

Analysis of Self-Driving Vehicles

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Abstract—In Today's world, vehicles are used widely by humans. So, most of the biggest car manufactures are building their own version of self-driving vehicles using different technologies. Vehicles are focused to be automated to make human relax from driving. There is a race happening right now that stretches from Silicon Valley to Detroit and back: who can make an autonomous car that behaves better than a human driver? To get that same kind of understanding, automated cars need lots of information and data. And the two companies with the most information and data are Tesla and Waymo. Google, has started working on the self-driving cars since 2009 and still developing new changes to give a whole new update to the automated vehicles. Waymo-Google self-driving car project—stands for a new way forward in mobility was began in 2009. The idea described in this paper is taken from google and tesla cars. Self-Driving vehicles are trained to reach the destination by using the computerized maps. The other application is self-driving vehicle during the heavy traffic jam, hence relaxing driver from continuously pushing brake, accelerator or clutch. During the heavy traffic jam, taking and intelligent decisions is the major issue for the self-driving vehicles which aspect also has been consider in this paper.

Keywords—Automated driving, traffic jam, dynamicdestination, self-driving, Car

I. INTRODUCTION

Automated vehicle (AV) technology has advanced significantly in recent years. Car manufactures have already provided vehicles with some automated features like self-parking and accident avoidance features such as automated braking, road mapping, alerting human driver. At present, many vehicles on the road are considered to be semi-autonomous due to safety features like proper parking and braking mechanism, and a few have the features of automatic drive, brake, steer, and park themselves. Automated vehicle technology depends on GPS technology and advanced sensing systems that can detect road boundaries, signs and signals, and unexpected obstacles. In this paper it shows information about how the automatic vehicles can deal with traffic and can take a intelligent decisions about parking and changing of lanes. Autonomous vehicles are expected to bring with them a few different benefits, but the most important one is likely to be improved safety on the roads. The number of accidents caused by improper driving is likely to reduce, as cars loses its control like human drivers can. Self-driving cars also don't get drowsy, and they don't have to worry about being distracted by text messages or by passengers in the vehicle. And a computer isn't likely to get into an accident due to road rage. A 2015 National Highway Traffic Safety Administration report found that 94 percent of traffic accidents happen because of human error: By taking humans out of the equation, self-driving vehicles are expected to make the roads much safer for all.

To accomplish a automated car must have an artificial intelligence system that examines its surroundings, processes the visual data to determine how to avoid collisions, operates car components like the steering and brake, and uses GPS to track the car's current location and route to proper destination. Companies like Google's Waymo put have put AI inside virtual cars and have the tested the vehicle to drive billions of miles throwing many perceivable obstacle and situation at the cars to see how they respond. There are various methods, algorithms and technology is used by automated vehicles to take human like intelligent decisions in traffic and avoid accidents.

II. GOOGLE SELF-DRIVING CAR

Google has been testing its prototype car on US roads – it's yet to be test in the UK – and revealed some details about how its self-driving cars work.

	LEVEL 0 No Automation	LEVEL 1 Driver Assist	LEVEL 2 Partial Automation	LEVEL 3 Conditional Automation	LEVEL 4 High Automation	LEVEL 5 Full Automation
Who monitors the road?	Human	Human	Human	Automation	Automation	Automation
Steering, Acceleration, Deceleration	Human	Human	Automation	Automation	Automation	Automation
Monitoring surroundings	Human	Human	Human	Automation	Automation	Automation
Fallback for self-driving failures	Human	Human	Human	Human	Automation	Automation
Automation takes full control	Human	Human	Human	Automation	Automation	Automation
Examples	Ford Model T	Crash assist, Cruise control, etc.	Tesla Autopilot, Nissan ProPilot Assist	Uber self-driving car	Waymo's autonomous vehicle	None

FIGURE 1: Levels of Automation



FIGURE 2: Google waymo consists of different sensors

Following are the technology used in Google self-driving car:

2.1 LIDAR

LIDAR is an acronym for Light Detection and Ranging, or Light Imaging, Detection and Ranging. LIDAR bounces light from objects to see where they are, just as radar uses radio waves and sonar uses sound. LIDAR systems sends out pulses of light outside of the visible spectrum and examine time how long it takes for them to bounce back. The time it takes for the light to reflect back from the object information the sensor how far away it is the object and what is its shape. The direction and distance between the LIDAR sensor and each detected object are then plotted on a 3D map called a 'point cloud' in to build up a detailed picture of the surroundings environment. While radar works for long distances, and sonar for short distances, LIDAR provides a is used for handy middle ground. The main component of Google's self-driving car is the rotating roof top camera mounted on top of the car, Lidar which is a laser range finder. With its array of 64 laser beams, this camera creates 3D images of objects to help the car see hazards object along the way. This device calculate how far is the object from the car by calculating the time taken for the laser beam to hit the object and come back. These high intensity lasers can calculate distance and plot the images of the objects in the range of 200m.

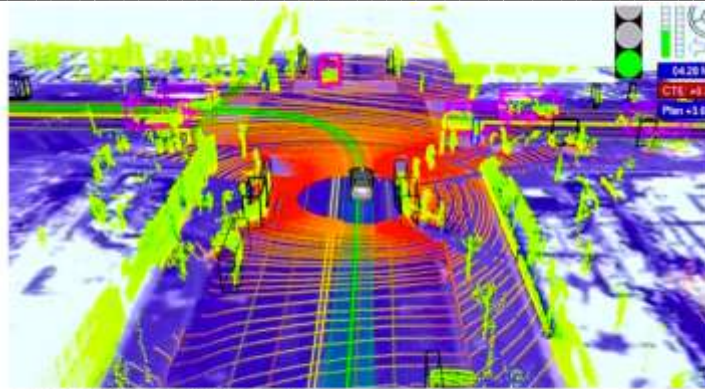


Image: Sebastian Thrun & Chris Umson/Google
Google's self-driving car uses lidar to create 3D image of its surroundings.

FIGURE 3: Google self-driving car uses lidar to create 3D image of its surroundings.

2.2 FRONT CAMERA FOR REAR VISION

A camera mounted on the windshield provide the information about the objects available in front of the car. These objects can be- pedestrians and other vehicles. This camera detects and records information about road signs and traffic signal lights, which is smartly interpreted by the cars in built software.

2.3 BUMPER MOUNTED RADAR

4 radars are mounted on the car's front and rear bumpers, that helps the car to get information of vehicles in front of it and behind it. The radar sensor on the vehicles bumpers keeps a continuous eye on the car ahead and back. The software inside a car is programmed to (at all times) maintain a distance of 2-4 seconds (it could even be higher) from the car ahead of it. So, with this technology the car will intelligently take decisions to speed up or slow down speed depend on the behavior of the car/driver ahead. Google's self-driving cars use this technology to keep passengers and other vehicles safe by reducing bumps and crashes

2.4 AERIAL THAT READ PRECISE GEO-LOCATION

An aerial present on the rear of the car receives information about the location of the car, thanks to GPS satellites. The inbuilt car's GPS navigation unit works along with the sensors and help the car to localize itself. But GPS signals may get low by several meters due to signal interferences and other atmospheric interference. To minimize this problem, the GPS data is compared with collected sensor map data from the same location. As the car moves, the car internal map is updated with new position information displayed by the sensors for the car.

2.5 ULTRA SONIC SENSOR ON REAR WHEEL

An ultrasonic sensor is present on one of the rear wheels that helps to keep track movement of car and will alert the car when there is obstacles in the rear. Cars that offer automatic Reverse Park Assist technology feature uses such sensors to help carto park itself into tight reverse parking spots. These sensors get activated when the car is get into the reverse gear.

2.6 DEVICES WITHIN CAR:

Altimeters, gyroscopes, and tachymeters are present inside the car that determine the very precise position of the car thanks to the various parameters they measure. This offers highly accurate information for the car to operate safely.

2.7 SYNERGISTIC COMBINING OF SENSORS:

All the data gathered by these sensors is combining and interpreted together by the car in built in software system to create a safe driving experience.

2.8 PROGRAMMED TO INTERPRET COMMON ROAD SIGNS:

The software in the car has been programmed to rightly interpret common road condition and motorist signs. For example, if a cyclist gestures that he intends to make a manoeuvre, the automated car understand it correctly and slows down to allow the motorist to turn. Predetermined shape and motion and gestures descriptions are programmed into the software to help the car make intelligent decisions. For example, if the car detects a 2-wheel vehicle and determines the speed of the vehicle as 10mph rather than 50 mph, the car instantly interprets that this vehicle is a bicycle and not a motorbike and behaves and take decision accordingly.

2.9 MAPPING IN ADVANCE:

Before a self-driven car is tested, a regular manual car is driven along the route and collected information or maps out the route and its road conditions including poles, road markers, signs and more. This map information is fed into the car in built software which help the car to identify what is a regular part of the road. As the car moves, laser range finder send laser beam and generates a detailed 3D map of the surrounding at that moment. The vehicle compares this detailed 3D map with the default-existing map to find out the non-related aspects in the road, which can be pedestrians and/or other motorists identify by car, thus avoiding them.

2.10 PROGRAMMING REAL LIFE ROAD BEHAVIOR:

Google engineers and developers have programmed some real-life behavior in these cars. The vehicles has also been programmed to advance ahead if it detects that the other vehicle is not moving.

III. TESLA ELECTRIC AND SELF-DRIVING CAR

Tesla, Inc. Formerly known as (2003–17) Tesla Motors, American electric cars manufacturer. Tesla Motors was formed to develop an electric sports car. Tesla manufactured electric cars and have the feature of self-driving called as Autopilot. In Autopilot mode car itself drive and no human driver is needed.

Autopilot is optional auto driver assist system for Tesla cars that will turn the tesla electric cars into fully self-driving vehicles. When Autopilot is into action, cars can self-steer, adjust speed, detect nearby obstacles, apply brakes, and park. It uses a radar, cameras, ultrasonic sensors, and GPS. Currently, Autopilot is not considered as completely self-driving system. Autopilot is considered as Level 2 automated system by the US National Highway Transportation Safety Administration. Level 2 means autopilot is capable of combined auto functions like acceleration and steering but the driver presence must be there while driving. Enhanced Autopilot is the latest version of the Autopilot software, provides driver-assist features mainly designed to help with highway driving.

Tesla says Autopilot's sensors allow the inbuilt computer system to build a detailed image of its surroundings, allowing the car to detect distance from the object so to reduce possible collisions with vehicles, pedestrians, cyclists, animals, debris, and other obstacles. It can detect road markings, signs, and traffic signal lights. For drivers that opt for the Autopilot and Full Self-Driving Capability, systems in cars launched since October 2016 depends on the following sensors.

3.1 FORWARD-LOOKING RADAR

The radar helps the autopilot to look 160m ahead of the car, through "sand, snow, fog--almost anything," according to Musk. Radar is the primary sensor that detect the vehicle's surroundings objects, along with the front-facing cameras.

3.2 EIGHT CAMERAS

On the windshield of the car for forward facing cameras are present serve as a backup to the radar. The cameras consist of a narrow camera that observe footage 250m in front, a main camera that captures 150m in front, a wide-angle camera that captures 60m in front, and a camera that captures footage 80m in front and to the side of the car. The wide-angle camera is there to read road signs and traffic signal lights, allowing the car to react accordingly.

3.3 SONAR

A 360-degree, ultrasonic sonar detects object in an eight-meter radius around the car. The ultrasonic sensors can spot objects like a human or a dog, and work at any speed. This feature can also detect objects in blind spots and inform or guide the car when automatically switching lanes

3.4 GPS

A satellite navigation system can detect the car's position on the road.

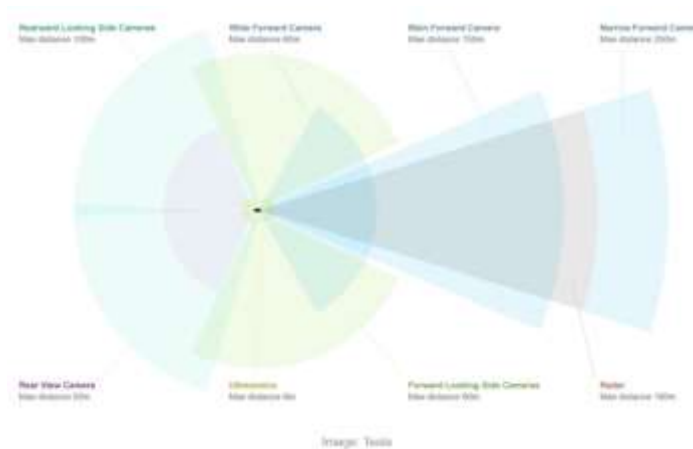


FIGURE 4: Tesla self-driving car uses different sensors

IV. MACHINE LEARNING ALGORITHM IN AUTONOMOUS DRIVING

Autonomous cars are very closely related with Industrial IoT. Every person has a question how are these autonomous cars functions. What actually inside that the car to make them work without drivers taking control of the wheel. These days cars are made with a lot of sensors, actuators, and controllers. These devices are instructed by software sitting on various function-specific software running on ECUs (Electronic Control Units). Machine learning software is also included in this.

One of the main goals of any machine learning algorithm in the automated car is to continuously observe the environment and the prediction of possible changes to those surroundings. These tasks is divided into four steps:

Object detection.

Object Identification or recognition and Object classification.

Object localization and prediction of movement.

Machine learning algorithms are used are of four type regression algorithms, pattern recognition, cluster algorithms and decision matrix algorithms.

4.1 REGRESSION ALGORITHMS

In Automated vehicles, images (radar or camera) play a very important role in localization and actuation of the object, and the biggest challenge for any algorithm is to develop an image-based model for feature selection and prediction. Regression algorithms that are used for self-driving cars are a Bayesian regression, neural network regression, and decision forest regression, among others.

4.2 PATTERN RECOGNITION ALGORITHMS (CLASSIFICATION)

Pattern recognition algorithms are good at observing and removing out unusual data points. Recognition of patterns in a data set is a primary step before the classification of the objects. These types of algorithms can also be called as data reduction algorithms. These algorithms help in reducing the data set by detecting object edges and fitting line segments (polylines) and circular arcs to the edges. Line segments are properly aligned to edges up to a corner, then a new line segment is started. Circular

arcs are fit into sequences of line segments that will approximate an arc. The image features likeline segments and circular arcs are combined in various ways to form the features that are used for recognizing an object.

4.3 CLUSTERING

It may happen that the classification algorithms may miss the object and fail to classify and report it to the system. The reason could be low-resolution images, few data points or discontinuous data. Clustering algorithm is good at discovering structure from data points. All methods are concerned with using the discovered structures in the data to organize the data into groups of maximum similarities. The most used type of algorithm is K-means, Multi-class Neural Network.

4.4 DECISION MATRIX ALGORITHMS

These algorithms are mainly used for decision making purpose. Whether a vehicle needs to take left turn or it needs to brake this decision depends on the level of confidence the algorithms have on the classification, recognition, and prediction of the next movement of objects. The mostly used algorithms are gradient boosting (GDM) and AdaBoosting.

V. CONCLUSION

People still think that self-driving cars are not safe, but self-driving cars are made more and more accurate in intelligent decision making this getting more and more safe. Driverless vehicles will be the next step in transportation industry.

In the future almost we will find all the vehicles automated and there will be more improvement in the decision-making capability of the automated cars. In India due to road conditions, self-driving cars are not possible to drive, but in the future there will be law and road conditions will be improved. Tesla has launched its electric vehicles and in various countries it is running successfully. More improvement will be done in the field of software's system of the automated cars so that humans can completely rely on the automated cars and can do relaxed driverless driving.

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REFERENCES

- [1] J. Clerk Maxwell, *A Treatise on Electricity and Magnetism*, 2nd ed., vol. 2. Oxford: Clarendon, 1892, pp. 68–73
- [2] *The Driver in the Driverless Car: How Our Technology Choices Will Shape the Future* by Vivek Wadhwa with Alex Salkever
- [3] *Driverless: Intelligent Cars and the Road Ahead* by Hod Lipson and Melba Kurman
- [4] *Ethics, Safety, And Software Behind Self-Driving Cars In The Aftermath Of First Pedestrian Killed* :By Lori Cameron and Michael Martinez.
- [5] *Cruising into a driverless future: Research on autonomous vehicles* By Chloe Reichel.
- [6] *How Google's Self-Driving Car Works* :By Erico Guizzo
- [7] *10 Astonishing Technologies that Power Google's Self-Driving Cars* by national.co.uk
- [8] M. Weber, "Where to? A History of Autonomous Vehicles," 2014.
- [9] Helbing, "Traffic and related self-driven many-particle systems," *Reviews of Modern Physics*, vol. 73, no. 4, pp. 1067–1141.
- [10] P. Rau, "Target Crash Population of Automated Vehicles," in *In 24th International Technical Conference on the Enhanced Safety of Vehicles (ESV)*, 2015, pp. 1–11.
- [11] "Details - google car," <http://googlecarjames.weebly.com/details.html>.
- [12] Fisher, "Inside Google's Quest to Popularize Self-Driving Cars," *Popular Science*, 2013.
- [13] "Google blog: Green lights for our self-driving vehicle prototypes,"



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- [14] K. R. Memon, S. Memon, B. Memon, A. R.Memon, and M.Z. A.S.Syed, "Real time Implementation of Path planning Algorithm withObstacle Avoidance for AutonomouVehicle," in 3rd 2016 InternationalConference on Computing for Sustainable Global Development",NewDelhi, India, 2016.
- [15] E. Frink, D. Flippo, and A. Sharda, "Invisible Leash: Object-Following Robot," *Journal of Automation, Mobile Robotics & Intelligent Systems*,vol. 10, no. 1, pp. 3-7, feb 2016.