Collision Avoidance in Autonomous Vehicles

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Abstract – *Since the inception of cars in 1886, the automobile industry has witnessed many changes, one of the most recent being the advent of the self-driving technology, under the bigger umbrella of intelligent transportation, and the cars or vehicles possessing this are termed as autonomous vehicles. As of now, it is an emerging technology, with a vision of providing the passengers with a safe and efficient transportation experience. Autonomous vehicles refer to those vehicles which, at some level, are capable of sensing their environment and have the ability to make quick decisions while moving through traffic. These vehicles, depending on how advanced they are, require partial to minimal interference from the driver, as and when needed. For these vehicles to self-drive, they have to explore their way through the roads, stop at traffic signals and obey the traffic signs as well. And most importantly, these cars have to complete these trips without hitting someone or something. The paper briefly discusses the various levels of autonomous vehicles and how a driverless car works. The paper also discusses haar features, why grayscale was chosen for detection and how object or vehicle detection took place with the help of that and the output image of vehicles detected on the road.*

Key Words: **autonomous vehicle, intelligent transportation, driverless cars, self-driving vehicles, haar features, object detection**

1.INTRODUCTION

A self-driving or an autonomous vehicle is a vehicle capable of driving itself without the need for the driver to interfere. The cars also come with certain other technologies that assist the driver in optimum driving and avoiding collisions. Some of these technologies are Automatic Brake Assist, Lane Keep Assist, Blind Spot Monitor, Adaptive Cruise Control and some with even Auto-Pilot like the Tesla.

Self-driving cars come with a variety of devices like 360-degree cameras, ultrasonic sensors, radar, narrow and wide-view cameras etc. Some of these devices are already available in the production vehicles today while some devices may be specific to the autonomous vehicles only.

Fig -1: Self-Driving Tesla | Tesla Autopilot System |Michael Simari | Source: Car and Driver

2. CLASSIFICATION OF AUTONOMOUS VEHICLES

A classification system with six levels – ranging from fully manual to fully automated systems – was published in 2014 by automotive standardization body SAE International (formerly the Society of Automotive Engineers) as J3016, *Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems*. [7][8] This classification is based on the amount of driver intervention and attentiveness required, rather than the vehicle's capabilities, although these are loosely related. [6]

Level 0: This is the basic level which corresponds to almost all the vehicles on the roads today. The driver controls the entire vehicle by himself. The automated system however may issue some warnings.

Level 1: This level corresponds to the shared control of the vehicle by the driver and the system. Examples include the Cruise Control where driver controls the steering and the system is set to a constant speed (or varying speed in Adaptive Cruise Control) and the Parking Assistance in which driver controls the throttle and system controls the steering.

Level 2: The car does all the main tasks of accelerating and steering both. This can be understood as a car having a combination of Cruise Control and Lane-Keep Assist. The driver can take his hands off the vehicular controls but must be ready to take over in accordance with the traffic and the surrounding conditions.

Level 3: It is from this level onwards the cars really start going towards automation. In this level, the car handles everything and the driver can take his attention away from driving tasks and relax. It can be thought of as a co-driver who will alert the driver in case his/her interference is required.

Level 4: It is similar to Level 3, however no driver interference would be required even in emergency situations like bad weather or roads because in such cases the car would be able to steer and park itself to safety. Within a certain designated environment and certain, the car can drive itself and the driver can even go off to sleep. Example could be a robotic taxi/car.

Level 5: This is the highest level of automation of a vehicle. The driver will set the destination and the car will handle everything, at all times, on all roads and in all conditions. These cars can come even without a steering. [6]

Fig -1: LIDAR: The Key Self-Driving Car Sensor | by Oliver Cameron | Source: Voyage

3. METHODOLOGY

It is a program incorporating the fundamentals of python and machine learning. The program reads an image consisting of cars or on road traffic, converts it into grayscale to ease the comparison, then detects cars of any size by comparing those with the pre-trained classifier. The program then draws boxes around the detected cars in the image. However, all the cars may not be detected in the image because the algorithm is not perfect.

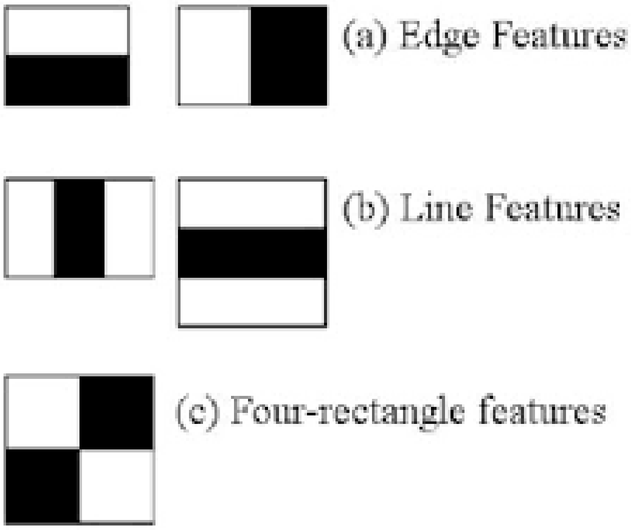

Fig -2: Haar Features | Source: OpenCV documentation

The general idea of haar like features was to describe an object as a cascade of simple feature classifiers organized into several stages.[1] This is a very quick method, performing car detection as effectively as any other method. Using these, we compare the grayscale image to any of the required haar features. If the comparison is successful, the algorithm detects it.

The traditional RGB image has three components of red, green and blue ranging from 0 to 255. However, in this case, for ease of comparison, grayscale is used as there is only one colour component to run through the classifier.

Fig -3: Grayscale Image of Output | Original Source: Google Images

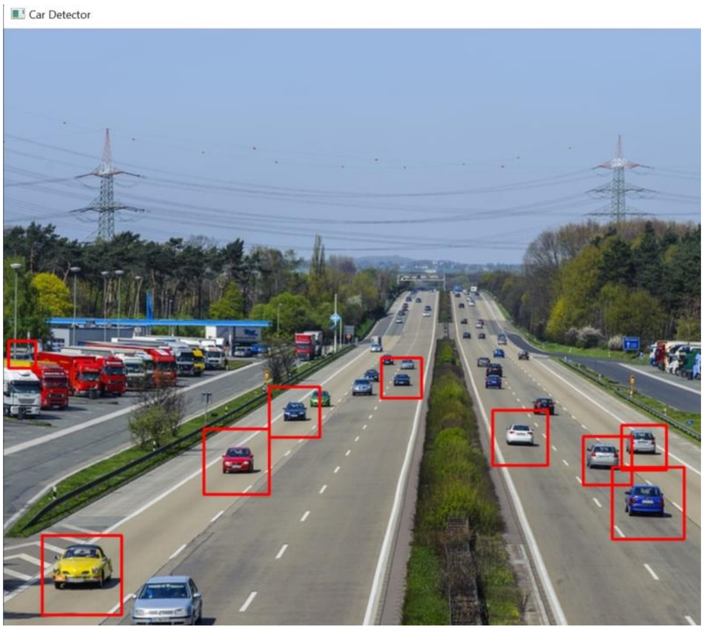

Fig -4: Final Image of Output | Original Source: Google Images

The algorithm prints a 2D list as the output coordinates of the detected vehicles. In order to give a visual effect to the output image, we draw red squares around the detections using the output coordinates.

The steps briefly stated below are:

1. Get lots of images of cars for the algorithm.
2. Read the images and make them black and white
3. Compare the image to haar features through classifier
4. Train the algorithm to detect cars

5. CHALLENGES

Despite the advancement in vehicles over the past few decades, the self-driving technology is fairly new and undergoing research and development, testing and pilot projects throughout the world. However, they pose some challenges for us from moral to technological. Here are some of them.

5.1 Sensors and Equipment

The expensive equipment used in these vehicles like the lidar is still not as technologically advanced as it may be required. Moreover, if there are multiple autonomous cars on the road, and the frequencies of their respective sensors are interfering with each other, then this would need to be taken care of.

5.2 Weather Conditions

The driving environment around the vehicle may not always be conducive for it to drive. In such cases, these vehicles can pose a challenge. Examples could be natural calamities like landslides, thunderstorms or heavy rainfall, snowfall or even fog causing low visibility. The question that now arises is that how would these vehicles fare through such unforeseen conditions.

5.3 Software Vulnerabilities

The computer requires to compute a number of operations in order to make the program run efficiently. In real time environment, the computer must be quick enough to react to the driving environment and at the same time be fairly accurate. Increasing the accuracy would increase the reaction time which would be undesired. Therefore, in simple terms a system should be fast enough to avoid accidents. Another issue could be that the computer in the self-driving car could be vulnerable to getting hacked, just like any other computer.

5.4 Traffic Conditions and Laws

If an autonomous vehicle is produced in a particular country, we may assume that the manufacturer would have taken care of the traffic rules and regulations in that country so that their vehicle would follow those rules. But can we surely say that all countries have more or less the same traffic rules – it is surely not the case. Moreover, how would these cars fare in bumper-to-bumper traffic, or in tunnels with low visibility. Such questions are yet to be answered.

5.5 Accident Liability

Although the self-driving cars come with big claims of safety for both the passengers and the pedestrians, but no one can guarantee that an accident won't happen. Who will be held responsible in such a case – the driver or the vehicle manufacturer? And in a fully automated vehicle without a steering, there won't even be an option for the driver to take over the control of vehicle.

5.6 Moral Concern

Imagine an emergency situation in which either the driver, along with the car, will take the impact or a fellow pedestrian on the road. Who would the car prioritize to be saved – the driver or pedestrian? And if the car saves the pedestrian despite itself taking the damage (which could even be life threatening for the passengers), then which owner would want to buy such a car that does not even keep the passengers safe.

6. CONCLUSION AND FUTURE SCOPE

The automobile industry, since its inception, has been continuously evolving with newer technologies for the betterment of the overall driving and ownership experience of its customers. One of the latest among such technologies is this – the Self-Driving technology. Although it may not be at the production ready stage yet, however advances are being made gradually and some of the technologies available in cars today are on the right path to evolve into autonomous technologies. People may argue that there are many concerns regarding these self-driving cars, however just because of some disadvantages, it won't be wise to discard the entire concept itself. It is just how technology evolves - improving over time. Moreover, there are advantages of it as well. Few of them include less travel times and fuel savings, convenient drive free experience, safe travel and less traffic jams on the roads. With the advent of these vehicles just around the corner, soon we may require laws and regulations in place for the same. Also, all the above listed concerns in a way serve as a guideline for these vehicles to improve in future and bring in a whole another level of convenience for the customers.

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