An autonomous driverless car: an idea to overcome the urban road challenges

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Abstract

This paper discusses an autonomous robotically handled urban driving vehicle. The approach presents here the number of features as innovations, which are well grounded in past re-search on autonomous driving and mobile robotics, such as mapping, tracking, global and local planning, probabilistic localization. The results of the Urban Challenge, along with prior experiments carried out by the research team, suggest that an autonomous vehicle is capable of navigating in other vehicles and human traffic. It successfully demonstrated merging, intersection handling, parking lot navigation, lane changes, and autonomous U-turns. These innovations include the obstacle/curb detection method, the vehicle tracker, the various motion planners, and the behavioural hierarchy that addresses a broad range of traffic situations. Together, these methods provide for a robust system for urban in-traffic autonomous.

Keywords: Self driving Google-Car, LIDAR Sensor, Potion Sensor & Radar Sensor.

1. Introduction

An autonomous vehicle is fundamentally defined as a passenger vehicle that drives by itself. This vehicle is also referred to as an autopilot, driverless car, auto-drive car, or automated guided vehicle. In the future, automated systems will help to avoid accidents and reduce congestion. The future vehicles will be capable of determining the best route and warn each other about the conditions ahead. In this paper we are discussing the Google's autonomous driverless car.

The Google Driverless Car is a project by Google that involves developing technology for driverless cars. The project is currently being led by Google engineer Sebastian Thrun, 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 Defense. The team developing the system consisted of 15 engineers working for Google, including Chris Urmson, Mike Montemerlo, and Anthony Levandowski who had worked on the DARPA Grand and Urban Challenges. The system combines information gathered from Google Street View with artificial intelligence software that combines input from video cameras inside the car, a LIDAR sensor on top of the vehicle, radar sensors on the front of the vehicle and a position sensor attached to one of the rear wheels that helps locate the car's position on the map. In 2009, Google obtained 3,500 miles of Street View images from driverless cars with minor human intervention. As of 2010, Google has tested several vehicles equipped with the system, driving 1,609 kilometres (1,000 mi) without any human intervention, in addition to 225,308 kilometres (140,000 mi) with occasional human intervention. Google expects that the increased accuracy of its automated driving system could help reduce the number of traffic-related injuries and deaths, while using energy and space on roadways more efficiently.[1][2]

2. A Driverless Google Car

The project team has equipped a test fleet of at least eight vehicles, consisting of six Toyota Prius, an Audi TT, and a Lexus RX450h, 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. The car has traversed San Francisco's Lombard Street, famed for its steep hairpin turns and through city traffic. The vehicles have driven over the Golden Gate Bridge and on the Pacific Coast Highway, and have circled Lake 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 in cars.

Google has been working on it's self driving car technology, where the user is required to enter an address in Google maps, after which the system gathers information from Google Street View and combines it with artificial intelligence software. The software includes information from video cameras in car, a LIDAR sensor on top of vehicle, radar sensors in front and a position sensor attached to one of the rear wheels that helps locate the car's position on map. These sensors aid the car in maintaining distance with surrounding vehicles/objects.[2]-[3]

3. The control mechanism of an autonomous vehicle

The control mechanism of an autonomous car consists of three main blocks as shown below:

1. Sensors

-laser sensors

-cameras
-radars
-ultrasonic sensors

-GPS, etc.

2. Logic Processing units

-Software
-Decision making

-Checking functionality

-User interface

3. Mechanical control systems

-Consists of servo motors and relays

-Driving wheel control

-Brake control

-Throttle control, etc. [2]

4. Control Mechanism and Embedded system of vehicle

4.1 Artificial Intelligence Software:

Artificial intelligence is the making of intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence. This system exhibits human intelligence and behavior include robots, expert systems, voice recognition, natural language processing, face recognition, handwriting recognition, game intelligence, artificial creativity and more.

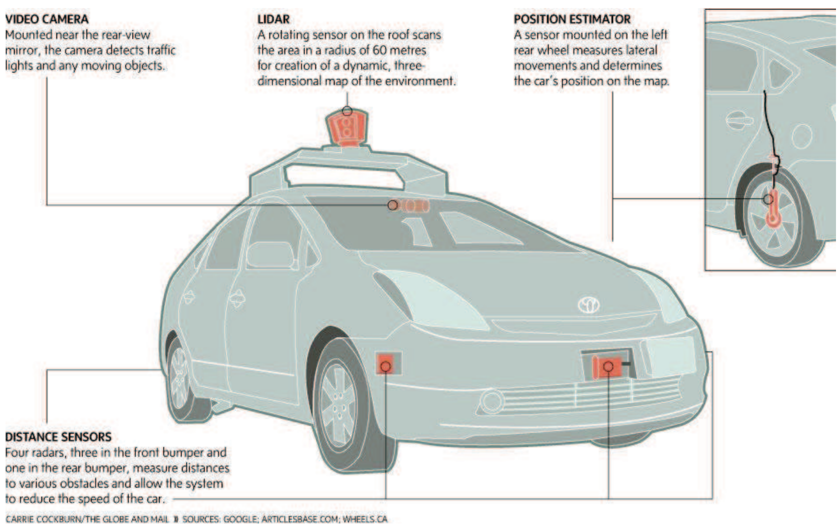

Figure 1 Google car

By this technology both Google map and Google street view are interrelated.[2]

4.2 Google Map:

Google map is the most powerfull and friendly service provided by google, which helps to find local business information including business locations, driving directions, navigations, contact information and so on.

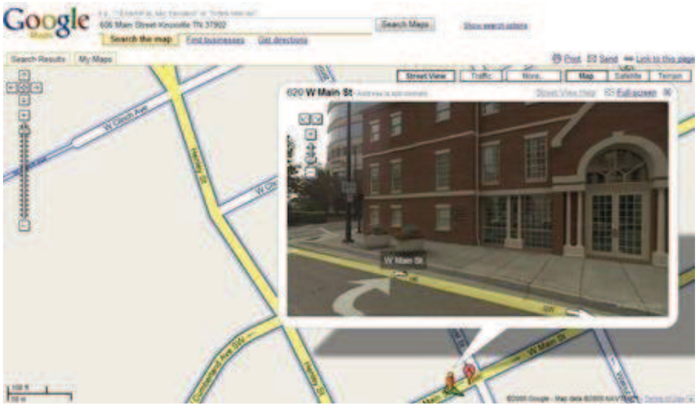

Figure 2 Google map

4.3 Google Street View:

In order to provide the street level images of entire cities all around the world Google Street View (GSV) has been extended by Google. This service is providing a number of unreachable and high density of geo-positioned images of world. A GSV user can roam around the city streets, by enabling him a wide range of uses such as finding any specific items.

4.4 LIDAR Sensor:

Light Detection And Ranging is an optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light, often using pulses from a laser. LIDAR uses ultraviolet, visible, or near infrared light to image objects and can be used with a wide range of targets, including non-metallic objects, rocks, rain, chemical compounds, aerosols, clouds and even single molecules. A narrow laser beam can be used to map physical features with very high resolution.

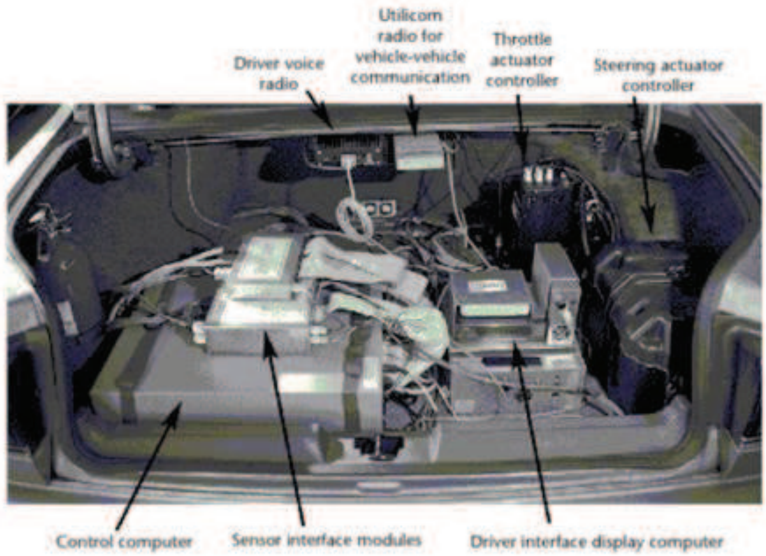

Figure 3 Control system established in Google car

Google's robotic test cars have about $150,000 in equipment including a $70,000 LIDAR (laser radar) 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 it self.

4.4.1 Velodyne 64-beam laser :

The HDL-64E LiDAR sensor is designed for obstacle detection and navigation of autonomous ground vehicles and marine vessels. Its durability, 360° field of view and very high data rate makes this sensor ideal for the most demanding perception applications as well as 3D mobile data collection and mapping applications. With its full 360° horizontal field of view by 26.8° vertical field of view, 5-15 Hz user-selectable frame rate and over 1.3 million points per second output rate, the HDL-64E provides all the distancing sensing data you'll ever need.

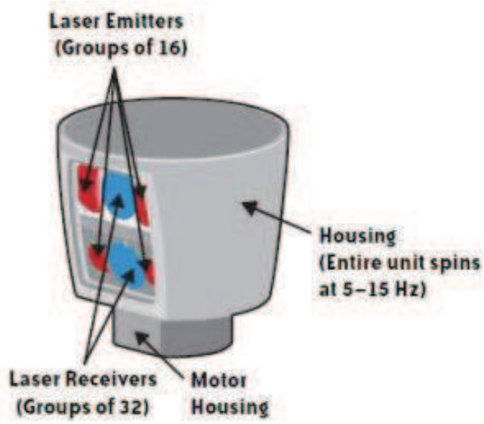

Figure 4 The Velodyne Lidar HDL-64E

The HDL-64E's patented one-piece design uses 64 fixed-mounted lasers to measure the surrounding environment, each mechanically mounted to a specific vertical angle, with the entire unit spinning. This approach dramatically increases reliability, field of view and point cloud density.[6]

4.5 Position Sensor:

This device provides the latitude, longitude and altitude together with the corresponding standard deviation and the standard NMEA messages with a frequency of 5 Hz. When geostationary satellites providing the GPS drift correction are visible from the car, the unit enters the differential GPS mode (high precision GPS). When no correction signal is available, the device outputs standard precision GPS.

4.6 Radar Sensor:

Radar (Radio Detection And Ranging) is an object-detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain. The radar dish or antenna transmits pulses of radio waves or microwaves which bounce off any object in their path. The object returns a tiny part of the wave's energy to a dish or antenna which is usually located at the same site as the transmitter.

5. Result

Google's approach involves driving a route manually, with all the sensors switched on, to build a detailed 3D map of features such as signs, guard-rails and overpasses. When the autonomous-driving mode is switched on (accompanied by a spaceship sound-effect), the software can predict hazards with reasonable accuracy. Every time a car follows a particular route, it collects all the data with the help og GSV and Google maps. Google's software also ingests data on speed limits and recorded accidents. Because the car's roof-mounted sensors can see in all directions, it arguably has greater situational awareness than a human driver.

6. Conclusion

A driverless cars clock up more miles, solutions are being worked out. To evaluate the danger posed by an object on the road, Google's software takes into account the behavior of other vehicles. If other cars do not swerve or brake to avoid it, it is more likely to be a plastic bag than a rock. "Fusing" data from various types of sensors can also remove uncertainty. To judge distances, for example, radar or lidar sensors in the front bumpers can be supplemented by video cameras. Infra-red sensors can pick up the heat signature of a human obscured by fog. One area where humans are still struggling in judging an object's material or weight. Unable to tell the difference between a block of steel on the carriageway and a chunk of mattress, a self-driving vehicle might brake harder than would be wise.

7. References

Journal of Field Robotics 25(9), 569–597 (2008) Cˇ 2008 Wiley Periodicals, Inc. Published online in Wiley InterScience (www.interscience.wiley.com).

http://www.mechanicalengineeringblog.com/3392-self-driving-car-technology-autonomous-car-car-of-the-future/

Buehler, M., Iagnemma, K., & Singh, S. (Eds.). (2006). The 2005 DARPA Grand Challenge: The great robot race. Berlin: Springer.

DARPA. (2007). Urban Challenge rules, revision Oct. 27, 2007. See www.darpa.mil/grandchallenge/rules.asp.

Ferguson, D., & Stentz, A. (2005). Field D∗:An interpolation-based path planner and replanner. In Robotics search: Results of the 12th International Symposium (ISRR'05), San Francisco, CA, edited by S. Thrun, R. Brooks, & H. Durrant-Whyte (pp. 239–253). Berlin: Springer

http://velodynelidar.com/lidar/hdlproducts/hdl64e.aspx

http://spectrum.ieee.org/automaton/robotics/artificial-intelligence/how-google-self-driving-car-works

U.S. Department of Transportation (2005). Transportation statistics annual report. Bureau of Transportation Statistics, U.S. Department of Transportation.

Simmons, R., & Apfelbaum, D. (1998). A task description language for robot control. In Proceedings of the Con- ference on Intelligent Robotics and Systems (IROS), Victoria, CA.