view of the car as shown in the Figure1 that can used to obtain the height and width of the car. The Record2 dataset provides the side view that can be used to obtain the length and height of the car as in Figure2.
The Blickfeld cube 1 is a solid state Lidar system which provides a thick point cloud data with a field-of-view of 70°x 30°as shown in Figure3. Velodyne provides a scarce point cloud data while compared to Blickfeld but it provides 360°data as shown in Figure4.

1.2 Algorithm and Calculations

The code provided in the moodle is used to visualize the point cloud on google colab. A 3D scatter plot is used to visualize the data by plotting all the points provided in the dataset with respect to the individual frames as shown in Figures 3 and 4. The required points to measure the dimensions are manually selected in the 3D plot and the respective point's data is noted to calculate the dimensions.

1.2.1 Height and Width

The width and height of the car is measured using the data from Record1. The dimensions are calculated from the Blickfeld data as it is denser compared to

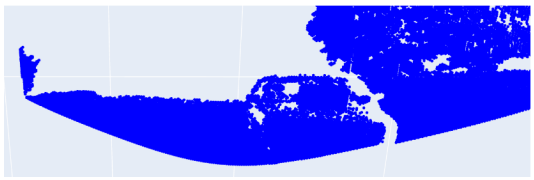

Figure 3: Point Cloud obtained from Blickfeld

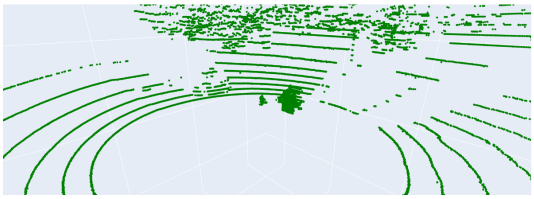

Figure 4: Point Cloud obtained from Velodyne

Velodyne data so there is no data loss. As we can observe from Figure 3 and 4 it is very difficult to recognize the car in the velodyne point cloud data even though both are taken from the same frame.
After careful observation of the camera images the object(car) is close to the sensor in the frames 000018, 000019, 000021. The point cloud data corresponding to the frames are used to obtain the dimensions of the car as shown in Table1.
To obtain the width two points from the edges of the mirror are considered as shown in Figure5. It is better to consider the edges of the mirror as it provides the extreme outermost points of the car. For example, from Table1 in frame 000019 the points 4009 and 3770 are selected to get the width. The corresponding x,y,z data of these points are noted and the distance is found using,

1. Euclidean Distance

$$d(p,q) = \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2} \tag{1}$$

2. abs(dimension1 - dimension2)

As we can observe from the Table 1 there is an error associated with the euclidean distance this is because the points don't lie on the same plane i.e. to calculate width we need a point with same z and y coordinates but different x this is very difficult to achieve which contributes to an error in euclidean distance. So the width is calculated again by taking the difference between the x coordinates of the two points (abs(dim1-dim2)).
The height is calculated using the top and bottom points and then repeating the method above to find the height. Another interesting observation made was that of finding length from the data in Record1. Some points were found at the back of the car as in Figure6. This was used to approximate the length but this cannot be considered as actual length as we are not sure if these points actually refer to the back of the car as the sensor is used to record the front view.

1.2.2 Length and Height

The Record2 dataset provides the side view of the car which can be used to find the length of the car. After careful observation of the camera images recorded the

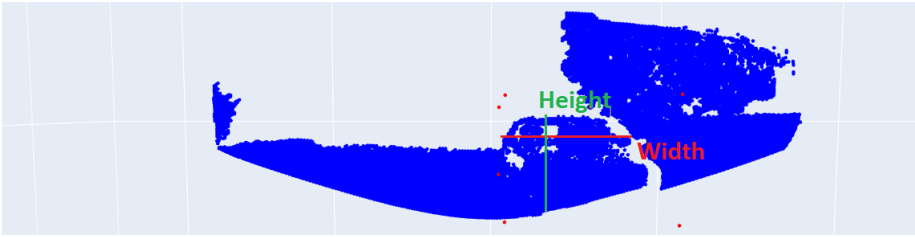

Figure 5: Demonstration of obtaining Height and Width from Record1 Blickfeld data

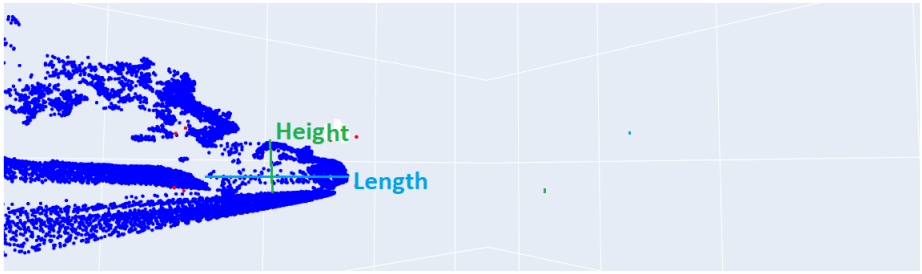

Figure 6: Demonstration of obtaining Height and Length from Record1 Blickfeld data

frame 000008 includes the full length of the car. The measurement of the length can be obtained from both Blickfeld as well as Velodyne data as shown in Figures 7 and 8 respectively.
Two points from the front and back of the car are considered for the measurement of length.The above mentioned method is repeated to calculate the distance between them as shown in the Table2.

1.3 Results

The average is calculated from the data obtained in Table1 between different frames. The data from Table2 is also represented in Table3 along with the average for better visualization. As already discussed the euclidean distance accounts to error as the points do not lie on the same plane so considering the result obtained by finding the difference between the points. We can conclude the Height of the car as 1.365m, Width as 1.870m and the length 4.268m. Please note the length from Blickfeld data(0.256) is due to some error in the points from the dataset which is neglected.
The bounding box dimensions are obtained to verify the result obtained. The data from Record1 of Blickfeld frame 000021 is considered and the respective dimensions are found as in Table4.
We can conclude the result obtained by using the point cloud data is approximately close to the bounding box data available.

Record 1							
Blickfeld							
Frame	Points	Dimension	x	y	z	Euclidean distance	|dim1-dim2|
19	4009	width	2.12E+00	5.59E+00	-2.49E-01	1.872	1.870
	3770		2.49E-01	5.51E+00	-2.79E-01		
	18909	length	1.02E+00	3.97E+00	-7.47E-01	4.273	4.245
	3784		1.36E+00	8.22E+00	-4.04E-01		
	1297	height	1.17E+00	6.21E+00	1.07E-01	1.560	1.386
	18100		4.54E-01	6.28E+00	-1.28E+00		
18	3667	width	2.09E+00	6.16E+00	-2.57E-01	1.861	1.861
	3407		2.33E-01	6.12E+00	-2.78E-01		
	745	height	1.19E+00	6.45E+00	6.22E-02	2.248	1.339
	23920		3.49E-01	4.85E+00	-1.28E+00		
21	3990	width	2.13E+00	5.63E+00	-2.50E-01	1.879	1.879
	3319		2.55E-01	5.65E+00	-2.57E-01		
	1106	height	7.20E-01	6.39E+00	9.65E-02	2.010	1.371
	23264		3.92E-01	4.96E+00	-1.28E+00		

Table 1: Dimensions from Record1 Blickfeld point cloud

Record 2							
Blickfeld							
Frame	Points	Dimension	x	y	z	Euclidean distance	|dim1-dim2|
8	25384	length	-1.75E+00	4.88E+00	-8.30E-01	4.498	0.256
	5436		2.69E+00	4.63E+00	-1.31E-01		
	5833	height	9.63E-01	4.76E+00	2.27E-01	2.569	1.307
	29964		-1.25E+00	4.76E+00	-1.08E+00		
Velodyne							
8	21494	length	5.19E+00	1.47E+00	-4.72E-01	4.280	4.268
	976		4.93E+00	-2.79E+00	-2.97E-01		
	22945	height	5.10E+00	-7.62E-01	2.70E-01	1.100	1.033
	22827		4.78E+00	-5.64E-01	-7.63E-01		

Table 2: Dimensions from Record2 Blickfeld and Velodyne point cloud

	Record1		Record2			
	Blickfeld		Blickfeld		Velodyne	
Average	|dim1-dim2|	Euclidean Distance	|dim1-dim2|	Euclidean Distance	|dim1-dim2|	Euclidean Distance
Height	1.365	1.939	1.307	2.569	1.033	1.100
Width	1.870	1.871				
Length			0.256	4.498	4.268	4.280

Table 3: Averaging the dimensions obtained in Table1 and Table2

Bounding Box							
Frame	Dimension	Points	x	y	z	Euclidean Distance	|dim1-dim2|
21	Length	2	2.225	4.073	0.336	4.304	4.298
		0	2	8.371	0.336		
	Width	2	2.225	4.073	0.336	1.939	1.937
		5	0.287	3.971	0.336		
	Height	5	0.287	3.971	0.3369	1.458	1.458
		7	0.287	3.971	-1.122		

Table 4: Bounding Box dimensions from Record1 Blickfeld frame 21 data

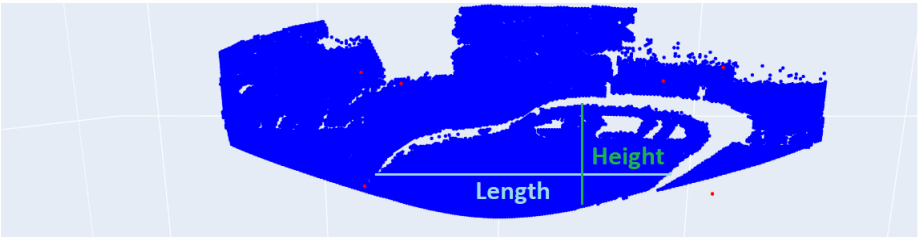

Figure 7: Demonstration of obtaining Height and Length from Record2 Blickfeld data

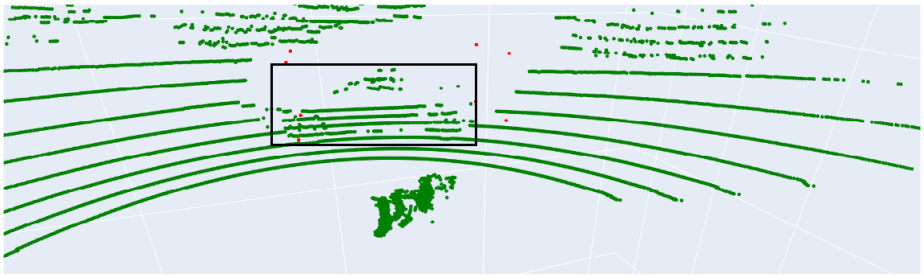

Figure 8: Demonstration of obtaining Height and Length from Record2 Velodyne data. (Note:Rectangular box to identify the car)