# Economic benefit, challenges, and perspectives for the application of Autonomous technology in self-driving vehicles

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**Abstract.** With the development and innovation of state-of-art autonomous driving technology, the feasibility of autonomous technology application in self-driving vehicles has become a social interest. Despite the several energy and economic advantages brought by autonomous driving, the safety, technic, and ethical issues are still of concern. Thus, this paper has carefully evaluated the feasibility of self-driving applications regarding the above aspects. Suggestions are also provided accordingly for further technology evolution. The results show that autonomous driving has greater benefits, but there is still room to fill in the legal and technical aspects. The benefits mainly include freeing up drivers and greater road capacity. In addition, smoother roads reduce motor vehicle emissions, allowing the environment to be protected. It also makes it safer for people to travel without the subjective emotional factors of drivers causing traffic accidents. Finally, further advanced automotive chip and sensors research is necessary to replace manual driving fully.

**Keywords:** Autonomous vehicles; energy consumption; energy saving.

## 1. Introduction

Nowadays, big breakthroughs have been made in autonomous driving technology. For example, the Arcfox Alpha S new Huawei-inside (HI) version autonomous vehicle made by Arcfox and Huawei, can do level three autopilot. Level 3 is truly autonomous driving rather than assisted driving. That means the HI car could be used in most road conditions without a human driver. If the technology can be applied to the mass market, traffic conditions may be greatly changed. The development of autonomous driving technology is accompanied by many benefits, such as a decrease in energy consumption costs of about 9.66% when the market penetration of autonomous driving reaches 90%. This will greatly reduce the problem of environmental pollution. But there are still technical difficulties and legal issues that are not easy to break with autonomous driving technology. China does not yet have separate legislation on autonomous driving, which is still governed by general traffic laws. This may pose a big problem; if the AI of autonomous driving encounters the Trolley Problem, then how should it be ruled? Whether people are willing to spend a lot of money on self-driving vehicles is also a big question, such as the Arcfox Alpha S new HI version autonomous vehicle mentioned above, which is worth about 400,000 RMB. People may not want to pay that much for autonomous driving. Therefore, this paper will focus on the advantages of autonomous driving technology, the existing disadvantages, and the future direction of development: whether it can replace manual driving.

## 2. Advantages of Autopilot

### 2.1. Environmental benefits

With the development of autonomous driving technology, there will be fewer traffic accidents and fewer traffic fatalities. Road capacity will also increase with technology development, which means less congestion and less energy consumption. In addition, pollution emissions will be reduced. These advantages are crucial because China consumed 4.64 billion tons of conventional coal for energy in 2018 and produced 11.6 million tons of carbon dioxide. The development of cleaner and more convenient transportation modes is necessary for China, a country with a large population. The seventh national census of China shows that there are 1.41 billion people in China, with 890 million people of working age between 16 and 59 years old. This means that at least 900 million people need transportation. So even if the market penetration rate of one hundred 90% of the self-driving technology can only reduce 50% of the current environmental pollution costs and 9.66% of energy consumption [1]. With a large number of people in China, such a reduction is also very significant.

### 2.2. Social and individual benefits

Autonomous driving can free the driver. Drivers will no longer break into a tizzy over malicious jams from other vehicles. Anger in a high-speed car can seriously affect road safety. Autonomous driving will make car driving more regulated and less irritating and will reduce driver involvement while driving, making them less likely to get angry. Overall, it will improve driving comfort and road safety. If public transportation also frees up drivers through self-driving technology, the operating costs of public transportation will be reduced it. Autonomous driving can also improve people's travel comfort. In addition to roads being less congested and people not feeling uncomfortable because of sudden braking, self-driving buses will be more punctual, safer, and provide better service. The vehicle would also not have to remain the same and thus have more passenger space, as there would be no driver.

According to the World Health Organization, there are 1.25 million fatalities and more than 20 million injuries globally due to traffic accidents each year. Mortality rates are particularly high among men (who account for three-quarters of all road deaths) and among 15- and 29-year-olds (for whom road accidents are most important). Traffic accidents are the leading cause of death. In Australia, there are approximately 1,200 road fatalities and 34,000 hospitalizations for injuries per year [2]. The World Health Organization estimates that traffic losses in developed countries such as Australia account for about 2% of GDP (about $18 billion). Almost all traffic accidents (93%) are caused by human error. Speeding, drinking, and distracted driving are common causes. Autonomous drivers can be programmed to obey speed limits, and their 360-degree field of view and fast reaction times can completely eliminate traffic accidents caused by human error. Completely eliminate traffic accidents caused by human error. Therefore, around 90% of accidents can be avoided by implementing full vehicle automation. This saves more than $16 billion annually and frees up thousands of hospital and rehabilitation facility beds. The benefits of accident prevention alone, therefore, warrant consideration of the role of public health in advocating and facilitating a rapid transition to autonomous driving. Shorter stopping distances and smoother lane changes minimize road problems and reduce fuel and brake consumption. Achieving a high degree of automation is expected to reduce fuel consumption by 25-80%, with the potential benefit of reducing the raw materials, processing, and transportation required to manufacture and deliver vehicles. Based on how long most cars are parked, we estimate that one shared self-driving car could replace 11 conventional cars. By reducing the total number of vehicles required, the required parking spaces can also be significantly reduced. Ultimately, the net effect of self-driving cars could nearly double highway capacity, "adding more roads to reduce widening pressure, leaving more room for cyclists, trees, and nature in the area [3].

### 2.3. Economic benefits

A new word, "SERV good," is introduced by Tien et al. to describe a physical good that is supported by services that increase its usefulness, intelligence, adaptability, and customizability. The term "sensed SERV good" refers to a SERV good that has additional services available to users as a result of the addition of greater computation and communication capabilities. The stages of a country's economic development, according to Tien et al., include mechanical and electrical (relating to the manufacturing of goods), informational, and internet (corresponding to sensed services). Self-driving cars are thus among the most promising candidates, along with other industries, for perceived services that have developed during the past ten years [4]. Over the past decade, the autonomous automotive industry has attracted numerous investors from the automotive industry, academia, and other businesses. According to Brookings Institution, about $80 billion was invested in different transactions (both commercial and corporate) between 2014 and 2017 [5]. It is also important to analyze the economic impact caused by self-driving cars in different industries. Without losing its generality, the emergence of autonomous cars directly impacts the automotive industry, both positively and negatively. For example, driverless cars will reduce the cost of trips to the US to approximately $0.57 to $0.74 per mile [6]. Another strategic shift is likely to take place in the automotive industry, with more investment in software and artificial intelligence than in the cars themselves. Similarly, the software industry is expected to grow substantially, especially in the areas of controls, artificial intelligence, deep learning, and computer vision. Total revenue in this area is estimated at $26.4 billion for self-driving cars in the U.S., including $680 million to $15.8 billion in software revenue (through 2040); revenue from other technologies, such as digital mapping services, will reach $10.6 billion by 2040. Similarly, autonomous car technology (from a healthcare company's point of view) will have a negative impact on the health sector as accident rates decline, leading to lower hospital visits. However, from the user's point of view, this will reduce user expenses.

# 3. The existing problems of autonomous driving

## 3.1. Technology problem

Despite the many benefits of autonomous driving, others talk about the existence of some problems. The most obvious of these is the lack of robustness and high latency of autonomous driving technology at this stage. This will take a long time to solve [7]. Second is the problem of decision planning. How to get the optimal decision? The two commonly used: are rule-based and artificial intelligence. Based on rules such as Baidu Apollo, more than 3,000 scenes, more than 10,000 if else, very clear but difficult to cope with unconsidered scenarios; artificial intelligence is generally deep learning, reinforcement learning, etc., can self-learning evolution, but is a pure black box, very easy to appear outside [8]. Even training 100 million times can not guarantee that the first billion and one is in line with expectations. The way to get the optimal trajectory is essentially a constrained nonlinear optimization problem. This mathematically cannot guarantee to find the optimal solution to a bunch of constraints (speed constraints, acceleration constraints, actuator change rate constraints, obstacle constraints, etc.). Or perhaps with the widespread use of autonomous driving, car accidents can easily be created as soon as hackers break into the onboard computers [9].

## 3.2. Ethical and safety problems

There are philosophical issues with autonomous driving, such as what to do when a self-driving car encounters a tram problem. Of course, it is best to keep smart cars from encountering such problems. But we have to imagine that such problems exist just in case. Suppose you are driving a driverless car and the brakes fail, and there is a fork in the road to the left and a fork in the road to the right, and Al's choice now is either to save five people or save one person, which would hit the AI's intelligence blind spot, not to mention whether Al should save the driver. I could give you a more detailed example. When self-driving cars carry a car full of scientists who could change the future, should our programmers program the cars to protect themselves first? It may kill some ordinary people in the process of driving. So if the car is filled with ordinary people, is it a priority to protect pedestrians? It seems unreasonable because everyone has the right to live. The people's right to life and health is guaranteed by the laws of the state [10].

The maps on the market nowadays are also not detailed and real-time enough. Some roads may be undergoing repair and not updated on the map, so there is a possibility of an accident. Or the change interval of the traffic light has changed, which may also make cars make a wrong judgment and then run the red light [11].

# 4. The future direction of development

At present, global autonomous driving is in a critical stage of transformation from L2 to L3 level, and the mass production of high-level autonomous driving products is accelerating. From the perspective of landing scenarios, domestic low-speed autonomous driving has started commercial landing in some specific scenarios, such as unmanned delivery, unmanned sanitation, and unmanned mining vehicles, etc. The Robotaxi and Robobus have also started trial operations in some areas, and the industry as a whole is still in the early stage of explosion.

On the other hand, the automotive chip should also be the direction of strong development. MCU (Microcontroller Unit) is commonly known as a microcontroller, and SoC is System on Chip, which further promotes the rapid shift to SoC chips as the demand for algorithmic computing power rises. SoC chips have become the high point of the intelligent driving race, although autonomous driving mostly used MCUs a few years ago [10].

One last question, will autonomous driving replace manual driving? In the long run, there is a good chance that autonomous driving will replace manual driving. Because the technical difficulties of autonomous driving will be overcome, the relevant laws will be improved, and the manufacturing cost will be gradually reduced. In the short term, it seems that it will probably develop in the freight industry first because it will not involve human life, and the cost of making mistakes is lower. Because for environmental detection, there are three primary methods: laser detection, visual detection, and radar detection. In laser detection, the concepts of reflection time and reflected signal force are used to generate cloud data from target points, such as position, condition, and form. Light detection and LIDAR are used to avoid collisions and situations requiring emergency braking. The lidar triggers numerous laser pulses per second. These impulses are reflections of interactions with the objects around them. This allows you to create a three-dimensional representation by performing calculations based on the speed of light and the distance traveled by the pulse. Radar sensing measures distance by calculating the time it takes for waves emitted by radar sensors to return, and short-range vehicle-to-vehicle communication is used by self-driving cars so they can communicate with their surroundings and other vehicles. For this communication to take place, the architecture must be duplicative and in real-time. State-of-the-art infotainment systems and uncompressed data from ADAS sensors require a network bandwidth of about 12-24 Gbps. VANETs were created by applying the principles of MANETs - the spontaneous creation of wireless networks for mobile devices - to the automotive field. Connected cars use AVNEET for communication with one another. To facilitate the integration of autonomous vehicles into existing VON technologies, autonomous vehicles need to use the same communication standards currently used for VON technologies. It's all technically difficult [12].

## 5. Conclusion

This article describes the state of the development of self-driving technology and some guesses about the future development of self-driving. Generally speaking, the current advantages of autonomous driving are mainly reflected in the liberation of the labor force and the increase in road flux. Machines may be able to make calmer judgments than humans in harsh external environments, thus achieving greater benefits and safety. Autonomous driving still has some legal and technical shortcomings, especially in the ethical aspect. It is hard for machines to solve moral problems that no human being can decide. In the future, autonomous driving may continue to improve in comfort and safety. This article gives an overview of the state of the art in autonomous driving technology and offers additional advice for speeding up the car automation process. This article gives an overview of the state of the art in autonomous driving technology and offers additional advice for speeding up the car automation process.

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