SEMINAR REPORT

On

AUTONOMOUS VEHICLES

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ABSTRACT

An autonomous vehicle is a driverless car that can drive itself from one point to another without assistance from a driver. Some believe that autonomous vehicles have the potential to transform the transportation industry while virtually eliminating accidents, and cleaning up the environment. According to urban designer and futurist Michael E. Arth, driverless electric vehicles—in conjunction with the increased use of virtual reality for work, travel, and pleasure— could reduce the world's 800,000,000 vehicles to a fraction of that number within a few decades. Arth claims that this would be possible if almost all private cars requiring drivers, which are not in use and parked 90% of the time, would be traded for public self-driving taxis that would be in near constant use. This would also allow for getting the appropriate vehicle for the particular need —a bus could come for a group of people, a limousine could come for a special night out, and a Segway could come for a short trip down the street for one person. Children could be chauffeured in supervised safety, DUIs would no longer exist, and 41,000 lives could be saved each year in the U.S. alone.

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1. INTRODUCTION

The inventions of the integrated circuit (IC) 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 roadway; and lateral control to maintain the car’s 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. Cruise control is common in cars today. Adaptive cruise control, in which the car slows if it detects a slower moving vehicle in front of it, is starting to become available on higher-end models. In addition, some cars come equipped with sensors to determine if an obstacle is near and sounds an audible warning to the driver when it is too close.

General Motors has stated that they will begin testing driverless cars by 2015. 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 complex situations, and then implement that decision far better than a human .

2. MILESTONES IN AUTONOMOUS VEHICLES

An early representation of the driverless car was Norman Bel Geddes's Futurama exhibit sponsored by General Motors at the 1939 World's Fair, which depicted electric cars powered by circuits embedded in the roadway and controlled by radio.

In the 1980s a vision-guided Mercedes-Benz robot van, designed by Ernst Dickmanns and his team at the Bundeswehr University Munich in Munich, Germany, achieved 100 km/h on streets without traffic. Subsequently, the European Commission began funding the 800 million Euro EUREKA Prometheus Project on autonomous vehicles (1987–1995).

Also in the 1980s the DARPA-funded Autonomous Land Vehicle (ALV) in the United States achieved the first road-following demonstration that used laser radar (Environmental Research Institute of Michigan), computer vision (Carnegie Mellon University and SRI), and autonomous robotic control (Carnegie Mellon and Martin Marietta) to control a driverless vehicle up to 30 km/h.

In 1987, HRL Laboratories (formerly Hughes Research Labs) demonstrated the first off-road map and sensor-based autonomous navigation on the ALV. The vehicle travelled over 600m at 3 km/h on complex terrain with steep slopes, ravines, large rocks, and vegetation.

In 1994, the twin robot vehicles VaMP and Vita-2 of Daimler-Benz and Ernst Dickmanns of UniBwM drove more than one thousand kilometres on a Paris three-lane highway in standard heavy traffic at speeds up to 130 km/h, albeit semi-autonomously with human interventions. They demonstrated autonomous driving in free lanes, convoy driving, and lane changes left and right with autonomous passing of other cars.

In 1995, Dickmanns´ re-engineered autonomous S-Class Mercedes-Benz took a 1600 km trip from Munich in Bavaria to Copenhagen in Denmark and back, using saccadic computer vision and Transputers to react in real time.

The robot achieved speeds exceeding 175 km/h on the German Autobahn, with a mean time between human interventions of 9 km, or 95% autonomous driving. Again it drove in traffic, executing manoeuvres to pass other cars. Despite being a research system without emphasis on long distance reliability, it drove up to 158 km without human intervention.

In 1995, the Carnegie Mellon University Navlab project achieved 98.2% autonomous driving on a 5000 km (3000-mile) "No hands across America" trip. This car, however, was semiautonomous by nature: it used neural networks to control the steering wheel, but throttle and brakes were human-controlled.

In 1996 Alberto Broggi of the University of Parma launched the ARGO Project, which worked on enabling a modified Lancia Thema to follow the normal (painted) lane marks in an unmodified highway. The culmination of the project was a journey of 2,000 km over six days on the motorways of northern Italy dubbed MilleMiglia in Automatico , with an average speed of 90 km/h. 94% of the time the car was in fully automatic mode, with the longest automatic stretch being 54 km. The vehicle had only two black-and-white low-cost video cameras on board, and used stereoscopic vision algorithms to understand its environment, as opposed to the "laser, radar - whatever you need" approach taken by other efforts in the field.

Three US Government funded military efforts known as Demo I (US Army), Demo II (DARPA), and Demo III (US Army), are currently underway. Demo III (2001) demonstrated the ability of unmanned ground vehicles to navigate miles of difficult off-road terrain, avoiding obstacles such as rocks and trees. James Albus at NIST provided the Real-Time Control System which is a hierarchical control system. Not only were individual vehicles controlled (e.g. throttle, steering, and brake), but groups of vehicles had their movements automatically coordinated in response to high level goals.

In 2010 VisLab ran VIAC, the VisLab Intercontinental Autonomous Challenge, a 13,000 km test run of autonomous vehicles. Four driverless electric vans successfully ended the drive from Italy to China, arriving at the Shanghai Expo on 28 October, 2010. It was the first intercontinental trip ever with autonomous vehicles.

3. GOOGLE DRIVERLESS CAR

3.1 OVERVIEW

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.

3.2 BLOCK DIAGRAM

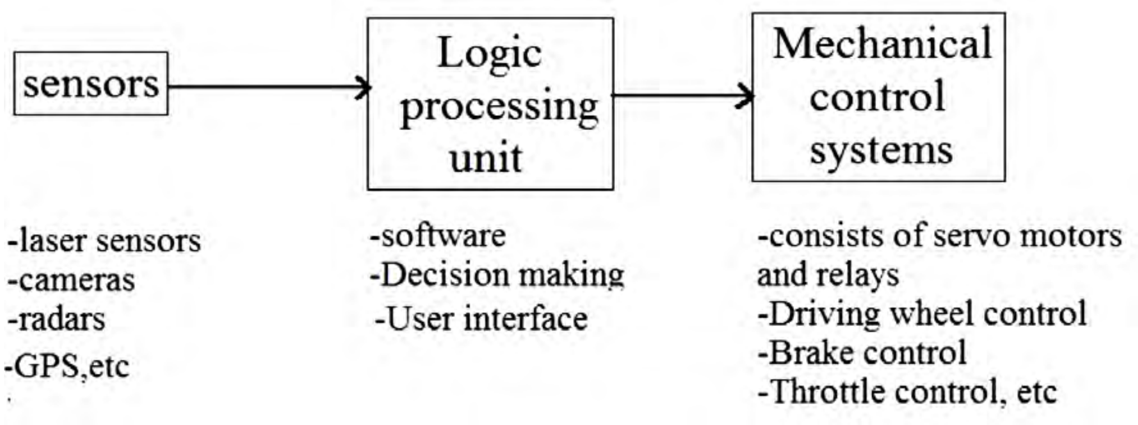


Figure 1 Block Diagram

3.3 SENSORS

3.3.1 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. 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. High tech radar systems are associated with digital signal processing and are capable of extracting objects from very high noise levels.

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—especially by most metals, by seawater, by wet land, and by wetlands. Some of these make the use of radar altimeters possible. The radar signals that are reflected back towards the transmitter are the desirable ones that make radar work. If the object is moving either closer or farther away, there is a slight change in the frequency of the radio waves, due to the Doppler Effect.

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 signals. 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—ranges at which other electromagnetic wavelengths, such as visible light, infrared light, and ultraviolet light, are too strongly attenuated. Such things as fog, clouds, rain, falling snow, and sleet that block visible light are usually transparent to radio waves. Certain, specific radio frequencies that are absorbed or scattered by water vapour, raindrops, or atmospheric gases (especially oxygen) are avoided in designing radars except when detection of these is intended.

Finally, radar relies on its own transmissions, rather than light from the Sun or the Moon, or from electromagnetic waves emitted by the objects themselves, such as infrared wavelengths (heat). This process of directing artificial radio waves towards objects is called illumination, regardless of the fact that radio waves are completely invisible to the human eye or cameras.

Figure 2 MA_COM SRS Radar

Here we use the MA COM SRS Radar Resistant to inclement weather and harsh environmental conditions, 24 GHz ultra wide band (UWB) radar sensors provide object detection and tracking. Parking assistance can be provided by rear-mounted sensors with 1.8 m range that can detect small objects in front of large objects and measure direction of arrival. Sensors with ability to scan out up to 30 m provide warning of imminent collision so airbags can be armed and seat restraints pre-tensioned.

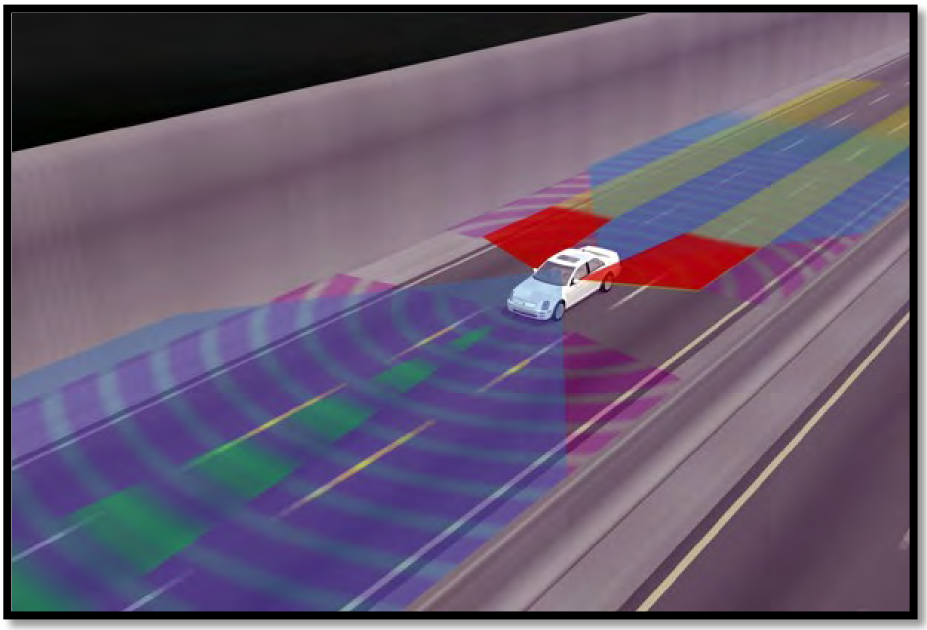


Figure 3 RADAR waves in autonomous cars

3.3.2 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. LIDAR technology has application in geometrics, archaeology, geography, geology, geomorphology, seismology, forestry, remote sensing and atmospheric physics, as well as in airborne laser swath mapping (ALSM), laser altimetry and LIDAR Contour Mapping. The acronym LADAR (Laser Detection and Ranging) is often used in military contexts. The term "laser radar" is sometimes used even though LIDAR does not employ microwaves or radio waves and is not therefore in reality related to radar. 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. Downward-looking LIDAR instruments fitted to aircraft and satellites are used for surveying and mapping. A recent example being the NASA Experimental 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 micrometers to the UV (ca.250 nm) are used to suit the target. Typically light is reflected via backscattering.

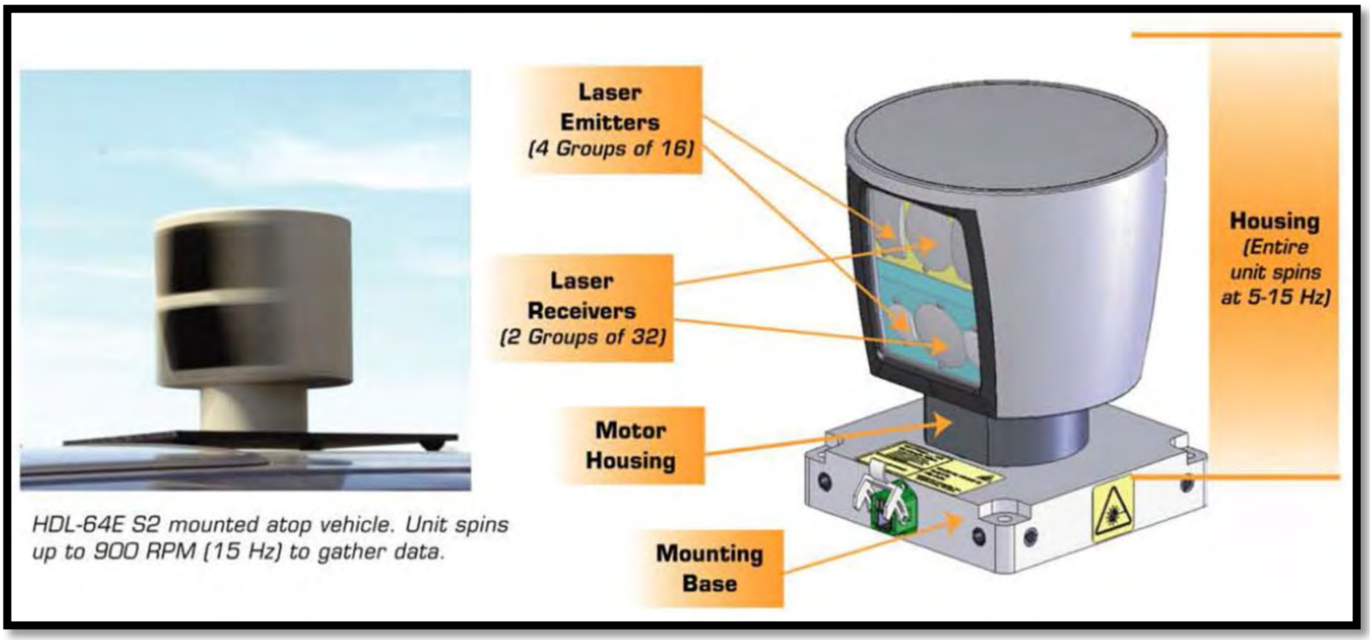


Figure 4 Velodyne LIDAR structure

There are several major components to a LIDAR system:

1. Laser

600–1000 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. Eye-safety is often a requirement for most applications. A common alternative 1550 nm lasers are eye-safe at much higher power levels since this wavelength is not focused by the eye, but the detector technology is less advanced and so these wavelengths are generally used at longer ranges and lower accuracies. They are also used for military applications as 1550 nm is not visible in night vision goggles unlike the shorter 1000 nm infrared laser. Airborne topographic mapping lidars generally use 1064 nm diode pumped YAG lasers, while bathymetric systems generally use 532 nm frequency doubled diode pumped YAG lasers because 532 nm penetrates water with much less attenuation than does 1064 nm.

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 whole 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 photomultipliers. 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 System receiver and an Inertial Measurement Unit (IMU).

3D imaging can be achieved using both scanning and non-scanning systems. "3D gated viewing laser radar" is a non-scanning laser ranging system that applies a pulsed laser and a fast gated camera.

Figure 5 Velodyne LIDAR HDL-64E

3.3.3 GPS

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. Each satellite continually transmits messages that include

- The time the message was transmitted
- Precise orbital information (the ephemeris)
- The general system health and rough orbits of all GPS satellites (the almanac).

The receiver uses the messages it receives to determine the transit time of each message and computes the distance to each satellite. These distances along with the satellites' locations are used with the possible aid of trilateration, depending on which algorithm is used, to compute the position of the receiver. This position is then displayed, perhaps with a moving map display or latitude and longitude; elevation information may be included. Many GPS units show derived information such as direction and speed, calculated from position changes. Three satellites might seem enough to solve for position since space has three dimensions and a position near the Earth's surface can be assumed. However, even a very small clock error multiplied by the very large speed of light — the speed at which satellite signals propagate —

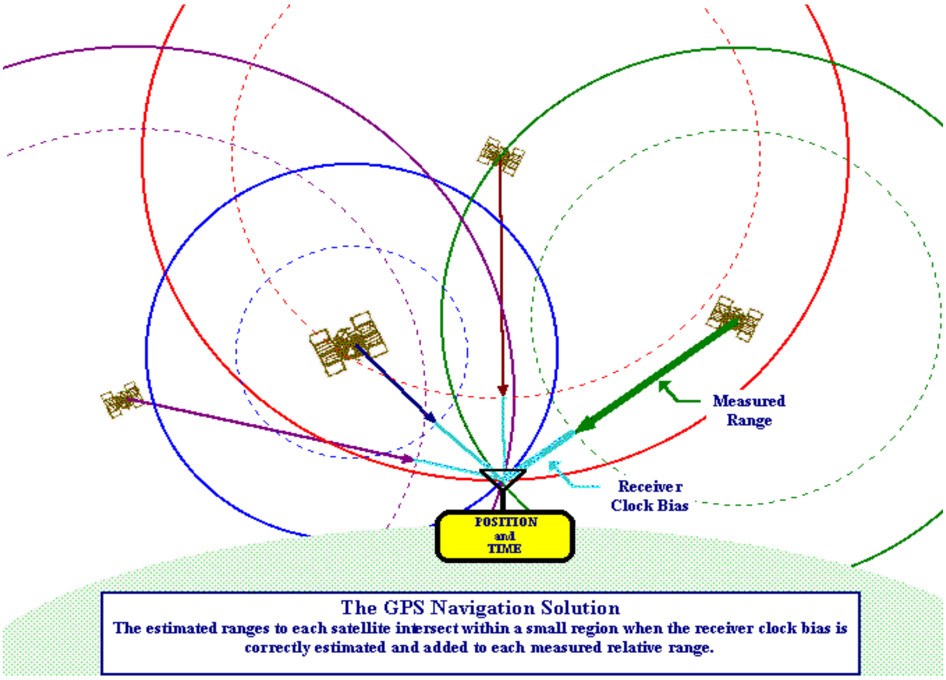


Figure 6 Positioning using gps satellites

results in a large positional error. Therefore receivers use four or more satellites to solve for the receiver's location and time. The very accurately computed time is effectively hidden by most GPS applications, which use only the location. A few specialized GPS applications do however use the time; these include time transfer, traffic signal timing, and synchronization of cell phone base stations. Although four satellites are required for normal operation, fewer apply in special cases. If one variable is already known, a receiver can determine its position using only three satellites. For example, a ship or aircraft may have known elevation.

3.3.4 POSITION SENSOR

A position sensor is any device that permits position measurement Here we use a rotatory 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. The output of absolute encoders indicates the current position of the shaft, making them angle transducers. Rotary encoders are used in many applications that require precise shaft unlimited rotation—including industrial controls, robotics, special purpose photographic lenses, computer input devices (such as optomechanical mice and trackballs), and rotating radar platforms.

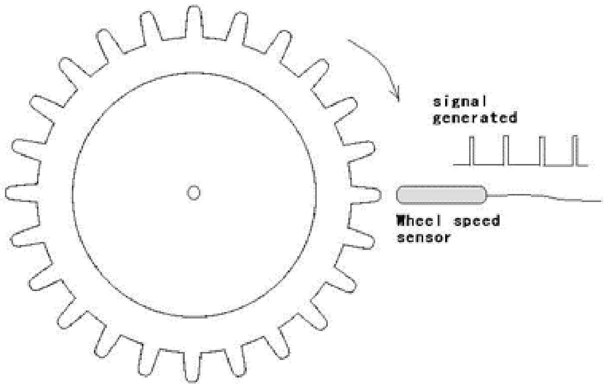


Figure 7 Wheel Speed Sensors

3.3.5 CAMERAS

Google has used three types of car-mounted cameras in the past to take Street View photographs. Generations 1–3 were used to take photographs in the United States. The first generation was quickly superseded and images were replaced with images taken with 2nd and 3rd generation cameras. Second generation cameras were used to take photographs in Australia. The shadows caused by the 1st, 2nd and 4th generation cameras are occasionally viewable in images taken in mornings and evenings. The new 4th generation cameras will be used to completely replace all images taken with earlier generation cameras. 4th generation cameras take near-HD images and deliver much better quality than earlier cameras.

Figure 8 Street View camera system.

3.4 LOGIC PROCESSING UNIT

The logical processing unit is responsible for all logical decision made by the vehicle.

3.4.1 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. There are also 3G/GSM/Wi-Fi antennas for scanning 3G/GSM and Wi-Fi hotspots. Recently, 'high quality' images are based on open source hardware cameras from Elphel.

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.

On November 21, 2008, Street View was added to the Maps application installed on the Apple iPhone. On December 10, 2008, Street View was added to the Maps application for S60 3rd Edition. Street View has now also been added to the Windows Mobile and Blackberry versions of Google Maps. All versions of Google Maps for the Android OS feature Street View, and the digital compass can be used to look around the locations.

In February 2010, Google introduced the Street View Snowmobile, a snowmobile with a 4th Generation camera mounted to take images on the Whistler Blackcomb Ski Slopes in preparation for the winter Olympics in Vancouver, Canada.

3.4.2 ARTIFICIAL INTELLIGENCE SOFTWARE

Artificial intelligence (AI) 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 is a trade secret of Google.

3.4.3 MECHANICAL CONTROL SYSTEM

This block considers the common mechanical parts of a car just like the driving wheel control, brake systems etc. and need no more clarifications here.

A TYPICAL ROBOTIC CAR DESIGN

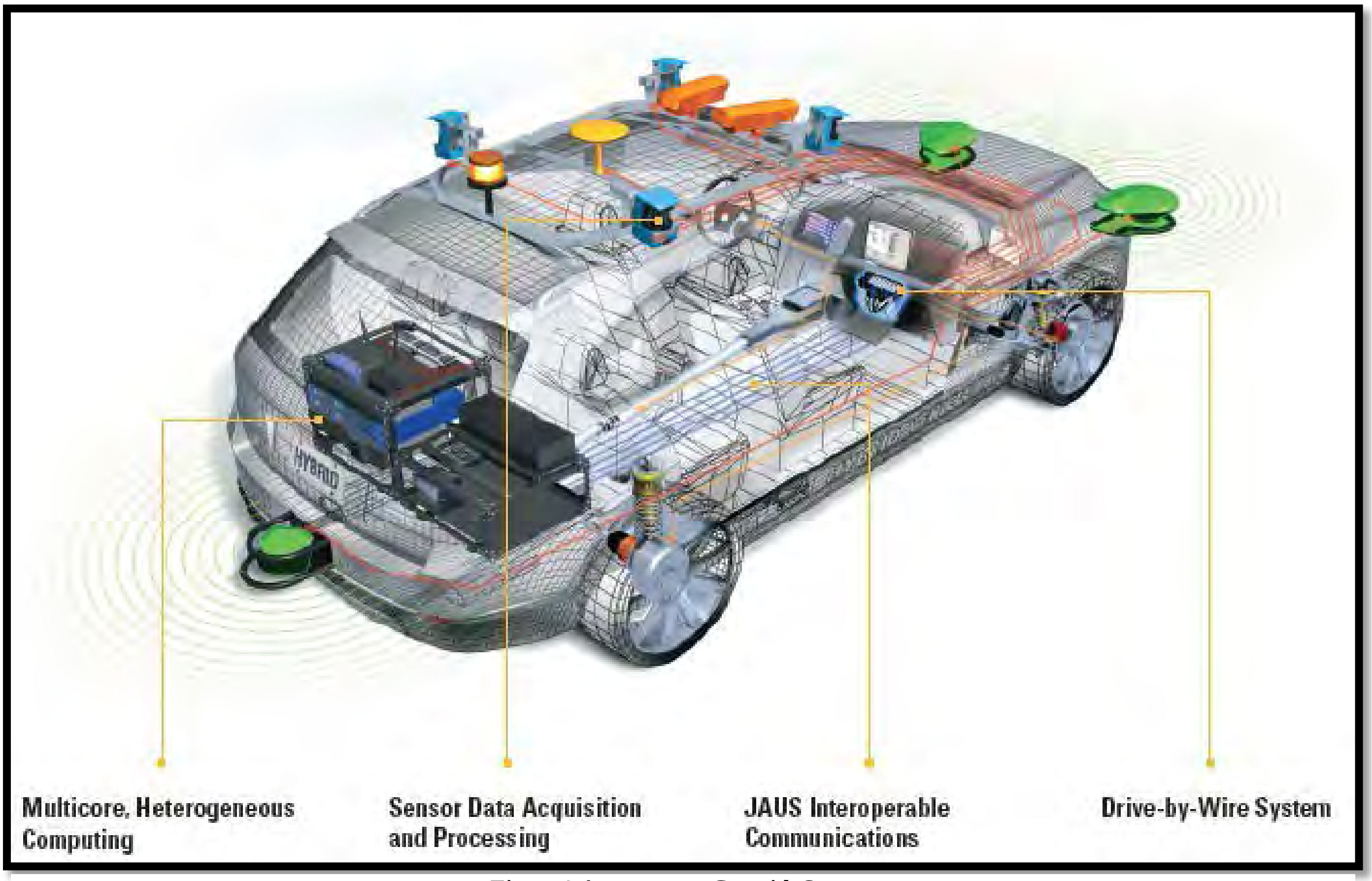


Figure 9 Autonomous Car with Sensors

3.4.4 MULTICORE, HETEROGENEOUS COMPUTING

LabVIEW applications on two HP dual quad-core servers performed sensor data and image processing and ran decision-making and planning modules. CompactRIO managed the lower level vehicle interface. An NI touch panel in the dashboard helped switch between autonomous and manual operation modes.

Heterogeneous computing systems refer to electronic systems that use a variety of different types of computational units. A computational unit could be a general-purpose processor (GPP), a special-purpose processor (i.e. digital signal processor (DSP) or graphics processing unit (GPU)), a co-processor, or custom acceleration logic (application-specific integrated circuit (ASIC) or field-programmable gate array (FPGA)). In general, a heterogeneous computing platform consists of processors with different instruction set architectures (ISAs).

A multi-core processor is a single computing component with two or more independent actual processors (called "cores"), which are the units that read and execute program instructions. The data in the instruction tells the processor what to do. The instructions are very basic things like reading data from memory or sending data to the user display, but they are processed so rapidly that human perception experiences the results as the smooth operation of a program. Manufacturers typically integrate the cores onto a single integrated circuit die (known as a chip multiprocessor or CMP), or onto multiple dies in a single chip package.

Figure 10 inside view of Google Car

3.4.5 SENSOR DATA ACQUISITION

Sensor data acquisition and processing LabVIEW applications running on multicore servers with Linux and Windows OSs processed and analyzed data from three IBEO ALASCA multiplanar LIDARs, four SICK LMS LIDARs, two IEEE 1394 cameras, and one NovAtel GPS/INS. Ethernet cables acted as the interface for all sensors. Sensor data acquisition means gathering of the data that the sensors are providing which collected from the current environment, then the collected data is processed here.

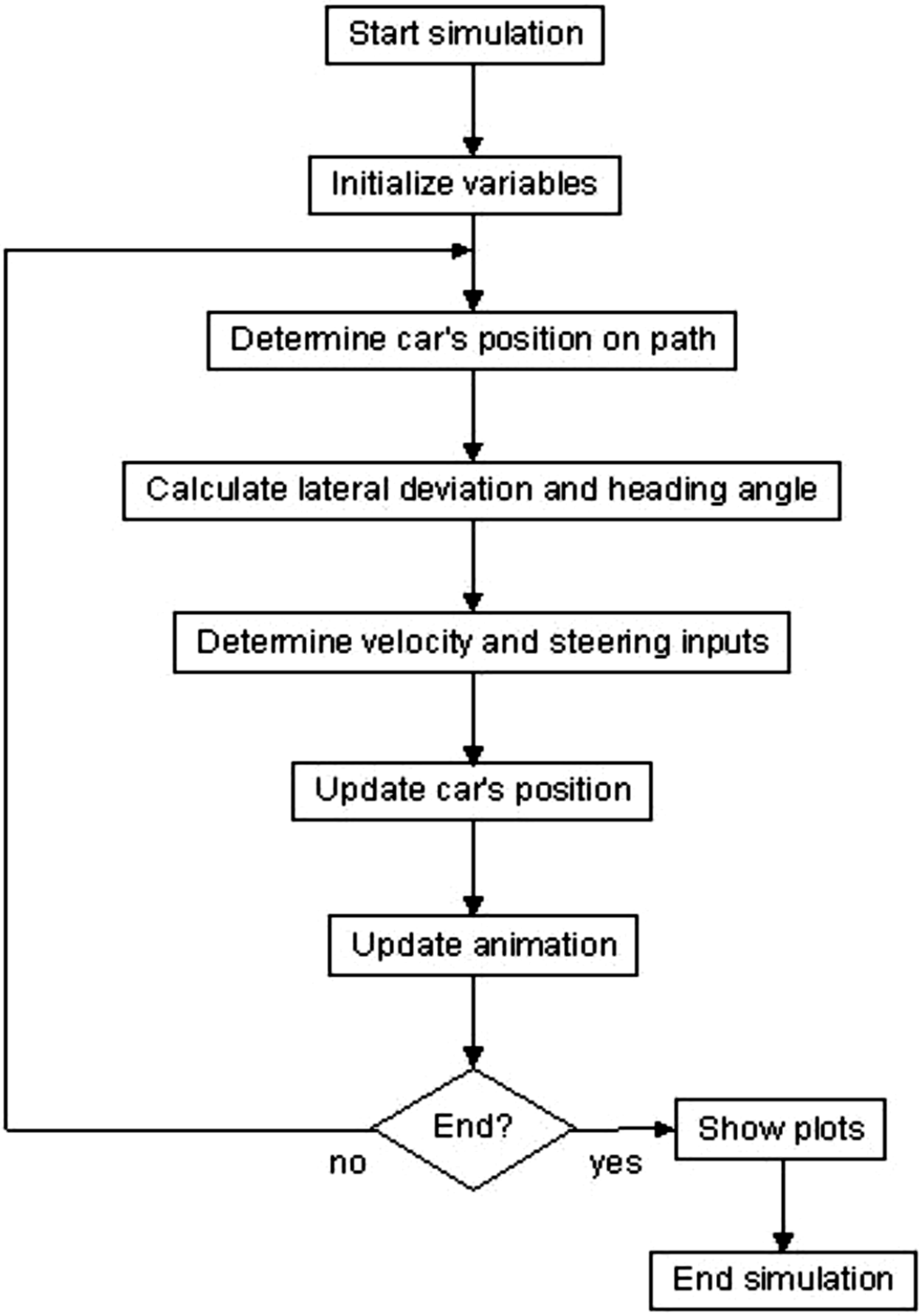
3.4.6 JAUS INTEROPERABLE COMMUNICATIONS

LabVIEW helped develop and deploy a set of tools for JAUS, an autonomous ground vehicle standard for passing messages and status information among various vehicle subsystems. This SAE AS-4 JAUS interoperable architecture was designed for use in other autonomous applications as well. Cooperating to select the minimum cover set has two advantages: preventing unnecessary energy consumption and extending the lifespan of the visual sensor network. In this section, we introduce our method to select a minimum cover set for the tracking of mobile objects.

3.4.7 DRIVE BY WIRE SYSTEM

Drive-by-wire, technology in the automotive industry replaces the traditional mechanical control systems with electronic control systems using electromechanical actuators and human machine interfaces such as pedal and steering feel emulators. Hence, the traditional components such as the steering column, intermediate shafts, pumps, hoses, belts, coolers and vacuum servos and master cylinders are eliminated from the vehicle.

4 ALGORITHM


Start simulation
Initialize variables
Determine car's position on path
Calculate lateral deviation and heading angle
Determine velocity and steering inputs
Update car's position
Update animation
End?
no
yes
Show plots
End simulation

4.1 APPROACHES TO CONSTRUCTING A FOLLOW ALGORITHM

Interactive Algorithms

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 centimeter-level precision in following a desired path.

5. PROGRESS IN THE FIELD

As of 2010, Google has tested several vehicles equipped with the system, driving 1,000miles (1,600 km) without any human intervention, in addition to 140,000 miles (230,000 km) with occasional human intervention, the only accident occurring when a car crashed into the rear end of a test vehicle while stopped at a red light. The project team has equipped a test fleet of seven vehicles, consisting of six Toyota Prius and an Audi TT, 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.

Many companies such as General Motors, Volkswagen, Audi, BMW, Volvo, have begun testing driverless car systems. General Motors has stated that they will begin testing driverless cars by 2015, and they could be on the road by 2018. Volvo has begun to develop an almost-autonomous 'road train' system for highways which could be integrated in cars by 2020. Google has lobbied for two bills which, in June 2011, made Nevada the first state where driverless 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 provides an exemption from the ban on distracted driving to permit occupants to send text messages while sitting behind the wheel. The two bills were expected to come to a vote before the Legislature’s session ends in Aug 2011.

In 2006 the United Kingdom government's 'Foresight' think-tank revealed a report which predicts a RFID-tagged driverless cars on UK's roads by 2056, and the Royal Academy of Engineering claims that driverless trucks could be on Britain's motorways by 2019.

6. APPLICATIONS

6.1 Intelligent transporting

Most promising application in the field of 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 deicing systems; and the like. Additionally, predictive techniques are being developed to allow advanced modeling and comparison with historical baseline data this technology will be a revolutionary step in intelligent transportation.

6.2 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.

6.3 Transportation in the hazardous places

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

6.4 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 every day driving for multiple day’s 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. The truck is also able to drive to their destination without having to stop to sleep, eat, or anything besides more fuel. All that is necessary is someone to load the vehicle and someone to unload the vehicle. This would save trucking companies a very large amount of money.

6.5 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. Taxis also drive around cities and wait in busy areas for people to request a cab. A taxi service comprised completely of autonomous vehicles could be started. A person can call in and request to be picked up and then be brought to their destination for a fee. There could be autonomous taxis waiting in designated areas for people to come and use them. Many taxi drivers need the job because they are unable to perform other jobs for various reasons. The need for a human in the service goes away almost completely. This is another example of a large amount of people being removed from their jobs because of autonomous vehicles being able to perform the task without the need of an extra person.

6.6 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. However, on a bus or shuttle, a person must follow rules, watch the actions of other drivers and pedestrians, keep the bus in lane, and make sure they stop at every bus station. These are many tasks that one person must be able to handle and react to and control at the same time. In the early stages of implementation, it would most likely keep the driver behind the wheel as a safeguard in case there is a problem with the system. The driver would also be needed in the beginning in order for the general public to trust it at first. As the life of the autonomous vehicle systems progresses, bus drivers would no longer be needed as the system would be able to perform all of the required tasks. It is a simple job of following a specific route and stopping at designated points. The most ideal situations when the autonomous vehicle systems have matured to the point that nearly every vehicle on the road is autonomously driven.

7. ADVANTAGES

7.1 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. Intelligent safety systems that are currently in use have already proven their success in helping drivers avoid accidents. According to EUROSTAT data, the number of road fatalities in the EU has been reduced from 56,027 to 28,849 people per year between the years of 1991 and 2010.5 this data indicates a reduction of about 30 percent, which reflects the better safety performance of recent vehicles when compared to previous vehicle generations.

7.2 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. The autonomous vehicles would be following all traffic laws while human drivers have the choice to break the law. As time progresses and the autonomous car becomes a more commonly used vehicle on the road, traffic would become far less congested. Cars would be able to seamlessly merge into moving traffic and then exit the highway just as easily. With the reduction of traffic, there is a chance that there could be economic improvements. Vehicles could be designed to optimize fuel usage at common speeds used on the road. The speed limit could be increased because there is no longer any concern with human error, and the vehicle would know how to control its situation on road.

7.3 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. Even if the fuel efficiency achieved by the autonomous vehicles were 1 percent better, this would result in billions of dollars of savings in the US alone. It is possible to obtain superior fuel efficiency as a result of the implementation of autonomous safety systems. Total savings that can be achieved by the increased fuel efficiency can be calculated by making some assumptions such as:

- 10% as a result of more efficient driving
- 5% as a result of cars being 300 pounds lighter on average
- 10% as a result of more efficient traffic flow

According to the assumptions made above, the implementation autonomous vehicles will result into fuel savings of 25 percent, which is rough estimate

7.4 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. Even if the time savings were not considered as having monetary value, having more time for leisure activities would raise our life standards. Lowering the amount of time lost will also enable people to be on time and more dynamic, resulting in a significant improvement in work efficiency. One of the biggest advantages of this technology will be the elimination of traffic problems in cities, which are at the top of the most frustrating problems list for most people. By enabling a smoother traffic flow, the new system will be saving a lot of time which can be used for work or leisure.

8. CHALENGES

- 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
- 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
- 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

9. FUTURE SCOPES

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. "We believe vehicle-highway automation is an essential tool in addressing mobility for the citizens of California," says Greg Larson, head of the Office of Advanced Highway Systems with the California Department of Transportation, who notes that “The construction of new roads, in general, is simply not feasible due to cost and land constraints”. It is clearly seen that most government officials and scientists see the future of transportation as a fully automated structure which is much more efficient than the current configuration. 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. Car manufacturers are already using various driver assist systems in their high-end models and this trend is becoming more and more common. 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. As a result of this trend, the early co- pilot systems are expected to gradually evolve to auto-pilots.

10. 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 over time 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. As more and more vehicles on the road become autonomous, the effects on everyday life will be shown. It will result in an increase of the efficiency of many companies as less time is wasted in travel and less money is spent on tasks autonomous vehicles can perform where a human was previously needed. This will also cause the loss of thousands of jobs all over the world. There would have to be a plan in place before society would allow this to happen. This is an important reason behind the lack of interest and slow development of fully autonomous vehicles. If this problem is solved, we could see fully autonomous vehicle systems in the near future.

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