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RISE OF AUTONOMOUS VEHICLES

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ABSTRACT

This paper reviews the mechanisms behind the making of self-driving vehicles or autonomous vehicles (AVs). It explains the concepts of artificial intelligence based on which autonomous vehicles are made such as deep learning and computer vision. These algorithms, based on deep learning and computer vision, allow the autonomous vehicle to make smart decisions based on its surroundings. To get complete data on their surroundings, AVs are embedded with various systems of sensors such as LIDAR and radar. The paper also provides a summary of the historical developments of automobiles and self-driving cars. It further explores some of the challenges and the recent developments in the field.

Keywords: Autonomous Vehicles, Artificial Intelligence, Self-Driving Cars, LIDAR, Deep Learning.

Introduction

Amazon's commission towards the American start up 'Plus' for the purpose of providing the giant with thousand autonomous vehicle systems, Tesla's attempts at making a supercomputer (a hardware which aims to bring self driving vehicles to life by the use of computer vision) or Ford's focus on how road users can interact with autonomous delivery vans - all make clear the possibility of having cars that drive themselves is not just the stuff of fiction anymore. The attempts at bringing the autonomous vehicle to life are fueled by the social, economic, and environmental advantages that they offer, some of them being: better public transport, increased road utilization which leads to need of lesser roads, less traffic fatalities which would increase road safety and reduction in fuel consumption which would pave the way for introducing alternative fuels.

Despite the recent enthusiasm shown towards autonomous vehicles, many people have refused to give this upcoming technology a chance. According to a poll done by Reuters/Ipsos in 2019,

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sixty four percent of Americans said that they would not buy a self-driving car. Another survey conducted by the American Automobile Association in 2019 stated that out of all the US drivers surveyed, Seventy one percent would be afraid to ride in a fully self-driving vehicle. It is known that often, uncertainty stems from lack of knowledge hence in this paper I would break down the mechanisms behind the working of this new technological advancement and how artificial intelligence plays a crucial role in bringing it to life. I would explain and break down these mechanisms and connect them to mechanisms of many appliances that we use in our daily life to try and make them seem as familiar as possible so that some of the general discomfort regarding self-driving cars can be put to ease.

To understand the processes by which autonomous vehicles are brought to life, we must understand the different types of autonomous vehicles. According to the National Highway Traffic Safety Administration (NHTSA), autonomous vehicles can be categorized by the level of involvement of humans in the working of these vehicles into 6 types ranging from level zero (no automation) to level five (full automation).

Most vehicles one would see on the road today would be level zero vehicles. These vehicles would have systems in place to assist the driver (such as an emergency brake system) but a human would be in full control of driving the vehicle. In level one and two vehicles, there are systems put into place to automate steering or the acceleration/deceleration of the car which lessens human involvement. Level three is where environmentally aware systems are put into place so the vehicle can make informed decisions for itself but a human is still required to be present to exercise control when the vehicle is unable to perform its tasks. Level four vehicles on the other hand do not require human intervention and can operate even when the system is unable to perform its tasks successfully. However, unlike level five vehicles which possess full automation, Level for vehicles can only operate within a limited area.

Background

The automobile first came to life in 1995 by Karl Benz in Mannheim, Germany. It was called “Benz Patent-Motorwagen”. The 'Ford Model T' was developed by the Ford Motor Company in 1908. This was further assembled at Ford's Piquette Avenue Assembly Plant in Detroit, Michigan. From its production from 1908 to 1927, over fifteen million Model T automobiles were undergoing production. In further years developments regarding self-driving cars expanded. For instance, in the 1920s we witnessed the development of the first radio-controlled car. In 1939 the first electric cars were showcased. Additionally in 1980, a robotic van was developed by Mercedes - Benz that used vision-guided systems.

AVs were considered to be just works of fiction until the 1930s. It was in 1939 when Norman

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Bel Geddes introduced the Futurama exhibit for the 1939 World's Fair. The exhibit allowed the public to see the potential behind self-driving cars, where they could yield the advantages of railways (not having to manage the operations of the vehicle) but with a more personalized approach. This original concept was, however, similar to that of a railway as self-driving cars could operate along a specialized path, much like a railway. This was because at that time technology was not capable of making decisions on its own. Now instead of creating specialized paths for self-driving cars, we can use artificial intelligence to design vehicles. The principle of having no human involvement in the driving process of these vehicles stays the same but with a different approach.

Discussion: Mechanics Behind AVs

Self-automated vehicles require a detailed analysis of their surroundings to make informed decisions regarding them and this can be achieved through several sensors which will be detailed in the discussion. To use this analysis to make informed decisions artificial intelligence is used. Artificial intelligence in simple words is the theory to develop computer systems that can perform tasks that require human intelligence such as speech visual perception and decision making.

As mentioned in the introduction, Automated vehicles use a combination of sensors and algorithms based on artificial intelligence to map their surroundings and make logical decisions based on the data they receive from sensors. In this section, I will break down the types of systems used and explain the artificial intelligence algorithms which allow self-driving cars to exist.

Certain systems are put into place which provides the AV with the information it needs with regards to its speed, direction, and position. The INS (inertial navigation system) is used to track the object's position in relation to a known starting point. The data regarding the longitude and the latitude of the AV's position can be determined by the GPS (global positioning system) and geographical information system. Electronic maps are used to store information regarding traffic and road facilities (these are also currently applied to level two or three self-driving cars).

In addition to geographical information, AVs also require high levels of environmental perception. This can be done using different methods such as visual perception, laser perception, and radar perception. In an AV, visual perception is used to convert the low-level information from the images captured by the camera to high-level information that the computer can use to make smart decisions. This is done through computer vision algorithms. LIDAR (light detection and ranging systems) makes use of laser perception. It emits numerous laser pulses which reflect off its surrounding environment to create a three-dimensional map of the surroundings. This map

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can further be used to identify road boundaries. Radar perception makes use of a sensor that releases radio waves that can monitor the position of the vehicles nearby. LIDAR is known to detect smaller objects with more accuracy and precision than radar because LIDAR uses lasers with much smaller wavelengths.

When the computer has gathered all information regarding its environment and geography, it needs to process this information and make smart choices regarding it. For this purpose algorithms based on artificial intelligence are used. We are all familiar with artificial intelligence to some extent as it plays a crucial part in many of our day-to-day applications. For example, an algorithm based on machine learning (a subset of artificial intelligence) is responsible for handling our Netflix recommendations. It does this by looking at your history and recommending shows based on that. Gmail also uses concepts related to that of artificial intelligence to filter emails as 'spams' or 'non-spams'. It does this by identifying certain words associated with spam emails and labeling emails that use those in words in abundance as 'spam'.

Unlike humans, who are born with the ability to see and perceive, computers learn this special ability by recognizing repeating patterns. Computer vision is a field in artificial intelligence that allows computers to learn this skill through the use of some special algorithms. Let us say, for example, we need computers to recognize a certain type of tree. First, we will train the computer on large amounts of visual data, in this case: lots of pictures of a specific type of tree. The computer will then derive patterns from these images and identify similarities to build a model of that tree. The computer will then use this model to identify whether the given image is that of a tree or not. This technology plays an important part in the working of AVs as well as it would be used to derive conclusions from the images obtained of the surroundings of the AV. These conclusions would later be used to make smart decisions.

To make smart decisions for AVs, another subset of artificial intelligence called deep learning would be implemented. Deep learning refers to the algorithms which mimic the way humans attain knowledge and make choices. Deep learning is implemented when the data set required to solve a problem is big. Through deep learning, the computer can pick what features of deep learning are significant to making a decision or solving a problem. Deep learning algorithms have already become commonplace in virtual assistance and facial recognition technologies.

While the rise of self-driving vehicles may seem sudden and jarring to one, we are familiar with most of the technologies and processes behind the making of AVs. The systems put in place for environmental perception and the algorithms derived from artificial intelligence concepts such as computer vision and deep learning have already been a part of our daily life. While these systems have been a part of our daily lives, we must conduct many more tests to ensure their reliability. AVs also require comprehensive testing because any decision made by the software affects

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human lives directly. These tests are currently being undertaken in several parts of the world. For example, the autonomous car testing facility 'Mcity' by the University of Michigan has proposed an independent safety test called the Mcity ABC test which tests the performance of AVs in terms of safety. Alongside comprehensive testing, a revision of the legal framework is also required. This is because in cases of accidents/collisions, there is a shift in responsibility from an individual driver to the companies which are behind the development of these vehicles. We must also look at the financial aspect of bringing AVs to life because a lot of the machinery required for the development of AVs is of high cost. A solution to this problem would be to divide this cost amongst a large number of people. Car sharing services like cabs based on AVs would be a solution to this problem.

Conclusion: Contemporary Developments

It can be observed that there has been a spike in the development of hardware and software development related to AVs. Keolis and NAVYA, who have been partners of automotive mobility since 2016, have launched the first autonomous electrical shuttle in Las Vegas in 2017. The American car company Cruise unveiled the Origin, a fully autonomous car without a steering wheel or pedal (which makes it a level 5 AV). The company Argo AI has also been developing technology that is according to level four of AV automation to deliver goods and share rides. Waymo, founded in 2009 is considered to be a leading company in the development of self-driving cars technology. This company has driven as many as twenty million cars on the road and is the closest to making level five of AVs.

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