PROJECT
OBJECT DETECTION USING RADAR

Guided by

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January 20,2023

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1 INTRODUCTION

The objects and the environment can be detected by using the sensors such as velodyne, blickfeld (lidar sensors), and radar. The detected objects are in the form of cloud points or cluster of points. Hence the task that needed to be accomplished was to detect the moving object through a radar sensor at a considerable distance when sensors such as Velodyne and blickfeld cannot record the actual measurements when the object is far from the standard distance that each of the sensors can measure. In order to fulfill the task a set of data is been provided in which we need to isolate the static, dynamic points of the object and the environment. Find a center point in the dynamic cluster to calculate the position of the object and test the reliability of the implemented algorithm.

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Keywords : Lidar,Velodyne,Blickfeld,Radar,Cluster

2 Methodology

2.1 Flowchart

The flow chart given below describes 4 major tasks to find the distance of the cluster center point for the record3 radar sensor data.

1. Separating the dynamic points from the static points in a frame. In this process, we also collected the points which are having velocity but do not represent the vehicle. We call this kind of point a disturbance/noise point from the background. We can remove these points by using filters.

2. In order to create a filter, we need to find out the bounding values of the filter. The filter bounding values are carried out by taking the mean of the distance between the center of the cluster and all the dynamic points.

3. Once the filter bounding value is carried out, we remove the values which are not meet the bounding values criteria. Here, we get the actual data points of the car from the radar without noise.

4. By taking the mean of all the coordinates of the points, which are found in the above step, we get the actual center point of the cluster. By using the distance formula we can find the distance between the sensor and the cluster center point.

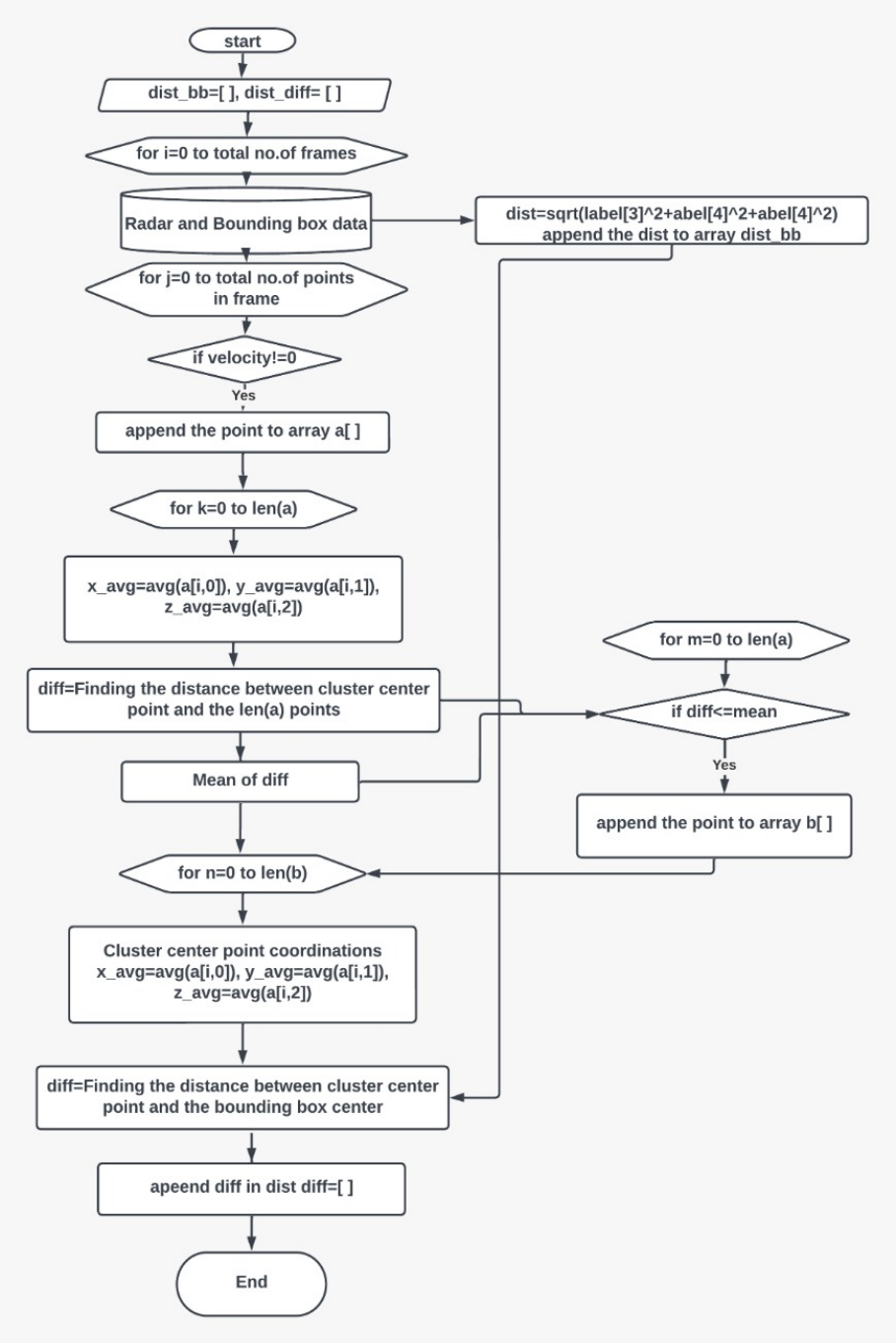
start
dist_bb=[ ], dist_diff= [ ]
for i=0 to total no.of frames
Radar and Bounding box data
dist=sqrt(label[3]^2+abel[4]^2+abel[4]^2)
append the dist to array dist_bb
for j=0 to total no.of points
in frame
if velocity!=0
Yes
append the point to array a[ ]
for k=0 to len(a)
x_avg=avg(a[i,0]), y_avg=avg(a[i,1]),
z_avg=avg(a[i,2])
for m=0 to len(a)
diff=Finding the distance between cluster center
point and the len(a) points
if diff<=mean
Yes
Mean of diff
append the point to array b[ ]
for n=0 to len(b)
Cluster center point coordinations
x_avg=avg(a[i,0]), y_avg=avg(a[i,1]),
z_avg=avg(a[i,2])
diff=Finding the distance between cluster center
point and the bounding box center
apeend diff in dist diff=[ ]
End

Figure 1:

3 RADAR

Radar(radio detection and ranging) is a sensor that follows electromagnetic principles and produces waves that get reflected back from the object. The echoed wave is received back from the object and hence distance is calculated. The data collected used in the task is MMWCAS-RF-EVM radar by texas instruments.

3.1 Isolation of Static and Dynamic points

The radar produces waves such that it not only gets the reflected wave from the object but also from the surrounding environment, to locate the exact object from the environment we have to isolate these points from the static points. The dataset provided to us consists of five columns i.e, x-axis, y-axis, z-axis, intensity, and velocity. Since the static points have no velocity we used this parameter to separate them from the dynamic points and these dynamic points are the actual points of the object. When we used frame 78 we got 169 cloud points in which around 49 dynamic points were recorded in the particular frame and the rest of the environment points that had zero velocity is eliminated.

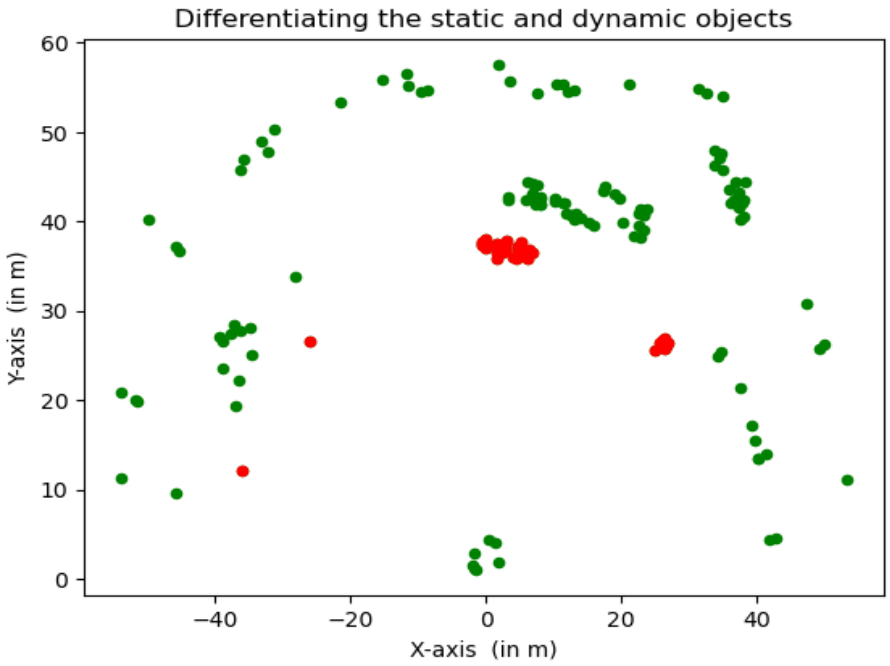

Figure 2:

3.2 Filtering of Noise :

In order to remove the noise from the dynamic points, we required a filter with a proper reference point. Here, we have taken the center point of the cluster as the reference point and found the distance between each dynamic point and reference point. After that, we take the arithmetic mean of the distances between dynamic points and the reference points. The mean provides the relation between the cluster points and their center and it helps to remove the points which are too far from the cluster center.

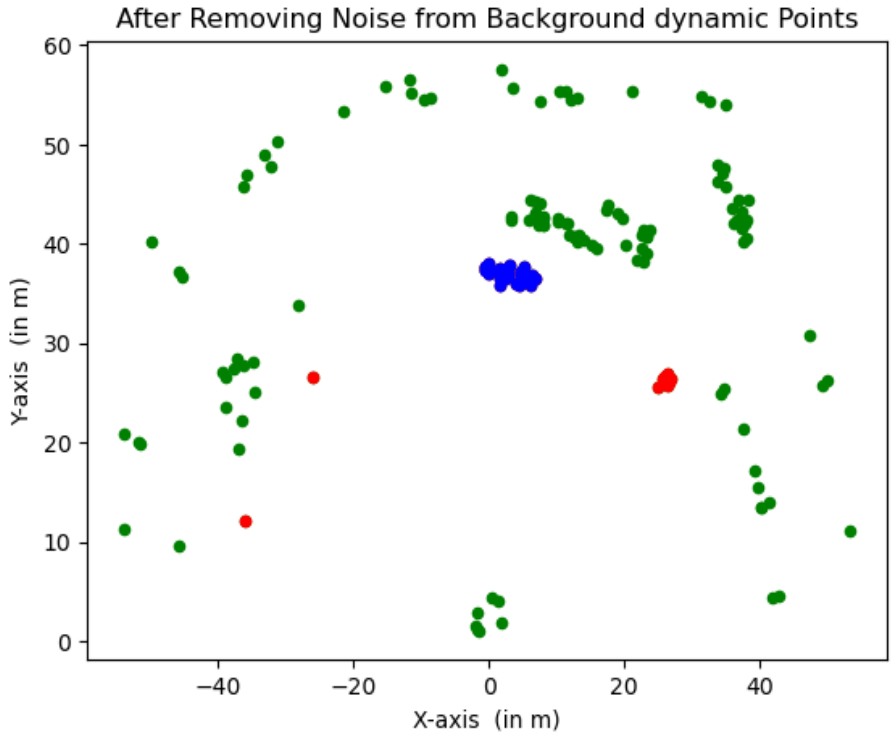

Figure 3:

In the above graph, we can clearly see that the points which are far from the cluster of the object are not taken into consideration and hence the cluster is been marked in blue, and the rest dynamic point which are are not taken into consideration are marked in red.

3.3 Finding center point of Cluster

Once after locating the dynamic cluster of points we have to create a center point to know the exact location of the object. By taking the arithmetic mean of all the coordinates of cluster points, which gives the actual coordinates of the center point of the object. In figure 4, the center point of the object is marked with an orange dot.

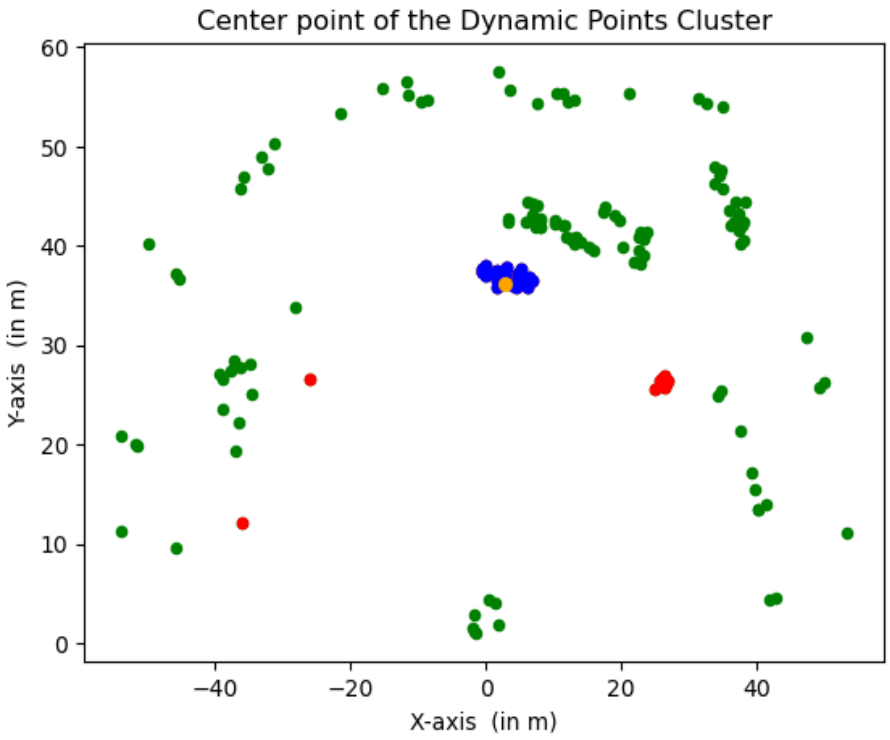

Figure 4:

3.4 Calculating distance between object and sensor

For each frame, once we found the center point of the cluster, we need to find the distance between the object and the sensor by using the distance formula. We are assuming the sensor is at the origin. The below graph shows the distance of the object from the sensor.

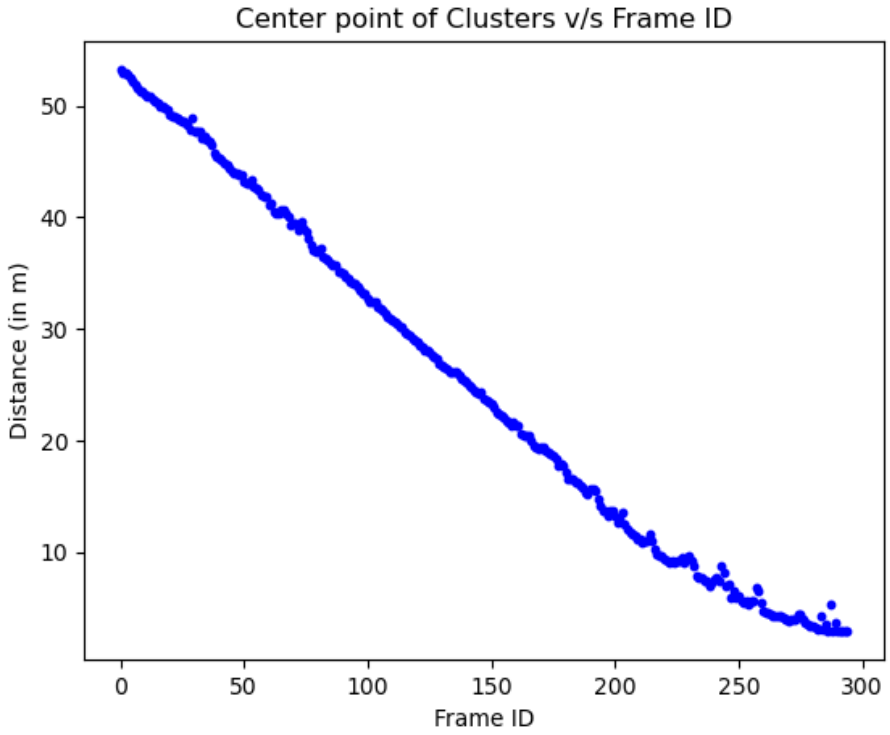

Figure 5:

4 Efficiency

To evaluate whether the radar sensor is suitable for object detection or not. First, we need to check its efficiency with respect to the actual data provided by the bounding box in the record1. Once we get the efficiency of the radar, we can apply the techniques to record 3 and find the distance of the cluster center point from the origin for all frames.

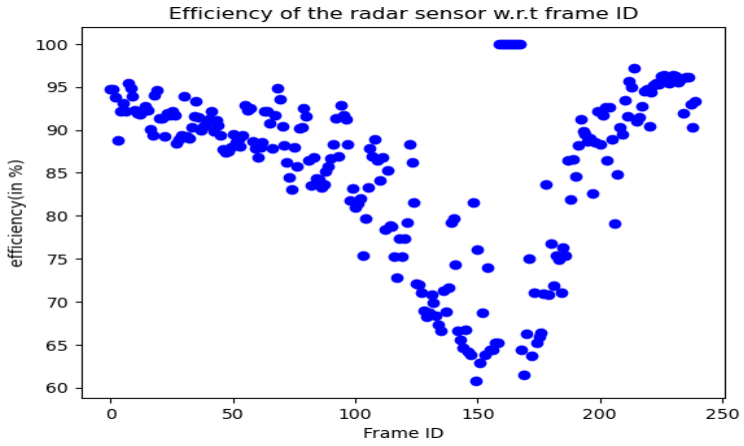

Figure 6:

Frame-id	Dynamic points	After filter Points
0	19	10
50	48	26
100	81	55
150	70	36
200	204	163
250	92	69

Figure 7: Table of points

Once we get the center point of the cluster, we find the percentage of absolute error between the cluster center point and the bounding box center point by finding

the distance between them. In order to find out efficiency, we take the mean of the absolute error of each frame and subtract the mean from 100, which gives the efficiency of the radar sensor with respect to actual data(in our case it is bounding box). In our, project we got an efficiency of 85.324 percent.

5 Conclusion

The project concludes that the radar sensors play a vital role in detecting objects when Lidar sensors fail to detect them in a longer range. The radar sensor also collects data on the environment, which includes noise from the environment. The process of differentiating actual object cloud points from the environment is complex. Using a particular algorithm if these points are eliminated then object detection would be much more accurate. Figure five clearly depicts that, the distance between the object and the sensor is decreased as we move from frame 0 to frame 295.

Bibolography :

1.Prof.Dr.Stefan Elser - Presentations followed by class lectures.
2.Mr.Felix Berens-Hands on Source code