Driverless Cars and machine learning

Machine Learning (Veer Surendra Sai University of Technology)

Seminar Report on Google Driverless Cars

Submitted in partial fulfilment for the requirement of the degree of

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In
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Submitted By

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CERTIFICATE

This is to certify that the seminar entitled Seminar Report on "**Google Driverless Cars**" is being submitted by Vivek Kumar, Regd. No.- 1802081011, to the Department of Information Technology, Veer Surendra Sai University of Technology, Burla, in partial fulfilment of the requirements for the degree of Bachelor of Technology in Information Technology.

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Abstract

Googles dramatic ascent and subsequent domination in the past fifteen years of the technology and information industries has financially enabled Google to explore seemingly unrelated projects ranging from Google Mail to the Google Car.

In particular, Google has invested a significant number of resources in the Google Car, an integrated system that allows for the driverless operation of a vehicle. While initial reports indicate that the Google Car driverless automobile will be safer and more efficient than current vehicles, the Google Car is not without its critics. In particular, the existential threat that the car presents to several large industries, including the insurance, health care and construction industries, creates an additional challenge to the success of the Google Car well beyond the standard competitive threats from other established car manufacturers in the automobile industry, which begs the question, Can the Google Car be successful? With so many challenges above and beyond the competitive forces typically threatening long-term profitability, will the Google Car be able to create and sustain a competitive advantage for Google in the driverless car space?

Content

1.Introduction

The inventions of the integrated circuit and later, the microcomputer, were major factors in the development of electronic control in automobiles. The importance of the microcomputer cannot be overemphasized as it is the brain that controls many systems in today's cars. For example, in a cruise control system, the driver sets the desired speed and enables the system by pushing a button. A microcomputer then monitors the actual speed of the vehicle using data from velocity sensors. The actual speed is compared to the desired speed and the controller adjusts the throttle as necessary.

A completely autonomous vehicle is one in which a computer performs all the tasks that the human driver normally would. Ultimately, this would mean getting in a car, entering the destination into a computer, and enabling the system. From there, the car would take over and drive to the destination with no human input. The car would be able to sense its environment and make steering and speed changes as necessary. This scenario would require all of the automotive technologies mentioned above: lane detection to aid in passing slower vehicles or exiting a highway; obstacle detection to locate other cars, pedestrians, animals, etc.; adaptive cruise control to maintain a safe speed; collision avoidance to avoid hitting obstacles in the road way; and lateral control to maintain the cars position on the roadway.

In addition, sensors would be needed to alert the car to road or weather conditions to ensure safe traveling speeds. For example, the car would need to slow down in snowy or icy conditions. We perform many tasks while driving without even thinking about it. Completely automating the car is a challenging task and is a long way off. However, advances have been made in the individual systems.

Googles robotic car is a fully autonomous vehicle which is equipped with radar and LIDAR and such can take in much more information, process it much more quickly and reliably, make a correct decision about a complex situation, and then implement that decision far better than a human can. Google anticipates that the increased accuracy of its automated driving system could help reduce the number of traffic-related injuries and deaths.

Fig.: 1.1 Google Driverless Car

The Google car system combines information gathered for 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. As of 2010, Google has tested several vehicles equipped with the system, driving 140,000 miles (230,000 km) without any human intervention, the only accident occurring when one of the cars was rear-ended while stopped at a red light. Google anticipates 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.

The combination of these technologies and other systems such as video-based lane analysis, steering and brake actuation systems, and the programs necessary to control all of the components will become a fully autonomous system. The problem is winning the trust of the people to allow a computer to drive a vehicle for them, because of this, there must be research and testing done over and over again to assure a near fool proof final product. The product will not be accepted instantly, but over time as the systems become more widely used people will realize the benefits of it.

2.BLOCK DIAGRAM:

2.1 BACKGROUND:

The block diagram of Googles driver less car is shown below. It includes sensor section, processor section and drive by wire technology.

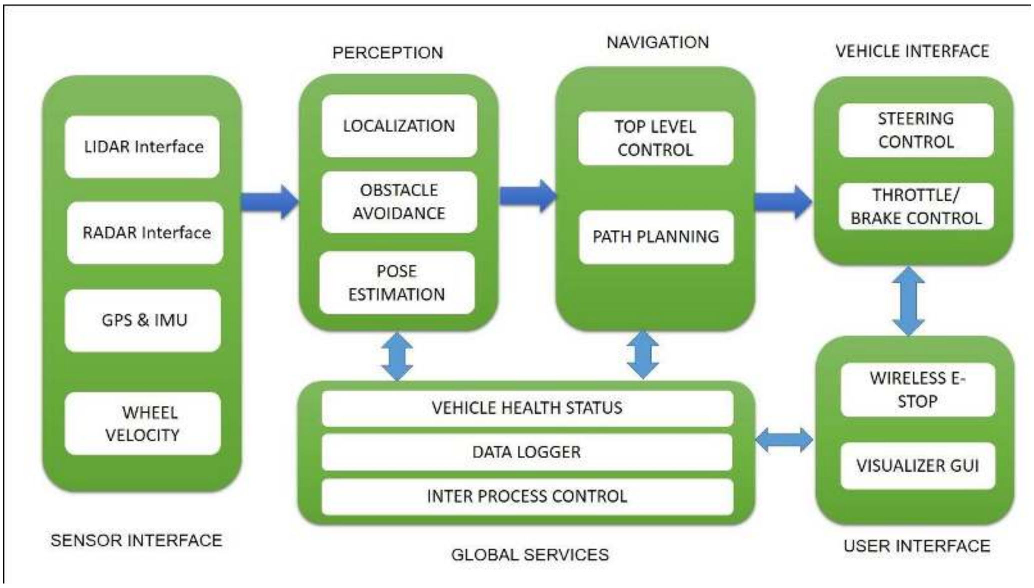


Fig: 2.1 Block Diagram

The main controller of the vehicle is the microprocessor section. There are two processors; one is for the general working and one for handling the sensory inputs which is real time.

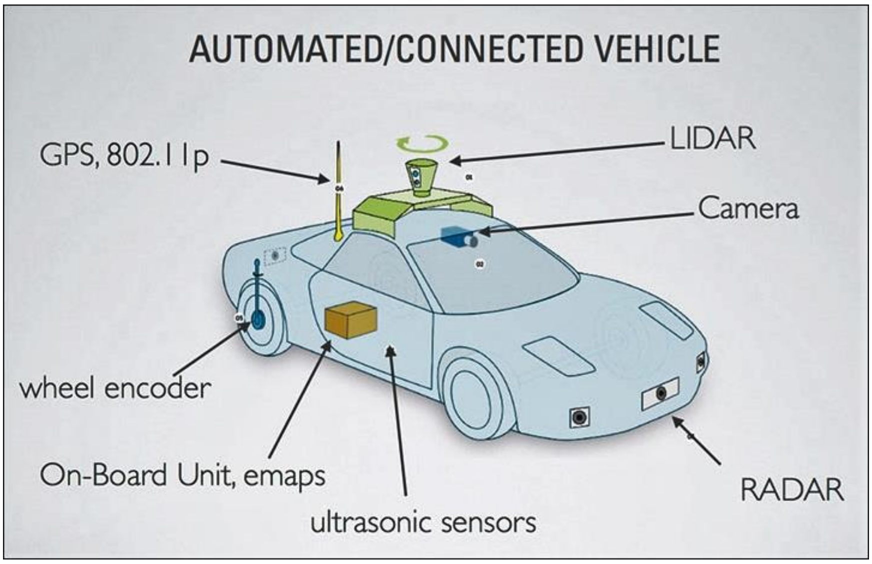


Fig: 2.2 Car Concept

There are two coprocessors for handling the steering and the brake. Accelerator is directly controlled by the general-purpose processor. The sensory inputs include inputs from the lidar, radar, position estimator and street view images. Lidar creates a 3-D images platform for mounting the obstacles and map. The

camera visuals are used for detecting the colour of the traffic signal based on which the vehicle moves on the road. The general-purpose processor is constantly communicating with the engine control unit.

3.CONTROL UNIT:

3.1HARDWARE SENSORS

3.1.1 Radar:

Radar is an object-detection system which uses electromagnetic waves specifically radio waves – to determine the range, altitude, direction, or speed of both moving and fixed objects such as aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain.

Fig.: 3.1 Radar

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. The modern uses of radar are highly diverse, including air traffic control, radar astronomy, air-defence systems, antimissile systems; nautical radars to locate landmarks and other ships; aircraft anti-collision systems; ocean surveillance systems, outer-space surveillance and rendezvous systems; meteorological precipitation monitoring; altimetry and flight-control systems; guided-missile target-locating systems; and ground-penetrating radar for geological observations.

A radar system has a transmitter that emits radio waves called radar signals in predetermined directions. When these come into contact with an object they are usually reflected and/or scattered in many directions. Radar signals are reflected especially well by materials of considerable electrical conductivity.

Radar receivers are usually, but not always, in the same location as the transmitter. Although the reflected radar signals captured by the receiving antenna are usually very weak, these signals can be strengthened by the electronic amplifiers that all radar sets contain. More sophisticated methods of signal processing are also nearly always used in order to recover useful radar signal.

The weak absorption of radio waves by the medium through which it passes is what enables radar sets to detect objects at relatively-long ranges at which other electromagnetic wavelengths, such as visible light, infrared light, and ultraviolet light, are too strongly attenuated.

Fig: 3.2 Car Tracking

3.1.2 LIDAR

LIDAR (Light Detection and Ranging also LADAR) 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.

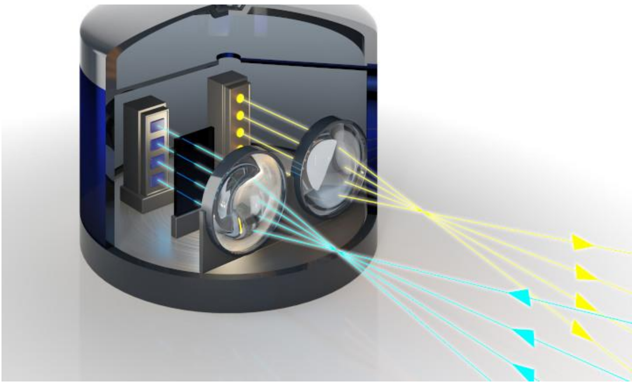


Fig 3.3 Lidar

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. LIDAR has been used extensively for atmospheric research and meteorology.

Advanced Research Lidar. In addition, LIDAR has been identified by NASA as a key technology for enabling autonomous precision safe landing of future robotic and crewed lunar landing vehicles. Wavelengths in a range from about 10 micrometres to the UV (ca.250 nm) are used to suit the target. Typically, light is reflected via back scattering. There are several major components to a LIDAR system:

1. Laser 6001000 nm lasers are most common for non-scientific applications. They are inexpensive but since they can be focused and easily absorbed by the eye the maximum power is limited by the need to make them eye-safe.

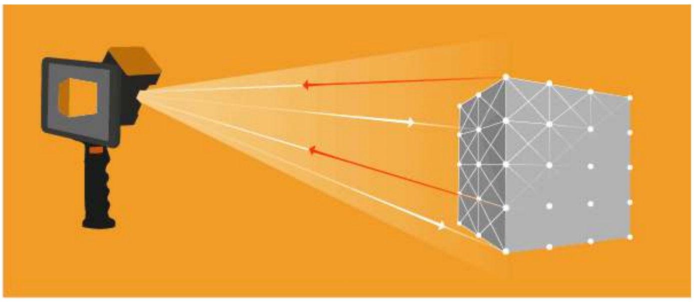


Fig 3.4 LIDAR Concept

2. Scanner and optics How fast images can be developed is also affected by the speed at which it can be scanned into the system. There are several options to scan the azimuth and elevation, including dual oscillating plane mirrors, a combination with a polygon mirror, a dual axis scanner. Optic choices affect the angular resolution and range that can be detected. A hole mirror or a beam splitter are options to collect a return signal.

3. Photo detector and receiver electronics two main photo detector technologies are used in lidars: solid state photo detectors, such as silicon avalanche photodiodes, or photo multipliers. The sensitivity of the receiver is another parameter that has to be balanced in a LIDAR design.

4. Position and navigation systems LIDAR sensors that are mounted on mobile platforms such as airplanes or satellites require instrumentation to determine the absolute position and orientation of the sensor. Such devices generally include a Global Positioning [5]System receiver and an Inertial Measurement Unit (IMU).3D imaging can be achieved using both scanning and non-scanning systems. ”3D gatedviewing laser radar” is a non-scanning laser ranging system that applies a pulsed laser and a fast gated camera.

3.1.3 Global Positioning System

The Global Positioning System (GPS) is a space-based global navigation satellite System (GNSS) that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. GPS receiver calculates its position by precisely timing the signals sent by GPS satellites high above the Earth.

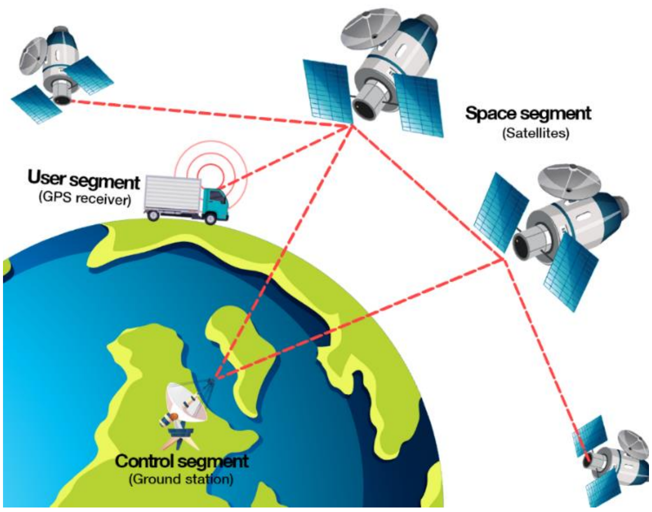


Fig 3.5 GPS Concept

Each satellite continually transmits messages that include

1) The time the message was transmitted
2) Precise orbital information (the ephemeris)
3) The general system health and rough orbits of all GPS satellites

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite.

3.1.4 Position sensor

A position sensor is any device that permits position measurement Here we use a rotator encoder also called a shaft encoder, is an electro-mechanical device that converts the angular position or motion of a shaft or axle to an analog or digital code. The output of incremental encoders provides information about the motion of the shaft which is typically further processed elsewhere into information such as speed, distance, RPM and position.

3.1.5 Cameras

Google has used three types of car-mounted cameras in the past to take Street View photographs. Generations 13 were used to take photographs in the United States.

Fig 3.6 360^{o} Camera

Thus, the total sensor components can be explained using the above figure assembled on the car. All the components are already explained.

3.2 LOGIC PROCESSING UNIT

3.2.1 Google Street View

Google Street View is a technology featured in Google Maps and Google Earth that provides panoramic views from various positions along many streets in the world. It was launched on May 25, 2007, originally only in several cities in the United States, and has since gradually expanded to include more cities and rural areas worldwide.

Google Street View displays images taken from a fleet of specially adapted cars. Areas not accessible by car, like pedestrian areas, narrow streets, alleys and ski resorts, are sometimes covered by Google Trikes (tricycles) or a snowmobile. On each of these vehicles there are nine directional cameras for 360 views at a height of about 8.2 feet, or 2.5 meters, GPS units for positioning and three laser range scanners for the measuring of up to 50 meters 180 in the front of the vehicle.

Fig 3.7 Street View using Google Street View

Where available, street view images appear after zooming in beyond the highest zooming level in maps and satellite images, and also by dragging a” pegman” icon onto a location on a map. Using the keyboard or mouse the horizontal and vertical viewing direction and the zoom level can be selected. A solid or broken line in the photo shows the approximate path followed by the camera car, and arrows link to the next photo in each direction. At junctions and crossings of camera car routes, more arrows are shown.

3.2.2 Artificial intelligence software

Artificial intelligence is the intelligence of machines and the branch of computer science that aims to create it. AI textbooks define the field as" the study and design of intelligent agents where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success. John McCarthy, who coined the term in 1956, defines it as" the science and engineering of making intelligent machines". Here the details about the software are a trade secret of Google.

3.3 PROCESSOR UNIT

3.3.1 Xeon Processor

Xeon Processor is a multi-core enterprise processor built on 32-nanometer process technology. It has up to 8 execution cores. Each core supports two threads (Intel Hyper-Threading).

3.3.2 Cortex Coprocessors

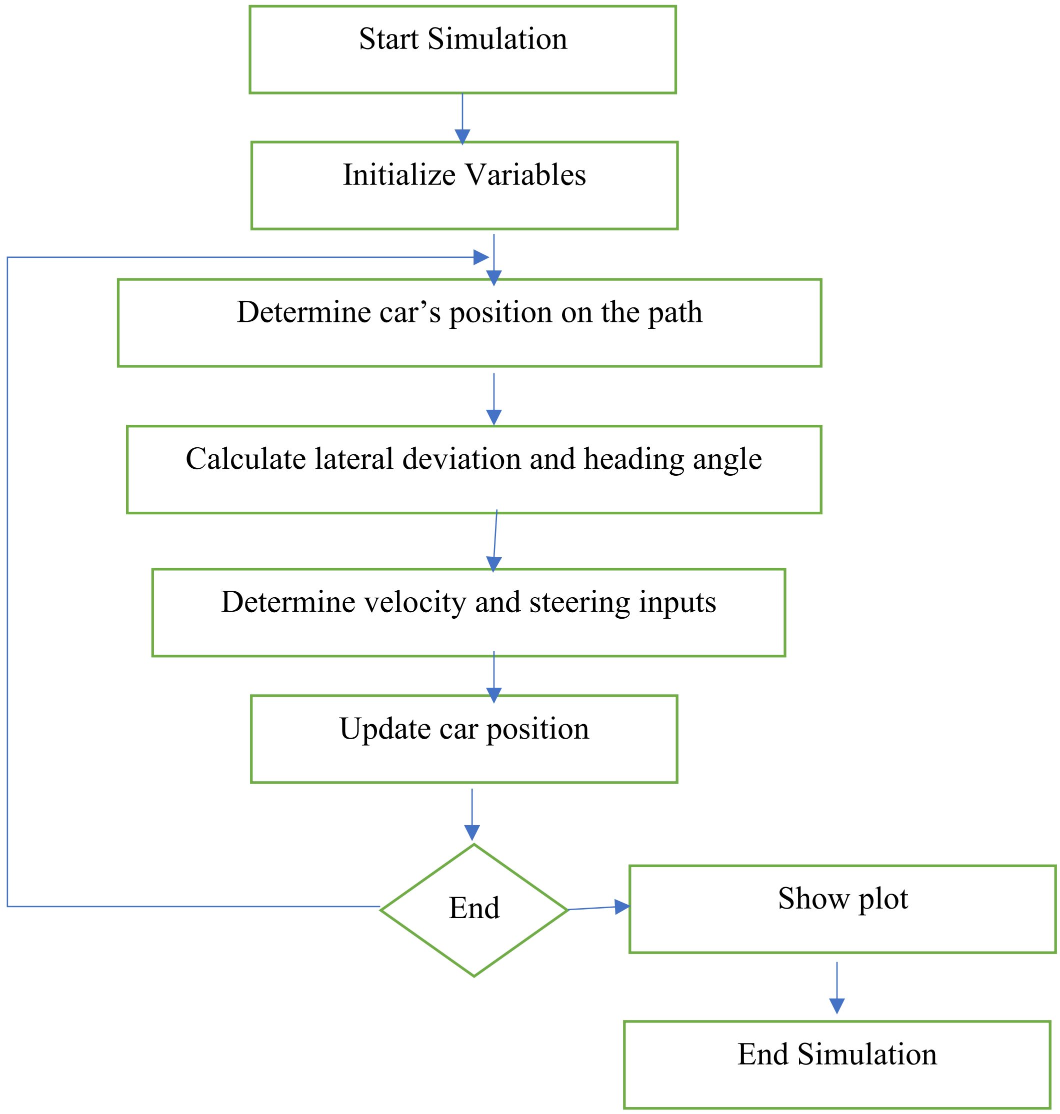
Two separate Cortex-A9 processors are used for

1)Steering

2)Brake

The ARM Cortex-A9 MP Core is a 32-bit multicore processor providing up to 4 cache-coherent Cortex-A9 cores, each implementing the ARM v7 instruction set architecture. They are high performance ARM processor with 1-4 cores version. It works on AXI high-speed Advanced Microprocessor Bus architecture. Its main feature is the increased peak performance for most demanding applications.

4. Algorithm



Interactive algorithms for path following involve direct communication with external sources such as receiving navigation data from the leader or consulting GPS coordinates. The Follow-the-Past algorithm is one such example; it involves receiving and interpreting position data, orientation data, and steering angle data from a leader vehicle.

The objective is to mimic these three navigational properties in order to accurately follow the path set by the leader. As orientation and steering angle are associated with GPS positional data, the following vehicle can update its navigational state to match that of the leader vehicle at the appropriate moment in time. One developed algorithm is best described as a placing a trail of breadcrumbs based on the leading vehicle's position. A cubic spline fit is applied to the generated breadcrumbs to establish a smooth path by which to travel. This developed algorithm was tested and showed centimetre level precision in following a desired path.

5. APPLICATIONS

The various applications of the technology are

5.1. Intelligent transporting

Intelligent transport systems vary in technologies applied, from basic management systems such as car navigation; traffic signal control systems; container management systems; variable message signs; automatic number plate recognition or speed cameras to monitor applications, such as security CCTV systems; and to more advanced applications that integrate live data and feedback from a number of other sources, such as parking guidance and information systems; weather information bridge dicing systems; and the like. Additionally, predictive techniques are being developed to allow advanced modelling and comparison with historical baseline data this technology will be a revolutionary step in intelligent transportation.

5.2. Military applications

Automated navigation system with real-time decision-making capability of the system makes it more applicable in war fields and other military applications.

5.3. Transportation in hazardous places

The complete real-time decision-making capability and sensor guided navigation will leads to replace the human drivers in hazardous place transportation.

5.4. Shipping

Autonomous vehicles will have a huge impact on the land shipping industry. One way to transport goods on land is by freight trucks. There are thousands of freight trucks on the road everyday driving for multiple days to reach their destination. All of these trucks are driven by a paid employee of a trucking company. If the trucks were able to drive on their own, a person to move the vehicle from one point to another is no longer needed.

5.5. Taxi services

Another business that would be strongly affected is taxi services. It is based solely on driving someone around who does not have a car or does not want to drive. Then an employee is dispatched to go and pick up the person and bring them to their destination. This type of service could lower the number of vehicles on the road because not everyone would have to own a car, people could call to request an autonomous car to bring them around.

5.6 Public transportation

Various forms of public transportation are controlled by a human operator. Whether it is on a bus, in a train, subway, streetcar, or shuttle, there is a person sitting in the driver's seat and they are controlling what the vehicle is doing. For trains and other rail-based transportation, it is a simpler process more involved with accelerating and decelerating the train from and into stops with no concern over keeping in a lane.

6. Advantages and Disadvantages

6.1 Advantages

1)Safety

Safety issues have the most serious impact on daily life out of all the transportation problems. Traffic accidents have colossal negative effects on economy. Traveling by car is currently the most deadly form of transportation, with over a million deaths annually worldwide. For this reason, the majority of the research projects in the transportation sector concentrate on developing safety systems. Implementation of autonomous vehicles can greatly reduce the number of crashes, since 90 percent of the traffic accidents are caused by human error.

2)Impacts on Traffic

With the introduction of a fully autonomous vehicle, traffic flow would drastically change. Traffic is currently a nuisance to drivers all over the world. In the early stages of implementation to the highway system there would be a combination of autonomously driven vehicles and human controlled vehicles. This could cause some confusion and problems concerning the reaction of motorists to the driverless vehicles and how well the autonomous vehicles can integrate into traffic flow.

3)Fuel economy

Autonomous vehicles will eliminate ineffective speeding up and braking, operating at an optimum performance level in order to achieve best possible fuel efficiency.

4)Time Costs

The phrase time is money is true for most situations in modern life and the monetary value of time is increasing every day. Using automated cars could save considerable amount of time in a person’s life, especially if the person resides in a busy city.

6.2 Disadvantages

1)The equipment’s and technologies used are costly the main equipment’s used in this technology are radar, lidar, position sensor, gps module, Multicore heterogeneous processor, JAUS interoperable communication systems, high resolution cameras are very costly now.

2)Complex artificial intelligence software the brain of the robotic car is its intelligent real-time decision-making software the design and implementation of this part of the system is much more complicated.

3)Present Road conditions may vary and which will affect the decisions made by the software since our system is mainly based on pure artificial intelligence, the non-ideal conditions and decisions made by other human drivers may vary. This may affect the ideal operation of the robotic car.

4)Professional drivers will be jobless

7. Future scope

The transition to an automated transportation structure will greatly prevent many problems caused by the traffic. Implementation of autonomous cars will allow the vehicles to be able to use the roads more efficiently, thus saving space and time. With having automated cars, narrow lanes will no longer be a problem and most traffic problems will be avoided to a great extent by the help of this new technology. Research indicates that the traffic patterns will be more predictable and less problematic with the integration of autonomous cars.

Smooth traffic flow is at the top of the wish list for countless transportation officials. Car manufacturers are already using various driver assist systems in their high-end models and this trend is becoming more and more common. As a result of this trend, the early co- pilot systems are expected to gradually evolve to autopilots. All developments show that one day the intelligent vehicles will be a part of our daily lives, but it is hard to predict when. The most important factor is whether the public sector will be proactive in taking advantage of this capability or not. The Public Sector will determine if the benefits will come sooner rather than later.

Since these assist systems are very similar with the systems that are used in autonomous car prototypes, they are regarded as the transition elements on the way to the implementation fully autonomous vehicles.

8. Conclusion

Currently, there are many different technologies available that can assist in creating autonomous vehicle systems. Items such as GPS, automated cruise control, and lane keeping assistance are available to consumers on some luxury vehicles. The combination of these technologies and other systems such as video-based lane analysis, steering and brake actuation systems, and the programs necessary to control all of the components will become a fully autonomous system. The problem is winning the trust of the people to allow a computer to drive a vehicle for them, because of this, there must be research and testing done over and over again to assure a near fool proof final product. The product will not be accepted instantly, but overtime as the systems become more widely used people will realize the benefits of it. The implementation of autonomous vehicles will bring up the problem of replacing humans with computers that can do the work for them. There will not be an instant change in society, but it will become more apparent over time as they are integrated into society.

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