INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact factor: 4.295

(Volume 4, Issue 2)

Available online at: www.ijariit.com

Computer Vision in Self Driving Cars

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ABSTRACT

In this paper, the examination of the current state of the art in Computer vision with self driving cars has been discussed. The main points which discussed here are the units of the self driving car, the core components of self-driving cars, Safety problems of road vehicles are also presented. A Self Driving car is a vehicle that is capable of sensing its environment and able to do the necessary navigation without the human input. The main idea which has been discussed here is General in-vehicle driver support system architecture. To detect and track vehicles and other kinds of objects often with different sensors are used. Thus giving humans the capability of using the self driving vehicle for daily usage will change the current scenario of transportation and helps to improve the user driving experience.

Keywords: *Computer Vision, LIDAR, Deep Neural Network.*

1. INTRODUCTION

Computer vision is an interdisciplinary field that deals with how computers can be made for gaining high-level understanding from digital images or videos. In Computer Vision we try to teach a computer how to see and that seeing can refer to understanding scenes, reconstructing 3D objects, recognizing objects, avoiding obstacles, helping blind people navigate and a lot of this makes use of machine learning and it also makes use of geometry and applied math.

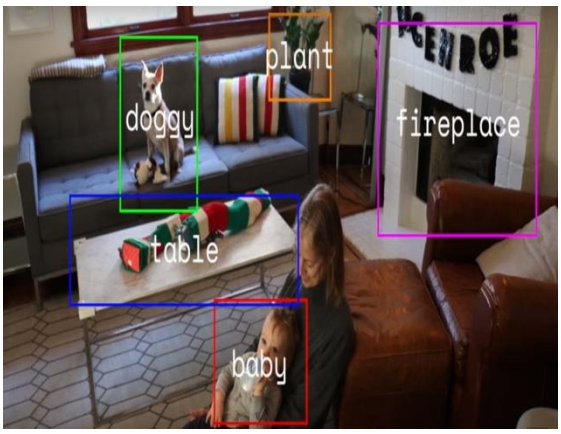


Fig 1: Computer Vision object Recognition System

Computer Vision can be seen to be used for various purposes such as - It helps stabilize videos and create virtual worlds. It helps cameras see faces so they're not blurry.

There a difference between human vision system and Computer vision system from a Computer perspective an image is just an array of the number or if its color it would be three arrays of numbers. By themselves, these pixels don't mean anything the computer has to interpret what they are as shown in Fig 2.

In Fig 1.Computer vision object recognition System has been described in which an image is given as input and the task is to find out where are all the object and what are they?

There is another approach to computer vision which is registration that sort of like tracking or alignment of models if you have a self-driving car and you want to track pedestrian, track lane marking.

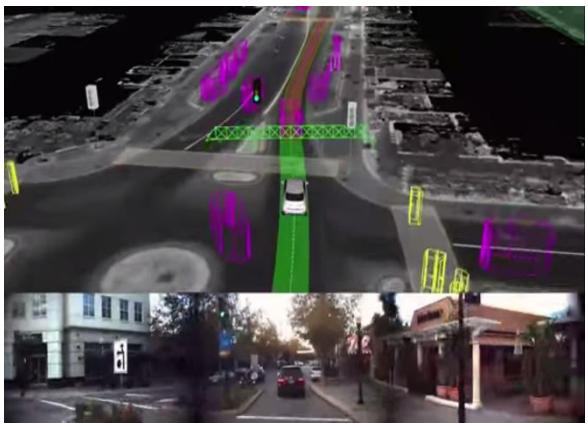


Fig 2: Human vision vs. Computer Vision

Computer Vision systems are trained with a massive amount of trained data and if you get the data which is unsupervised then the task at hand is to just get the data and somehow reorganize it in a way where you make sense of it.

It sort of feels like magic and so we can say that the computer vision will show something about the world which you couldn't see otherwise.

2. UNITS OF SELF DRIVING CAR

There are various units of the self driving car which makes it different from a normal car –

1) LIDAR

LIDAR stands for Laser illuminating detection and Ranging which is a equipment mounted on the roof of the car and has a range of at least 100m to detect objects in the environment. By firing off millions of beams of light per second, the measurements from the LIDAR sensor enable a visualization of the world that is truly 3D when those laser beams bounce off surfaces surrounding the car. The LIDAR can take up to 1.3 million readings per second and is able to position the objects in the surrounding on the 3D map which update itself in real time because most of the object is not static. The LIDAR has proved itself an essential part of a self-driving car because detecting and track obstacles like cars, pedestrians, and football helmets etc. Fig 3 describes a type of LIDAR mounted on the car.

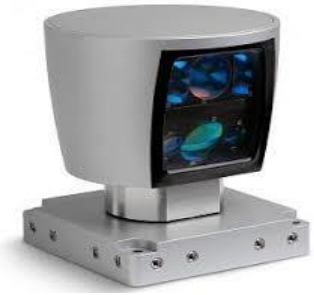


Fig 3: LIDAR

2) RADAR

Radar stands for Radio Detection and Ranging a RADAR uses radio waves to detect objects and determine their range, angle, and/or velocity. RADAR performs well in extreme weather conditions in rain, snow, fog. Radar doesn't necessarily give you granularity of LIDAR but it is very essential for self-driving in case of emergencies such as conditions from a collision from other objects in the scenario.

Fig 4: RADAR in Self Driving Cars

RADAR in a self driving car can also be used to maintain a specific distance between it and the car running in front of it for the safe driving.

3) Camera

Cameras are the eyes of self-driving cars just like you can look through a camera and see a clear picture of the environment around you, cars will be able to do the same thing. By outfitting cars with cameras at all angles, the vehicles will be able to maintain a 360-degree view of their surroundings as shown in Fig 5.

Fig 5: 360° Camera view inside a self-driving car

3. CORE COMPONENTS OF SELF DRIVING CAR

Fig 6: Components of Self Driving Car

Self-driving cars have five core components:

- Computer Vision
- Sensor Fusion
- Localization
- Path Planning
- Control

1) Computer Vision

Computer vision is how we use cameras to see the road. Humans demonstrate the power of vision by handling a car with basically just two eyes and a brain. For a self-driving car, we can use camera images to find lane lines or track other vehicles on the road.

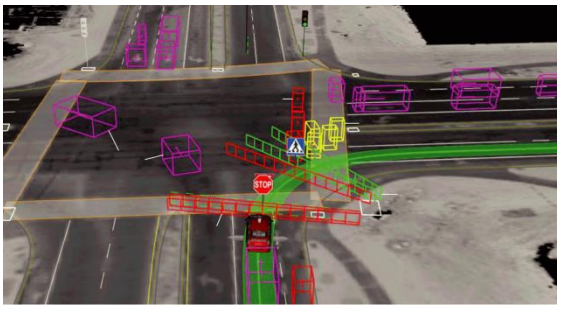


Fig 7: Computer Vision in self-driving cars

The GPU units of the car use a trained deep neural network to draw the bounding boxes around the other objects on the road which is done by feeding them up with lots and lots of data about those objects to make them able to recognize things in the scenario. In Fig 7 the green path represent the path that the vehicle intends to follow the red boxes represent the cyclists, the yellow boxes represent the pedestrians, the pink boxes represent the vehicles, the green fences corresponds to the object that potentially affects our speed and the red fences corresponds to the location where the car will stop until it's safe to proceed.

2) Sensor Fusion

Sensor fusion is how we integrate data from other sensors, like radar and lasers—together with camera data—to build a comprehensive understanding of the vehicle's environment. As good as cameras are, there are certain measurements—like distance or velocity—at which other sensors excel, and other sensors can work better in adverse weather, too. By combining all of our sensor data, we get a richer understanding of the world as shown in Fig 8.

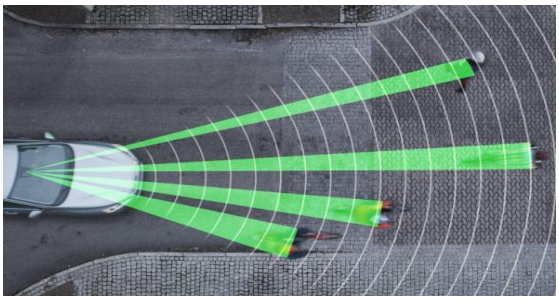


Fig 8: Sensor Fusion in Self Driving cars

3) Path Planning

Path planning is the next step, once we know what the world looks like, and where in it we are. In the path planning phase, we chart a trajectory through the world to get where we want to go. First, we predict what the other vehicles around us will do. Then we decide which maneuver we want to take in response to those vehicles. Finally, we build a trajectory, or path, to execute that maneuver safely and comfortably as shown in Fig 9.

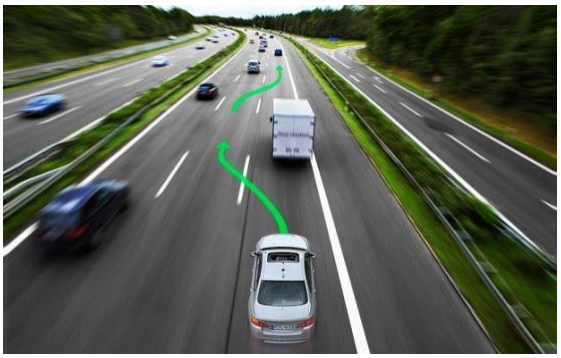


Fig 9: Path planning in self-driving cars

4) Control

Control is the final step in the pipeline. Once we have the trajectory from our path planning block, the vehicle needs to turn the steering wheel and hit the throttle or the brake, in order to follow that trajectory. If you've ever tried to execute a hard turn at a high speed, you know this can get tricky! Sometimes you have an idea of the path you want the car to follow, but actually getting the car to follow that path requires effort. Race car drivers are phenomenal at this, and computers are getting pretty good at it, too!

The Components of self driving car which are described in Fig 6 also represent how a self driving car works.

4. SAFETY PROBLEM IN ROAD VEHICLES

According to the survey study results published in the National motor vehicle crash causation survey," U.S. Department of Transportation annually about 100 000 crashes in the USA result directly from driver fatigue. It is the main cause of about 30% of all severe traffic accidents. In the case of French statistics, a lack of attention due to driver fatigue or sleepiness was a factor in one in three accidents, while alcohol, drugs or distraction was a factor in one in five accidents in 2003.

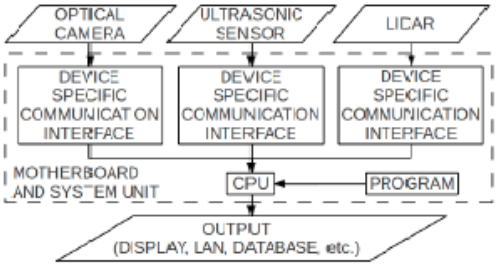
Based on the accidents records from most common traffic accidents causes are:

- Frontal crashes, where vehicles driving in opposite directions have collided.
- Lane departure collisions, where a lane changing vehicle collided with a vehicle from an adjacent lane.
- Crashes with surrounding vehicles while parking, passing through an intersection or a narrow alley, etc.
- Failures to see or recognize the road signalization and consequently cause a traffic accident due to inappropriate driving.

5. VISION SYSTEM REQUIREMENTS

To define an appropriate vision system architecture some application areas related requirements need to be considered. Firstly obtained data should be available in time after a possible critical situation has been detected. The second important requirement is the capability to adapt to rapid changes of environment monitored using cameras. In Fig. 10 general in-vehicle vision system

architecture has been described which is a fully fledged system for a road vehicle to become resistant to various physical influences (e.g. vibrations, acceleration/deceleration).



6. FUTURE OF SELF DRIVING CARS

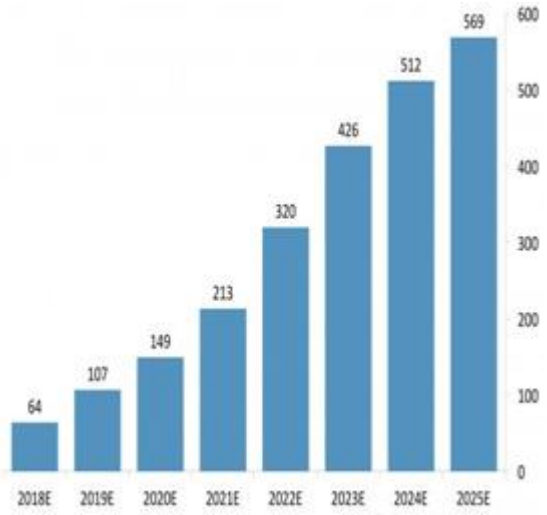
The Technology Trend of Artificial intelligence especially deep learning has improved significantly and is making driverless car possible in today's environment. Regulations will change quickly within countries regarding the use of autonomous vehicles because of a global autonomous race. Entire cities will flip from drivers to driverless all at once, and they'll change how we live and commute.

When the self-driving vehicles come on the road "Suddenly, you can work in your car while you commute," And you can imagine, if self-driving cars work well, it should dramatically reduce traffic jams because the cars can all communicate with each other." "With cars, you have a dynamic that is going to be very amenable to fast-moving regulatory change because tons of people are employed in it, it's seen as strategic by lots of large countries, and there isn't really a countervailing industry fighting against it

The Comparison between different levels of automation are-:

Level of Automation	Name of Automation	Description
Level – 0	No Automation	Traditional manually driven vehicles
Level – 1	Function Specific Automation	One or more independent automated primary control System. In this human and computer system work together with information about the driving environment
Level -2	Combined Function Automation	Two or more automated primary control System designed to work in unison to relieve the driver from the control in some situation
Level -3	Limited Self Driving Car Automation	Automated but Driver can take back control of the vehicle in some situations
Level – 4	Full Self Driving Car Automation	Automated and Driver has no ability to take back control of the vehicle in any situations

The future of Self Driving car is also very bright as the market for Autonomous technology is constantly growing. The below graph shows the growing market value of Autonomous System –



7. CONCLUSION

In this paper we provided a general survey on Safety problems in the road vehicles, Units of Self Driving car and components of self-driving car why they are necessary for functioning of the self-driving car and a brief description of computer vision for autonomous vehicles are also described which is used for vehicle detection and obtained recognition consist of many subsystems. Computer vision is concerned with the automatic extraction, analysis, and understanding of useful information from a single image or a sequence of images. Autonomous driving that because of its size would lead to an enormous amount of results due to the extensive applications, testing and research in other fields (robotics, underwater vehicles, military, aeronautics, space vehicles etc. This will also change many aspects of mobility and change the perception of people by reducing fatality on roads and will make driving more efficient.

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