Evaluation of dimensions of a vehicle using Velodyne and Blickfeld LiDAR

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Abstract— LiDAR acts as an eye of the autonomous vehicles and help them to drive smoothly without collisions. In this research paper, we focus on the calculation of dimensions of a car using two LiDAR sensors. Velodyne Puck and Blickfeld Cube 1 sensors were used to capture the dataset of a car in two different situations which were then evaluated using Python. Further, we compare the results of both the sensors and the 3D bounding box. Thus, we conclude that when the car is coming directly towards the sensor, Blickfeld LiDAR was more accurate whereas Velodyne LiDAR produced accurate results when the car is going in a direction parallel to the sensor.

Index Terms—Autonomous vehicle, Blickfeld, Dimensions, LiDAR, Python, Sensor, Velodyne.

1. INTRODUCTION

A vehicle that can drive itself by sensing its environment is known as an autonomous vehicle. LiDAR stands for Light Detection and Ranging. It assists self-driving vehicles to navigate its surrounding environment in real-time. The LiDAR system emits thousands of LASER pulses every second. The differences in laser return times and wavelengths are used to make the 3D representation of the target. Depth perception and 3D mapping by creating cloud of points are considered as the major advantages of LiDAR. This enables LiDAR to detect the dimensions of the obstacle and maintain safe distance depending upon the type of obstacle. LiDAR being and active system can be used in both clear and harsh conditions. The researchers selected Puck LiDAR sensor manufactured by Velodyne that is compact, reliable and intelligent thus making it ideal for driver assistance applications. On the other hand, they selected Cube 1 a versatile LiDAR sensor a product of Blickfeld. Cube 1 has adaptable field of view, a user- friendly interface and is light in weight.

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2. OBJECTIVES

a. To evaluate dimensions of a car using Blickfeld cube 1 and Velodyne Puck LiDAR.
b. To compare the measurements from Blickfeld and Velodyne sensor, considering the bounding box as accurate.
c. Analyse results of LiDAR sensors in two different traffic situations.

3. METHODOLOGY

Initially the researchers selected the appropriate image from set of images captured by the fish eye camera. Then with the help of Python, using available dataset of the Velodyne puck and Blickfeld cube LiDAR the dimensions of the car were calculated. They evaluated the dimensions of car coming from front in situation 1 and car moving parallel to sensor in situation 2.

3.1. Selection of appropriate image for car coming from front (Situation 1)

Fig 1. Car coming from front (Situation 1)

The researchers selected an image in which the car is closest to the sensor set. As the mirrors are clearly visible, the width of the car can be easily calculated. Along with the width, height of car can also be calculated from this selected image.

3.1.1 Evaluation of (Situation 1) using Blickfeld Cube 1

As the point cloud for Blickfeld data is very dense, it is easy to identify objects in its field of view.

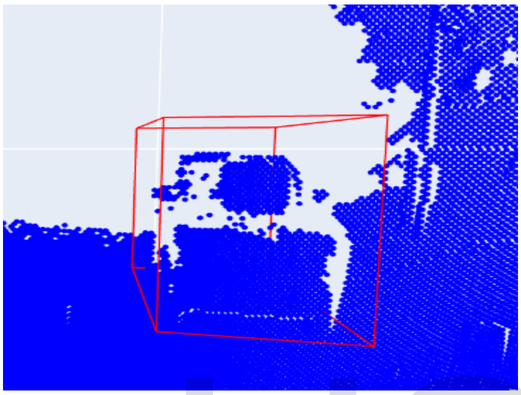

Fig 2. Point cloud captured using Blickfeld enclosed by bounding box for situation 1.

The mirror-to-mirror distance can be considered to calculate the width. Thus, two points (0.4080, -6.3846, -0.3436) and (2.0027, -5.4750, -0.3240) are selected keeping the z-axis coordinate same to get accurate horizontal distance.

Similarly, height of vehicle can also be measured using distance formula considering the following points (2.8388, -6.9400, -1.3529) and (2.7231, -6.9303, -0.2461). Here, the y-axis coordinate is kept same.

3.1.2. Evaluation of (Situation 1) using Velodyne Puck

It can be observed in the following image that Velodyne Puck gives a 360-degree representation of the environment but the point cloud is not as dense as the Blickfeld point cloud.

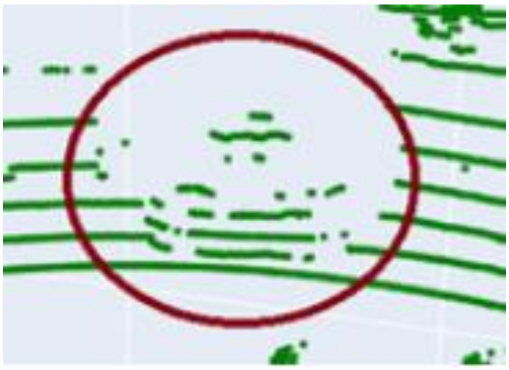

Fig 3. Point cloud captured using Velodyne Puck for situation 1.

Here, the outermost points of the car are considered as the mirrors are not visible. Keeping z-axis coordinate constant, the following points were considered for calculation of width of the car (1.6550, -4.9840, -1.0208) and (-0.0125, -5.1535, -1.0017).

From the above figure, calculation of the height of car using Velodyne LiDAR is difficult due to less points in its cloud.

The coordinates of bounding box for calculation of width and height are as follows respectively (1.1758, -3.9956, 0.2472) and (-0.4779, -5.0098, 0.2472); (-0.4779, -5.0098, 0.2472) and (-0.4779, -5.0098, -1.2117).

3.2. Selection of appropriate image for car moving parallel to sensor (Situation 2)

For calculation of the length and height of car moving parallel to the sensor set, the researchers selected a best image captured by fish eye camera which gives us accurate results.

Fig 4. Car moving parallel (Situation 2)

3.2.1. Evaluation of (Situation 2) using Blickfeld Cube 1

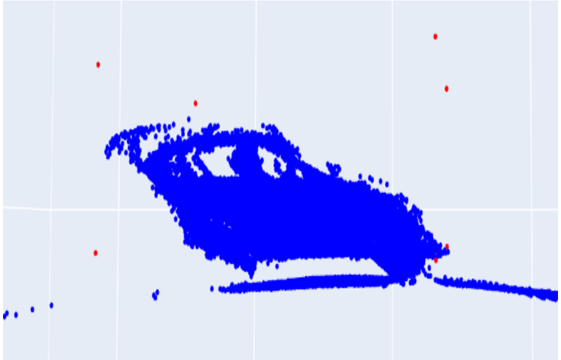

Fig 5. Point cloud captured using Blickfeld for situation 2.

In the above image, the car can be easily identified. Keeping z-axis dimension constant to get accurate length, following points were considered (5.0683,0.3637, -0.2497) and (5.0461, -3.3949, -0.2059).

Using the same image, height of car can also be calculated considering (4.7500, -2.0252, -0.9209) and (4.9539, -2.0256, 0.3125) and keeping y-axis same.

3.2.2. Evaluation of (Situation 2) using Velodyne Puck

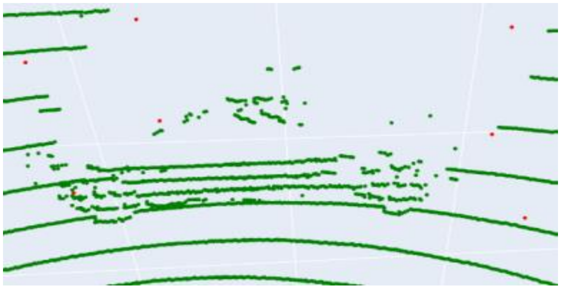

Fig 6. Point cloud captured using Velodyne for Situation 2.

Above is the point cloud for image selected for situation 2. Points considered for calculation of length of car keeping z-axis same are, (5.0861, 1.3675, -0.2760) and (4.9314, -2.7946, -0.2970).

In similar manner consider (4.7578, -0.7459, -0.7627) and (4.8659, -0.7220, 0.2578) for calculating the height of car.

The coordinates of bounding box for calculation of length and height are as follows respectively (4.9121, 0.9801, 0.7801) and (4.1183, -3.2500, 0.7801); (4.1183, -3.2500, 0.7801) and (4.1183, -3.2500, -0.6788).

4. CALCULATIONS AND RESULTS

Using Distance formula,

$$D = \sqrt{(X2 - X1)^2 + (Y2 - Y1)^2 + (Z2 - Z1)^2}$$

Following are the results for both the situations in consideration.

Table No. 1 Car coming from front (Situation 1)

Result	Width	Height
Blickfeld Cube 1	1.8359	1.1128
Velodyne Puck	1.6762	N. A
Bounding Box	1.9399	1.4589

*All dimensions are in meters.

From Table No.1, it can be inferred that the width and height of car determined by Blickfeld Cube 1 is approximately same to the dimensions of the bounding box.

Table No. 2 Car moving parallel (Situation 2)

Result	Length	Height
Blickfeld Cube 1	3.7589	1.2501
Velodyne Puck	4.1650	1.0264
Bounding Box	4.3039	1.4589

*All dimensions are in meters.

From Table No.2, it can be inferred that the length and height of car determined by Velodyne Puck sensor is approximately same to the dimensions of bounding box.

5. CONCLUSIONS

Dimensions of car were calculated using distance formula in two different situations using datasets of Velodyne Puck and Blickfeld Cube 1 LiDAR.

From the results, the researchers conclude that in situation 1 when the car is coming from front, Blickfeld Cube 1 was more accurate than Velodyne Puck in comparison with the Bounding box.

This is due to less number of points present in the cloud of Velodyne sensor which can be seen in Fig 3.

Whereas, in situation 2, when the results of Velodyne Puck were compared with the Bounding box results, it was found more accurate as compared to the Blickfeld dimensions. The reason for this is less number of points in rear of car which can be seen Fig 5. For Blickfeld Cube 1.

Thus, they conclude that, each sensor has its own importance in certain situations. As environment detection is critical and essential in autonomous driving, a network of sensors consisting of camera, LiDAR and RADAR will be integrated in future for better performance and utmost safety of the commuter.

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