WORKING OF AUTONOMOUS VEHICLES

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Abstract – *Autonomous car/Driverless car can also be called as robotic car since it automatically operates by itself without the aid of any driver. This car senses environment such as traffic, weather, surface conditions, road infrastructure, adjacent cars, maps, sign boards etc with the help of cameras, radar, lidar, GPS and navigational paths. The advantages of autonomous cars over normal cars is such as fewer traffic collisions, increased reliability, increased safety, reduction of accidents, increased efficiency, secured human life etc. The main disadvantages of it, is the issues of cyber security, software malfunction, liability of damage and loss of driver related jobs. This paper gives the information on working of autonomous cars by explaining the working of various sensors used to control it.*

Key Words*: *RADAR, LIDAR, GPS, WSS, Camera, Processors, Control Algorithms, Connectivity

INTRODUCTION

Autonomous vehicle is also called as self-driving vehicle which is capable of sensing its environment and moving safely with no human input. Self-driving cars combine a variety of sensors to perceive their surroundings, such as radar, lidar, sonar, GPS. The first truly autonomous cars appeared in the 1980s, with Carnegie Mellon University's Navlab and ALV projects funded by the United States' Defense Advanced Research Projects Agency (DARPA) starting in 1984. This kind of vehicle has become a concrete reality and may pave the way for future systems where computers take over the act of driving. Generally, it can also be termed as Wheeled Mobile Robot. It is a intelligent car which can arrive at any destination based on the information provided by the sensors.

HISTORY

This gives an overview on the past inventions of the various parts related to design of autonomous vehicles in their respective years'

In 1920's

- Transmitting antenna

In 1930's

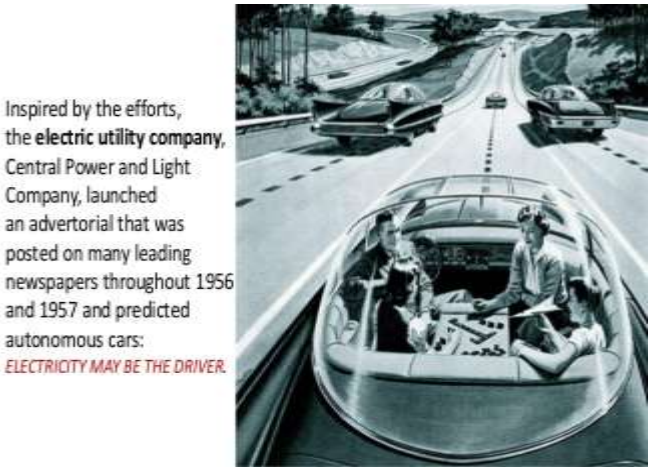
- Embedded circuits and Radio controllers

In 1950's

- Detector circuits
- Special radio receivers
- Audible and visual warning devices

In 1960's

- Electronically controlled highways
- Powered and controlled by buried cables
- Wayside communicators relaying computer messages



In 1980's

- Laser radar, computer vision and autonomous robotic control
- Off-road map and sensor-based autonomous navigation

In 1990's

- Extensive systems engineering work and research
- Video cameras on board use of stereoscopic vision algorithms

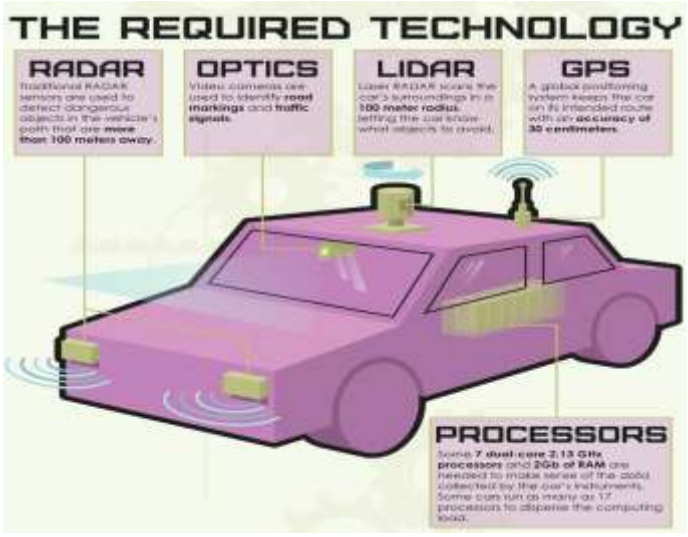
In 2000's

- Real-time control system
- RFID-tags

In 2010's

- Artificial intelligence
- GPS, LIDAR, RADAR, 3D mapping, cameras, sensors, etc.

VARIOUS TECHNOLOGIES INVOLVED IN MAKING AUTONOMOUS CARS



There are **three** main technologies involved in designing autonomous cars, they are:

1) SENSORS

There are 2 types of sensors in particular, they are:

- Active sensors: - They are the one which sends energy in the form of waves and look for objects based upon the information that comes back.

  E.g. RADAR

- Passive sensors: - They are the one which simply takes in information from the environment without emitting any waves.

  E.g. Camera

The main sensors found in autonomous vehicles are as follows with their working principle,

❖ RADAR(Radio Detection and Ranging):

It is a sensor which is used to detect dangerous objects in the vehicle's path that are more than 100 meters away and it works best in detecting objects made of metal. It can accurately tell you the distance of a detected object. Automotive radar is typically found in 2 forms 77GHz and 24GHz Where 24GHz is used for short range applications and 77GHz is used for long range sensing. The radar chirps between 10 and 11GHz over 5 millisecond period, transmitting the radar signal from centrally located antenna cone. Two receive cones, separated by approximately 14 inches, receive the reflected radar energy. It's the technology which mainly operates on adaptive cruise control and automatic emergency braking in autonomous car. It can see 100's of yards and can pick out the speed of all objects it perceives. It's nowhere near precise enough to tell the computers that you are a cyclist, but it should be able detect the fact that you are moving along with the speed and direction which is helpful to drive a car by itself. RADAR device emits a radio wave, which moves at a speed of light, and bounces back to the radar device when it encounters object in its path. Based on how long it takes for the radio wave to hit the designated object and how long it takes the wave to bounce back, the radar device can figure out the distance between the vehicles and object which is encountered in its path.

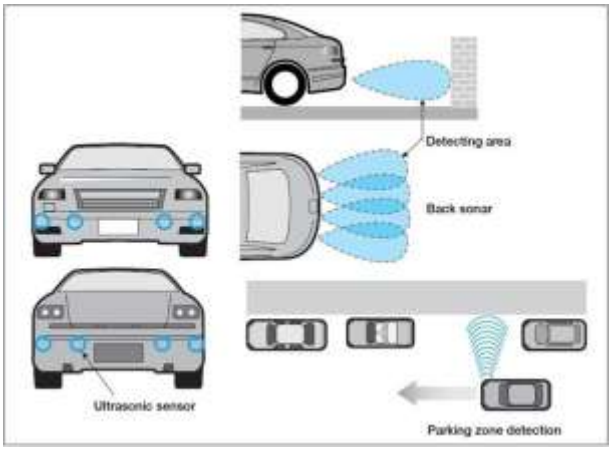
❖ LIDAR(Light Detection and Ranging):

Lidar is an active sensor which provides a 360 degree view of the surrounding which helps the vehicle to drive safely. The lidar system continuously keeps rotating and sends thousands of laser pulses every second. It acts as an eye of the self driving cars. Lidar is mounted on the roof of the vehicle and it consists of emitter, mirror and receiver. Emitter is the one which senses laser beam that bounces cylindrical housing at 10-revolutions per minute. After bouncing off of the object, the laser beam returns to the mirror and is then sent towards the receiver where it can be interpreted into data (3D representation). 3D representation data is created by measuring the speed of light and distance covered by it which helps to determine the vehicles position with other surrounding objects. 3D representation data monitors the distance between the other passing by vehicle and any other vehicle in front of it. Thus, it helps to command the brakes to slow down or stop the vehicle. And when the road ahead is clear, it also allows the vehicle to speed up. Once the data is obtained, the vehicle can generate a map of its surroundings and use that map to avoid objects. Lidar is also being incorporated into a new development called **pre-scan**. This pre-scan laser scans the road surface several

hundred times a second. Then this information is fed to the car's onboard computer and processed in fraction of second which helps to adjust the individual suspension at each wheel. This improves the safety and makes autonomous cars less prone to accidents.

❖ Ultrasonic sensor:

This sensor uses sound propagation to detect objects. An ultrasonic sensor present on one of the rear wheels helps to keep track of the movements of the car. It also calculates the number of rotation of the wheel to find exact location of the car with the help of GPS and GOOGLE MAP. It also alerts the car about the obstacles in the rear. Cars that offer automatic 'Reverse Park Assist' technology utilize such sensors to help navigate the car into tight reverse parking spots. Typically, these sensors get activated when the car is engaged in reverse motion.



❖ Wheel Speed Sensor(WSS):

The autonomous vehicle uses steering-software **wheel speed sensors** to obtain information on current overall speed compared with speed from GPS device and movement sensors. It measures the road-wheel speed and direction of rotation. It is a type of Tachometer. It is a sender device used for reading the speed of a vehicle's wheel rotation. It usually consists of a toothed ring and pickup. These sensors provide input to a number of different automotive systems including the anti-lock brake system and electronic stability control.

❖ GPS (Global positioning system):

It is the one which keeps the cars on its intended route with an accuracy of 30cm. With GPS covering the macro location of the cars, smaller on deck cameras can recognize smaller details like red light, stop signals and construction zones. The data is received from several GPS satellites to calculate longitude, latitude, speed and course to help the car to navigate. Once the information is received, the GPS receiver pin-point your location using a process called **Trilateration**.

❖ Camera:

Camera is a passive sensor which is used to get the information from the surroundings. It is mounted near the rear-view mirror and builds a real-time 3D image of the road ahead spotting hazards like pedestrians and

animals. It is also used to identify the road markings i.e. road lanes, signboards and traffic signals.

PROCESSORS:

Some 7 dual-core 2.13GHz processors and 2GB of RAM are needed to make sense the data collected by the car's components. Some cars run as many as 17 processors to dispense the computing load. Graphics processors are replacing CPU's in automated vehicles to be trained with huge amounts of data in order to function accurately.

Processors being used in autonomous cars are:

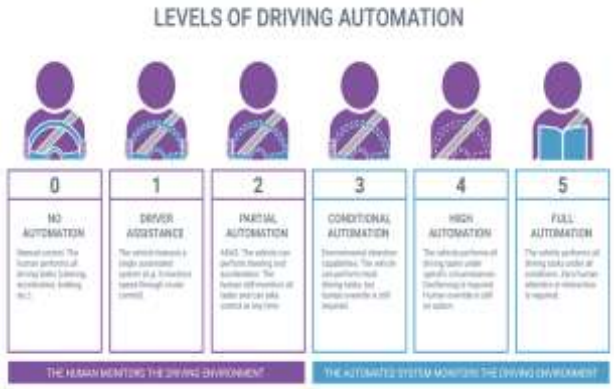
- Intel® Core™ X-Series.
- 10th Gen Intel® Core™ i7.
- 10th Gen Intel® Core™ i5.
- 10th Gen Intel® Core™ i3.

2) CONNECTIVITY

It means that car have access to the latest traffic, weather, surface conditions, construction, maps, adjacent cars, road infrastructure. This is the data used to monitor a car's surrounding operating environment to anticipate breaking or avoid hazardous conditions. It gives the overall connections between the various parts of the car to the car's body and helps to navigate in a proper direction.

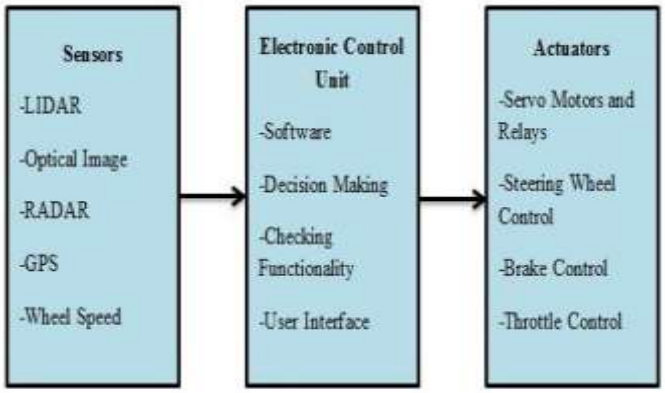
3) SOFTWARE/ CONTROL ALGORITHM

Control algorithms are necessary to capture the data from sensors and connectivity and make decisions on steering, breaking, speed and routine guidance. By far, the most complex part of self driving cars is the decision making of the algorithms which must be able to handle a multitude of simple and complex driving situations flawlessly. The software used to implement these algorithms must be fault tolerant and robust.



WORKING OF AUTONOMOUS VEHICLE

Autonomous cars rely on sensors, actuators, complex algorithms, machine learning system and powerful processors to execute software. The signal received by the sensors are used by the electronic control unit for making the decisions using a software code, then the control unit sends the signal towards the actuator whose main objective is to control the vehicle. These cars create its own map of the surrounding based on the various sensors which is present at different parts of it. Then, the received information from the map is the output to the user interface located inside the vehicle. Hard-core rules, obstacles avoidance algorithms, predictive modeling and object recognition help the software follow traffic rules and navigate obstacles.



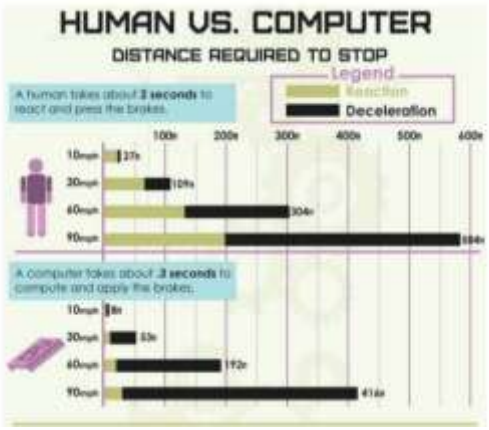
ADVANTAGES

- It reduces the traffic collisions.
- Reduces the traffic congestion.
- Increased roadway capacity.
- Avoids the human errors while driving.
- Higher speed limit for autonomous cars.
- Reduces the need for traffic police and vehicle insurance.
- Enables smoother ride.

- Reduces accident rates.
- The need o learn driving is not a compulsion.
- It enables time saving.
- It provides comfortable, fearless and secure ride.
- Reduction of space required for vehicle parking.
- Reduction of physical road signage.
- Reduces engine emission which in turn reduces the pollution.

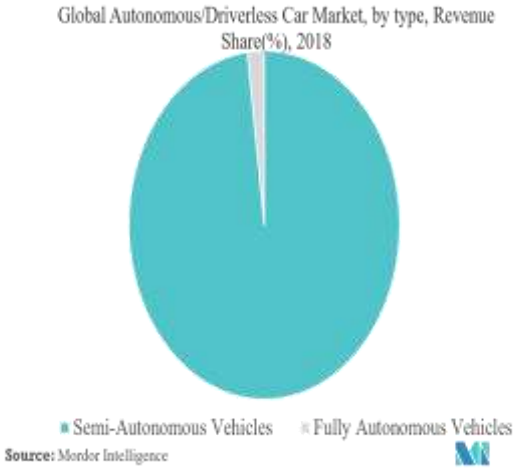
DISADVANTAGES

- Loss of driver related jobs.
- Autonomous cars which rely on lane markings cannot differentiate faded, missing or incorrect lane markings.
- Temporary construction zones which is not posted to any maps or data bases.
- The question of determining the potholes or debris on the road.
- Cyber security.
- Liability for damage.
- Software reliability.
- Poor performance in adverse weather conditions.
- In case of failure of main sensors, the vehicle can create a chance of accidents.
- Implementation of legal framework and establishment of government regulations for self driving cars.
- High cost.



AUTONOMOUS VEHICLES MARKET REPORT:

The two main companies which focused on the advancement of self driving car are Google and Tesla in which Google uses lidar sensor technology and going straight to cars without steering wheels or foot pedals whereas Tesla uses a software system called autopilot which consists of hi-tech camera sensors as a car's eyes to some of its cars already on the market. Right now, autonomous cars are legal only in few U.S states .The company Toyota modified one of its car names Toyota Prius into a Google driverless car. By 2020, Volvo envisages having cars in which passengers would be immune from injuries and Mercedes, Benz, Audi, Nissan and BMW all expect to sell autonomous cars.



COMPANIES INVOLVED IN MAKING OF AUTONOMOUS CARS

CONCLUSION

Autonomous vehicles have been subject to research and development for nearly a century. Vehicle to vehicle communication is in the near future. Cars will no longer he thought of as simple a transportation option, but rather a mobile entertainment centre equipped with WI-FI, television and a entertainment dedicated onboard computer. Autonomous car is a super computer with deterministic network on wheels. 5G will play significant role in autonomous vehicle. Upon addressing the mechanics of the driverless car as well as its benefit and potential issues, it is quite interesting to see how the world will actually look by the year 2040.Companies manufacturing them should take great care and control mechanisms for these vehicles

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