

# A Review on Google Self Driving Car Technology

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**Abstract:-** Google has launched this new car project. This is a self driven car. It does not need any driver to drive it. This is very ambitious project. The driverless driving of the car is achieved with the help of many technologies. The sensors and camera are some of the important things which make this possible. The car is still in testing stage. It is said to be out shortly and is driving very well. This car has a LiDAR system which is the most important thing inside it. Google has a separate software that powers this car. It is given the name of Google chauffer .It also has a range finder mounted on it. This is velodyne 64 beam laser. With the help of this laser,the vehicle can create 3D map of the surroundings and get a clear idea of the air around it. This helps in clear and smooth driving without running into things .The laser is very effective and accurate.

## I. INTRODUCTION

The Google Self-Driving Car, commonly abbreviated as SDC, is a project by Google X that involves developing technology for autonomous cars, mainly electric cars. The software powering Google's cars is called Google Chauffeur. Lettering on the side of each car identifies it as a "self-driving car". The project is currently being led by Google engineer Sebastian Thrun, former director of the Stanford Artificial Intelligence Laboratory and co-inventor of Google Street View. Thrun's team at Stanford created the robotic vehicle Stanley which won the 2005 DARPA Grand Challenge and its US\$2 million prize from the United States Department of Defence. The team developing the system consisted of 15 engineers working for Google, including Challenges. Legislation has been passed in four U.S. states and Washington, D.C. allowing driverless cars. The state of Nevada passed a law on June 29, 2011, permitting the operation of autonomous cars in Nevada, after Google had been lobbying in that state for robotic car laws. The Nevada law went into effect on March 1, 2012, and the Nevada department of motor vehicles issued the first license for an autonomous car in May 2012, to a Toyota prius modified with Google's experimental driverless technology. In April 2012, Florida became the second state to allow the testing of autonomous cars on public road and California became the third when Governor Jerry brown signed the bill into law at Google HQ in Mountain View. In December 2013, Michigan became the fourth state to allow testing of driverless cars in public roads. In July 2014, the city of Coeur d'Alene ,Idaho adopted a robotics ordinance that includes provisions to allow for self-driving cars. In May 2014, Google presented a new concept for their driverless car that had neither a steering wheel nor pedals, and unveiled a fully functioning prototype in December of that year that they planned to test

on San Francisco Ban Area roads beginning in 2015. Google plans to make these cars available to the public in 2020.

## II. TECHNOLOGY

The project team has equipped a number of different types of cars with the self-driving equipment, including the Toyota Prius, Audi T T, and Lexus RH450h, Google has also developed their own custom vehicle, which is assembled by Roush Enterprises and uses equipment from Bosch, Z F Lenksysteme, LG and Continental.

Google's robotic cars have about \$150,000 in equipment including a \$70,000 LIDAR system. The range finder mounted on the top is a Velodyne 64-beam laser. This laser allows the vehicle to generate a detailed 3D map of its environment. The car then takes these generated maps and combines them with high-resolution maps of the world, producing different types of data models that allow it to drive itself. As of June 2014, the system works with a very high definition inch-precision map of the area the vehicle is expected to use, including how high the traffic lights are; in addition to on-board systems, some computation is performed on remote computer farms. A self-driving car is capable of sensing its environment and navigating without human input. To accomplish this task, each vehicle is usually outfitted with a GPS unit, an inertial navigation system, and a range of sensors including laser rangefinders, radar, and video. The vehicle uses positional information from the GPS and inertial navigation system to localize itself and sensor data to refine its position estimate as well as to build a three-dimensional image of its environment.

Data from each sensor is filtered to remove noise and often fused with other data sources to augment the original image. How the vehicle subsequently uses this data to make navigation decisions is determined by its control system.

The majority of self-driving vehicle control systems implement a deliberative architecture, meaning that they are capable of making intelligent decisions by 1) maintaining an internal map of their world and 2) using that map to find an optimal path to their destination that avoids obstacles (e.g. road structures, pedestrians and other vehicles) from a set of possible paths. Once the vehicle determines the best path to take, the decision is dissected into commands, which are fed to the vehicle's actuators. These actuators control the vehicle's steering, braking and throttle.

This process of localization, mapping, obstacle avoidance and path planning is repeated multiple times each second on powerful on-board processors until the vehicle reaches its destination.



On board computers of Stanford/Audi autonomous TTS

The next section focuses on the technical components of each process: mapping and localization, obstacle avoidance and path planning. Although car manufacturers use different sensor suites and algorithms depending on their unique cost and operational constraints, the processes across vehicles are similar. The descriptions below most closely mirror their implementation in state-of-the-art self-driving military vehicles.

**ROAD TESTING**



A Toyota prius modified to operate as a Google driverless car, navigating a test course.

In 2012, the test group of vehicles included six, Toyota prius an Audi T T, and threeLexus RX 450 h, each accompanied in the driver's seat by one of a dozen drivers with unblemished driving records and in the passenger seat by one of Google's engineers. By May 2015, that fleet consisted solely of 23 Lexus SUVs.

Google's vehicles have traversed San Francisco'sLombard street, famed for its steep hairpin turns, and through city traffic. The vehicles have driven over the Golden Gate Bridge and aroundLake Tahoe.The system drives at the speed limit it has stored on its maps and maintains its distance from other vehicles using its system of sensors. The system provides an override that allows a human driver to take control of the car by stepping on the brake or turning the wheel, similar to cruise control systems already found in many cars today.

On March 28, 2012, Google posted a You Tube video showing Steve Mahan, a resident of Morgan Hill California, being taken on a ride in Google's self-driving. Toyota prius,In the video, Mahan states "Ninety-five percent of my vision is gone, I'm well past legally blind". In the description of the YouTube video, it is noted that the carefully programmed route takes him from his home to a drive-through restaurant, then to the dry cleaning shop, and finally back home.

In August 2012, the team announced that they have completed over 300,000 autonomous-driving miles (500,000 km) accident-free, typically have about a dozen cars on the road at any given time, and are starting to test them with single drivers instead of in pairs. Four U.S. states have passed laws permitting autonomous car as of December 2013: Nevada, Florida, California, and Michigan. A law proposed in Texas would establish criteria for allowing "autonomous motor vehicles". In April 2014, the team announced that their vehicles have now logged nearly 700,000 autonomous miles (1.1 million km). In late May, Google revealed a new prototype of its driverless car, which had no steering wheel, gas pedal, or brake pedal, being 100% autonomous.In June 2015, the team announced that their vehicles have now driven over 1 million miles, stating that this was "the equivalent of 75 years of typical U.S. adult driving", and that in the process they had encountered 200,000 stop signs, 600,000 traffic lights, and 180 million other vehicles. Google also announced its prototype vehicles were being road tested in Mountain View, California. During testing, the prototypes' speed cannot exceed 25 mph and will have safety drivers aboard the entire time.



**TRAFFIC ACCIDENTS**

As of July 2015, Google's 23 self-driving cars have been involved in 14 minor traffic accidents on public roads, but Google maintains that in all cases the vehicle itself was not at fault because the cars were either being manually driven or the driver of another vehicle was at fault.

In June 2015, Google founder SergyBrinconfirmed that there had been 12 accidents as of that date, eight of which involved being rear-ended at a stop sign or traffic light, two in which the vehicle was side-swiped by another driver, one of which involved another driver rolling through a stop sign, and one where a Google employee was manually driving the car.

In July 2015, three Google employees suffered minor injuries when the self-driving car they were riding in was rear-ended by a car whose driver failed to brake at a traffic light. This was the first time that a self-driving car collision resulted in injuries.

### COMMERCIALIZATION

In 2012 Google founder Sergey Brin stated that Google Self-Driving car will be available for the general public in 2017, and in 2014 this schedule was updated by project director Chris Urmson to indicate a possible release from 2017 to 2020. Google has partnered with suppliers including Bosch, ZF Lenksysteme, LG, Continental, and Roush, and has contacted manufacturers including General Motors, Ford, Toyota, Daimler and Volkswagen.

An attorney for the California department of motor vehicles raised concerns that "The technology is ahead of the law in many areas," citing state laws that "all presume to have a human being operating the vehicle". According to the New York Times, policy makers and regulators have argued that new laws will be required if driverless vehicles are to become a reality because "the technology is now advancing so quickly that it is in danger of outstripping existing law, some of which dates back to the era of horse-drawn carriages".

Google lobbied for two bills that made Nevada the first state where autonomous vehicles can be legally operated on public roads. The first bill is an amendment to an electric vehicle bill that provides for the licensing and testing of autonomous vehicles. The second bill will provide an exemption from the ban on distracted driving to permit occupants to send text messages while sitting behind the wheel. The two bills came to a vote before the Nevada state legislature's session ended in June 2011. It has been speculated that Nevada was selected due to the Las Vegas Auto Show and the Consumer Electronics show, and the high likelihood that Google will present the first commercially viable product at either or both of these events. Google executives, however, refused to state the precise reason they chose Nevada to be the maiden state for the autonomous car.

Nevada passed a law in June 2011 concerning the operation of autonomous cars in Nevada, which went into effect on March 1, 2012. A Toyota Prius modified with Google's experimental driverless technology was licensed by the Nevada Department of Motor Vehicles (DMV) in May 2012. This was the first license issue in the United States for a self-driven car. License plates issued in Nevada for autonomous cars will have a red background and feature an infinity symbol( $\infty$ ) on the left side because, according to the DMV Director, "...using the infinity symbol was the best way to represent the 'car of the future'." Nevada's regulations require a person behind the wheel and one in the passenger's seat during tests.

In August 2013, news reports surfaced about Robo-Taxi, a proposed driverless vehicle taxicab service from Google. These reports re-appeared again in early 2014, following the granting of a patent to Google for an advertising fee funded transportation service which included autonomous vehicles as a method of transport. Paid Google consultant

Larry Burns says self-driving, taxi-like vehicles "should be viewed as a new form of public transportation

Two decades and many technological advances later, and almost every large car manufacturer is pursuing a version of Dickmann's idea. There is, Aeberhard suggests – as we bomb along the autobahn – not that much sharing of technology between manufacturers, beyond some limited European-wide initiatives. Each manufacturer is trying to find its own way of creating autonomy, while mindful of going too far too fast. Toyota, for example, has learned lessons from its experience in 2005, when it introduced the world's first self-parking car; far from being greeted as a game-changing advance, it was mostly criticised for being over-engineered as well as expensive, and was not widely copied. Volvo has made many advances in incorporating automated safety systems, with its stated ambition of achieving "no accidents involving Volvo cars by 2020". But so far this is mainly with an emphasis on keeping the driver alert. For example, if a car crosses a lane line without the driver using an indicator signal, the dashboard flashes the image of a steaming coffee cup and the words "time for a break". If it is still drivers that cause accidents, we would like to believe it is also careful drivers that prevent them.

### III.LIMITATIONS

As of August 28, 2014 the latest prototype has not been tested in heavy rain or snow due to safety concerns. Because the cars rely primarily on pre-programmed route data, they do not obey temporary traffic lights and, in some situations, revert to a slower "extra cautious" mode in complex unmapped intersections. The vehicle has difficulty identifying when objects, such as trash and light debris, are harmless, causing the vehicle to veer unnecessarily. Additionally, the lidar technology cannot spot some potholes or discern when humans, such as a police officer, are signalling the car to stop. Google projects having these issues fixed by 2020. "Hacking is a concern for any technology company," Aeberhard says. "In BMWs, to get access to the systems that control the steering wheel and so on, you have to have physical access to the car. You need to be physically attached to the wires and then you need to know the protocols for the system to do anything, and still then it is very hard to get the car into a state where it is responsive. In automated cars there will be further layers of security."

### REFERENCES

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