

Lidar Vs Radar in Self Autonomous Cars

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Abstract— Self driving cars are the most viable solution to travel seamlessly without any human interaction with the machine thus reducing the number of fatalities on the road. In this research paper we will be discussing about lidar and radar technology and we will also have a look on what does the future hold in the self-driving technology and which of these will be relevant in the future.

Keywords—LIDAR; RADAR; WAYMO; TESLA

I. INTRODUCTION

India is now currently trying to adopt electric cars, though not many people have adopted electric cars. After the dawn of electric vehicles in India the next big thing would be self-autonomous (self-driving) cars. Though self-autonomous cars may be a technology that is a very farfetched concept on Indian roads, it is an undeniable technology that everyone will have to adopt. There are basically five levels of autonomy in self driving cars. Tesla is currently the leading automobile manufacturer that manufactures vehicles with the self-driving feature and their cars have attained autonomy up to level 2.5 - 3. We would talk in this paper further about how Tesla might have cracked the code to total autonomy in cars.

In this paper we will be discussing about the most controversial topic related to self-autonomous(self-driving) cars. A brief introduction to LIDAR and RADAR will be given. We will be trying to understand the Advantages and Disadvantages of each of the two devices. I will also be giving my views on which technology might lead self-autonomous cars into its eternal glory.

II. INTRODUCTION TO LIDAR TECHNOLOGY

LIDAR is an acronym of Light detecting and ranging. LIDAR is basically used to determine distances between two objects by using lasers.

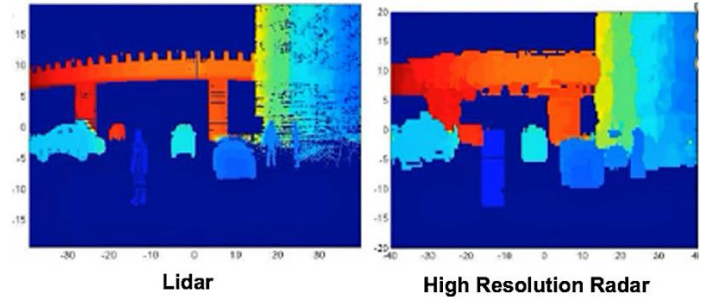
This is a technology that is widely used in airplanes, forestry, agricultural mapping and river surveys.

LIDAR used in self driving vehicles is mounted on the top of vehicles and it rotates at high speed about these vehicles and emits laser beams that hit the obstacles around it thus giving the vehicle a good image of the obstacles in its environment.

Time taken by the laser to reach back to the device can be used to determine the shape, depth and distance of the obstacles around the car.

III. ADVANTAGE OF LIDAR

1. Image processing in LIDAR is better than RADAR.



This image gives a clear view of how a processed image looks in LIDAR VS RADAR. This is a point that gives LIDAR an advantage over RADAR.

The reason for image processing being better in LIDAR is because LIDAR uses lasers in image processing which is at a much lower wavelength than radar thus providing exquisite and detailed images.

2. LIDAR uses high speed light waves and lasers thus they provide accurate data.

IV. DISADVANTAGES OF LIDAR

1. LIDAR may get fooled by fake echoes that would make it show near objects as far objects and vice versa.
2. One transmitter and two pulse generators can create multiple copies of LIDAR signals and send them to the receiver, which makes the device see non-existent objects.
3. It is found to be difficult to use LIDAR in rain, snow and fog.
But we will be discussing a recent study that proves this point false.

V. HOW CAN LIDAR FUNCTION PROPERLY IN SNOW AND RAIN?

SOLUTION 1 (The FORD Solution)

FORD has been testing its self-autonomous cars for a longtime.

These cars mainly rely on LIDAR system and therefore they faced the problem that every car manufacturer that uses LIDAR faced that is with the LIDAR being useless in snow and rain.

The reason for LIDAR to be useless in snow is because the laser that LIDAR emits hits snowflakes and raindrops and then reflects thus making the system feel that these might be an obstacle in the car's path.

So, the solution devised by FORD was when a laser goes through the rain or snow, part of it will hit a raindrop or snowflake, and the other part will likely be diverted towards the ground. The algorithm, by listening to the echoes from the

diverted lasers, will build up a picture of the ground plane as a result.

Jim McBride, technical leader for autonomous cars at FORD said that “If you record not just the first thing your laser hits, but subsequent things, including the last thing, you can reconstruct a whole ground plane behind what you’re seeing, and you can infer that a snowflake is a snowflake.”

This can be a game changer for FORD Motor company and a game changer for all those that believe in autonomous cars.

SOLUTION 2

In a research blog by Raffi Mardirosian on OUSTER, a testing of camera vs LIDAR was done in rain. It was found out that rain affected the camera’s sight more than it affected LIDAR sensors. Camera used was a GoPro 4K camera and the LIDAR used was an OS1 lidar sensor.

Now, the LIDAR was not affected a lot due to rain drops on its sensor window because according to the experimenters the trick is to use a LIDAR with a large aperture of the sensor window (larger aperture than the rain drops). Though the raindrops did reduce the range of the LIDAR sensor but did not distort the image at all.



This image shows us how the sight of camera in the left is affected by rain and on the right, it shows us how LIDAR remains unaffected.

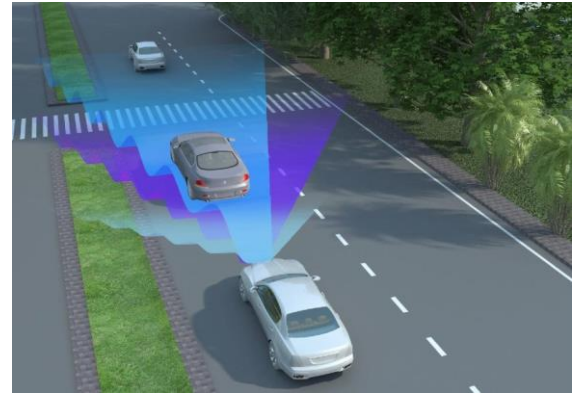
LIDARs with large aperture in sensor window allows it to see all the rain drops and therefore does not pickup the rain as an obstacle in its path.

VI. INTRODUCTION TO RADAR TECHNOLOGY

RADAR unlike LIDAR does not use a light signal like laser for determining it instead uses radio waves to determine distance, angle and velocity of objects around it.

This is a technology widely used in aircrafts, ships, space shuttles.

Though LIDARs and RADARs use different signals for transmitting but their principle is quite similar.



ADVANTAGES OF RADAR

1. RADAR can be used for detecting objects at long distances.
2. It operates quite easily in cloudy weather and at night.
3. It is cheaper than LIDAR, LIDARs can cost up to \$75000, though WAYMO has been successful at bringing the price down to \$7500 but it still is not as cheap as RADAR.

DISADVANTAGES OF RADAR

1. As it uses shorter wavelength so it might not detect obstacles that are smaller in size.
2. Precise image of objects is not formed.

VII. HOW HAS TESLA SOLVED THIS DISPUTE OF LIDAR VS RADAR IN SELF DRIVING CARS

Tesla used to use only RADAR and other sensors in its cars, but it has now dropped RADAR from its arsenal. Now, the reason for dropping RADAR might be because of many complaints from customers about their Tesla cars braking on highways when it heads below an underpass or a bridge. Another reason for discontinuing the use of RADAR might be because of the fatal accident that occurred in 2016 where a passenger lost his life because his tesla car could not detect a white semi-truck crossing in front of it and therefore led it to ram directly into the truck. Tesla has now taken up a vision-based approach i.e.,

Tesla has now shifted to only using cameras instead of using RADAR. Tesla claims it to be a very efficient system and unbelievably cheap in cost. According to Elon Musk, the vision system has advanced a lot that it was now better off without the RADAR.

CONCLUSION

Finally I would conclude by saying that though Tesla’s approach is quite remarkable but is making compromises in the system to reduce the cost of the car really worth endangering lives?

Though LIDAR and RADAR have its own share of advantages and disadvantages, but according to me though

LIDAR is expensive but WAYMO is trying its best to reduce cost and if according to our solution 2, LIDARs can work properly even in rain and fog then I definitely don't think compromising on LIDAR is worth it.

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