Autonomous Driving

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Division of reporting

Collaboration:	Introduction, Recommendations for Autonomous Driving
Jian Yao:	Placeholder in passenger, Impacts on passenger, Similar issues and concerns in algorithmic hiring, Compare findings with initial conceptual investigation
Chenkai Shen:	Demands and goals, Placeholder in government, Impact on government, Concerns on Autonomous Driving (government)
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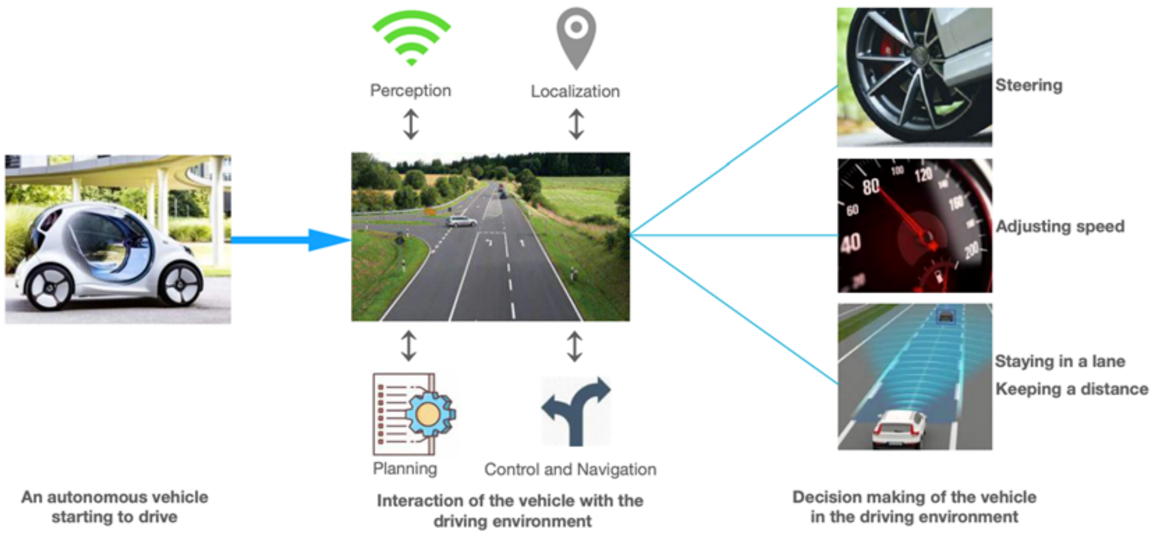
Introduction

With the continuous development of the automobile industry and intelligent electronic devices, autonomous driving has become a very popular direction. Compared with traditional car systems, autonomous driving systems are more intelligent and mainly consist of multiple complex sensors, such as on-board radars and cameras. and ultrasonic infector. These sensor systems can provide cars with comprehensive and accurate road information and make road decisions to avoid hazards and collisions with pedestrians and other vehicles.



Autonomous driving restricted vehicles are new energy vehicles or fuel vehicles. But the main difference in autonomous driving is the change in driving decisions. With the help of autonomous driving, the driver does not need to be too involved in decision-making, or not involved in driving at all. With the continuous development of autonomous driving technology, it has been successfully implemented in many fields and is now gradually moving towards operation in general road environments.

Autonomous driving technology brings various conveniences to society. First, autonomous driving can reduce traffic accidents and improve overall road safety by introducing human error. In addition, autonomous driving does not require the driver to rest and can make better use of the vehicle. And autonomous vehicles have the ability to optimize traffic flow, reduce congestion and increase transportation efficiency. With the help of a variety of sensors, autonomous driving can obtain more environmental information and make accurate decisions. In this report, we will discuss three stakeholders and users of autonomous driving technologies, they are passengers, manufacturers and the government.

Demands and goals

The evolution of autonomous driving spans a spectrum of automation levels, from basic driver assistance systems (Level 1) to fully autonomous vehicles requiring no human intervention (Level 5). This ongoing development is marked by diverse companies progressing at various stages in the implementation of autonomous features (Kyriakidis, 2017). Central to the objectives of autonomous driving is the paramount goal of enhancing safety. Human error, a significant contributor to road accidents, stands as a primary target for mitigation through autonomous technology.

Efficiency and convenience are key drivers, with autonomous vehicles designed to optimize traffic flow, alleviate congestion, and deliver a more streamlined and convenient transportation experience. Beyond these improvements, the scope of autonomous driving extends to enhancing accessibility. By providing a viable transport option for individuals unable to drive due to age, disability, or other reasons, autonomous driving holds the potential to significantly broaden mobility opportunities. Safety improvement represents a fundamental outcome of autonomous driving, addressing issues such as distracted driving and impaired judgment. The resulting reduction in traffic accidents can reshape the landscape of road safety (Raval, 2017). Additionally, the optimization of traffic flow contributes to greater traffic efficiency and overall road network performance. Autonomous vehicles also serve as a solution for increased mobility, offering transportation alternatives for the elderly and people with disabilities.

Furthermore, the environmental impact of autonomous driving cannot be overlooked. Efficient driving patterns facilitated by autonomous systems, coupled with the potential for electrification in autonomous fleets, stand to contribute substantially to the reduction of fuel consumption and greenhouse gas emissions. As autonomous driving continues to progress, these multifaceted objectives underscore its potential to redefine not only the driving experience but also the broader landscape of transportation and environmental sustainability.

Placeholder in passenger

The advent of autonomous driving technology represents a seismic shift in the automotive landscape, steering us towards a future where the human role transitions from active driver to passive passenger. Here, the driver transforms into a monitor, a caretaker of a system that promises to navigate the intricacies of roadways with precision surpassing human capability. Passengers, now free from the task of driving, become recipients of a service that offers convenience, accessibility, and, importantly, a commitment to safety through technological prowess. This breakthrough, powered by a confluence of sensors and AI, heralds a new era of mobility where vehicles are not just transport mediums but intelligent entities capable of perception, decision-making, and learning.

Stakeholder	**Direct User**
Description	people in autonomous vehicles
Attributes	People of any age or with limited physical ability
Needs	Security, Easy of use, Controllability
Skills	Detailed understand of autonomous driving and solve an emergency
Role in Autonomous Driving	Direct experience and feedback

Impacts on passenger

The deployment of autonomous driving brings forth pressing ethical challenges centered on fairness, privacy and security, transparency and accountability. Ensuring that algorithmic decisions are non-discriminatory, protecting sensitive data collected, and clearly defining liability in an accident are critical to passenger trust and advancing autonomous driving technology.

Fairness in the context of autonomous driving technology encompasses several dimensions, which involve the avoidance of bias, the equitable distribution of benefits, and the accessibility of the technology to all segments of society. Autonomous driving systems rely heavily on algorithms that process data to make decisions. These algorithms can potentially reflect or amplify societal biases if the data they are trained on is not representative of all passengers. The benefits of autonomous driving, such as increased safety and enhanced mobility, should be available to all segments of society (i.e. affluent or poor areas). According to Intellias, one ethical challenge is ensuring that the deployment of autonomous vehicles does not neglect communities that often have less voice in technological developments (*Intellias, n.d.*). Fairness also means ensuring that autonomous vehicles are accessible to passengers with disabilities or those without the means to own such vehicles. This could involve designing user interfaces that are usable by passengers with a range of abilities and offering shared autonomous vehicle services to ensure that the technology is not exclusive to those who can afford personal autonomous vehicles.

Privacy and security in the domain of autonomous driving are about safeguarding the personal and operational data of users from unauthorized access and ensuring the integrity of autonomous driving systems against various forms of cyber threats. The systems generate and process vast amounts of data, some of which are personal and sensitive. This can include location data, travel patterns, biometric data (if used for passenger identification or health monitoring), and personal preferences. Ensuring privacy means this data must be handled with the utmost care, ensuring that it is used only for the intended purposes and not shared without consent. Security concerns revolve around protecting the vehicle's systems from malicious attacks that could compromise functionality. All self-driving vehicles depend on sensor and software technology, both of which are sensitive to manipulation. Physical sensor manipulation can be performed in order to make the vehicle dysfunctional or (worse) to hurt or kill its passengers (Petit & Shladover, 2015). Therefore, the impact of safety and privacy on passengers in autonomous driving systems is huge.

Transparency in autonomous driving systems is a crucial aspect that goes hand in hand with building trust between the technology and its users. It involves open communication regarding how the vehicles operate, make decisions, and interact with their environment. Transparency ensures that users are not left in the dark about the functioning of the vehicles they entrust their lives to. A transparent autonomous driving system provides clear information on how it perceives its surroundings, interprets data, and makes driving decisions. For example, when an autonomous vehicle decides to change lanes, the system can inform the passenger of the reasons behind this decision, such as the presence of a slower vehicle ahead or an upcoming exit. This type of transparency is vital for safety, ensuring that users are aware of any limitations or malfunctions that could affect the vehicle's performance.

Accountability in the context of autonomous driving pertains to the assignment of responsibility when something goes wrong, such as an accident or system failure. It's about determining who or what must answer for the consequences. This is a complex issue due to the involvement of various entities including the manufacturers, software developers and even the passengers themselves. Autonomous vehicles present new challenges for accountability because they shift decision-making from humans to algorithms. When an autonomous vehicle is involved in an accident, the traditional approach of assigning blame to a human driver may no longer apply. Instead, we must consider the role of the vehicle's programming, the conditions under which its sensors operate, the possibility of a cyberattack compromising the vehicle's systems, as highlighted in the ResearchGate article (*Boloor, 2019*). However, it is also possible that the passenger misoperated the autonomous driving system or intentionally did so in an emergency. From an ethical standpoint, accountability is tied to the notion of justice, ensuring that harm can be redressed. Legally, accountability involves navigating an emerging field of law that must balance innovation with consumer protection. Without clear accountability, the public may be reluctant to adopt AVs, no matter the potential benefits.

Similar issues and concerns in algorithmic hiring

In the domain of algorithmic hiring, tools such as automated resume analysis and AI-driven applicant screening have been adopted to improve efficiency and ostensibly reduce human bias in recruitment processes. However, these technologies have encountered significant challenges concerning fairness and accountability. Raghavan and Barocas (2019) at Brookings documented how algorithmic hiring tools can unintentionally reproduce and amplify biases present in the training data, leading to discrimination against certain groups of applicants. This issue of fairness is further compounded by the lack of transparency around how these algorithms function and the criteria they use to evaluate candidates.

Addressing these biases requires a multipronged approach, including the use of de-biasing techniques where models are tested for disparate impacts and refined to eliminate discriminatory factors. Furthermore, to tackle the issue of accountability, vendors and employers are exploring the development of alternative algorithms that could perform equally well without introducing bias. Despite these efforts, challenges persist in ensuring that the models are truly fair and do not conceal poor performance for minority populations. Moreover, solutions to mitigate disparities in algorithmic decision-making often necessitate knowledge of legally protected characteristics, which introduces a risk of perpetuating disparate treatment. The focus on reducing disparate impact must also consider the risk of concealing differential validity, where a model's accuracy varies across different groups. To mitigate this, a combination of diverse data sets and a broader range of model inputs is required to enhance the predictive accuracy for all candidate profiles.

These findings in algorithmic hiring parallel concerns in autonomous vehicle technology, where fairness in algorithmic decision-making and accountability for outcomes are pivotal. The lessons from the hiring domain indicate the necessity of rigorous testing, transparency in algorithmic processes, and continuous refinement to address biases—approaches that are equally vital for the development and deployment of ethical autonomous vehicle systems.

Compare findings with initial conceptual investigation

Comparing the findings from the detailed analysis of algorithmic hiring tools with the initial conceptual investigation into autonomous driving, several parallels emerge:

Firstly, the concern was how autonomous driving algorithms might reflect societal biases. This is mirrored in hiring algorithms, where biases in training data led to unfair candidate screening. Both domains face the challenge of ensuring algorithms do not perpetuate existing inequalities.

Secondly, the initial investigation into autonomous driving highlighted concerns about accountability in decision-making. Similar issues are evident in hiring algorithms, where there is a lack of transparency and difficulty in determining responsibility for biased outcomes.

In both cases, the critical analysis reveals a need for robust ethical frameworks, transparent algorithms, and accountability mechanisms to address these challenges effectively.

Placeholder in Manufacturer

As the providers and developers of autonomous driving technology, manufacturers are directly responsible for the development, design, production and testing of autonomous vehicles. Usually, they are companies with rich resources and professional knowledge in the fields of engineering and data analysis, which also have a diverse workforce worldwide.

Stakeholder	**Manufacturer**
Description	The company specializes in manufacturing and promoting autonomous vehicles, aiming to realize the automation and innovation of the future transportation system.
Attributes	The main attributes include technological innovation, security concerns, compliance, user experience optimization, and marketing capabilities.

Needs	They urgently need innovative technological solutions to maintain competitiveness.
Skills	They possess advanced engineering design, data analysis, and system integration skills.
Role in Autonomous Driving	Responsible for R&D, design, manufacturing and promotion of autonomous vehicles, promoting technology development, ensuring vehicle safety and performance, meeting market demand, cooperating with government regulators to ensure compliance, and shaping the direction of future transportation systems.

In the rapidly developing field of autonomous vehicles, manufacturers are at the forefront of technological innovation and ethical challenges. In essence, the driving force of them is the pursuit of innovation and safety. The development of autonomous driving technology is expected to completely change transportation, provide unprecedented levels of efficiency, and reduce traffic accidents. Manufacturers like Tesla and Waymo are not just selling cars, they provide a safer and more interconnected vision for the future [1]. However, this vision is not without ethical significance. One of the main problems is the decision algorithm of autonomous vehicles. When collision is inevitable, the dilemma of how to give priority to life danger for autonomous vehicles puts manufacturers in a position where they must balance technological progress and moral responsibility.

Moreover, gaining consumer trust remains the direction of manufacturers' efforts because a major obstacle to the use of autonomous vehicles is public acceptance.[Waung, 2021] Despite strong technical strength, public doubts about the safety of autonomous vehicles still exist. Therefore, manufacturers must not only invest in technology, but also establish public confidence through transparency and consistent safety records.

In summary, autonomous vehicle manufacturers affect the performance and safety of their products who are not only users of this technology, but also key stakeholders. They are dealing with a complex ethical and regulatory environment, striking a balance between innovation and responsibility, and are at the center of the transportation revolution. As they move forward, their decisions will not only shape the future of travel, but also the ethical framework within which this technology operates.

Impact on Manufacturer and public base on sensor technology

With the development of society, autonomous driving technology has become increasingly popular and the potential impact of it on manufacturers and the public is multifaceted. According to the survey, the number of road traffic fatalities reached 1.35 million, of which 90% were caused by human error [Yeong, 2021]. In order to alleviate and avoid this situation, manufacturers have invested heavily in the development of autonomous driving technology, and the use of sensor technology which is the important fundamental of autonomous driving technology has greatly improved the stability and feasibility of autonomous vehicles. Sensors play a crucial role in autonomous driving, which are fundamental to the perception of vehicle surroundings in an automated driving system [Yeong, 2021]. This includes radar, cameras, LiDAR, and ultrasonic sensors. Cameras are used for visual recognition, radar is used for ranging and speed detection, and LiDAR provides high-precision 3D environment mapping.

The real-time data provided by sensors enables autonomous vehicles to better understand road conditions and traffic conditions. This helps vehicles make more accurate decisions, including lane changes, deceleration, acceleration and improve their ability to quickly identify obstacles, other vehicles, and pedestrians, thereby ensuring overall road safety and reducing traffic accidents. Manufacturers adopting advanced sensor technology can enhance their competitiveness in the autonomous driving market. Safe and reliable research products can attract consumers and partners at all times, and manufacturers increase sales and visibility by promoting their research results.

However, advanced sensor technology is necessary for autonomous vehicles to have good performance. This also potentially leads to a sharp rise in the manufacturing cost of autonomous vehicles, which increases the investment cost of manufacturers. Using a large number of test scenarios and data to test and maintain sensors is also one of the crucial tasks of manufacturers, which undoubtedly increases the complexity and duration of research and development of autonomous driving technology. What’s more, although manufacturers will minimize the error of automatic vehicle operation, it is also impossible to fully ensure the safety of automatic vehicles. When accidents occur, the issue of responsibility allocation can also become a major challenge for manufacturers and the public. Once not handled properly, it will seriously affect the manufacturer's level of trust in the public.

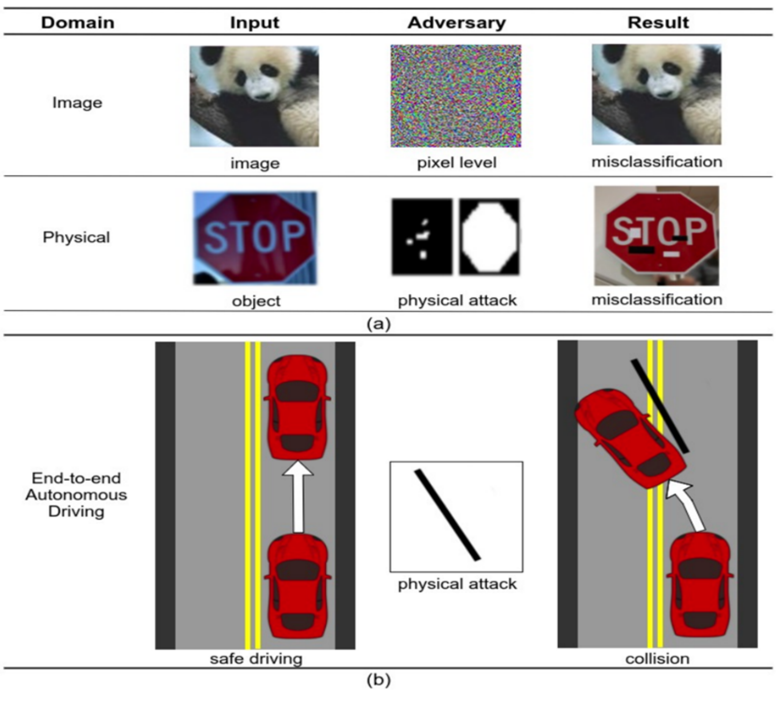
From the ethical principle of fairness, sensors in autonomous driving technology help protect the lives and health of all road users. This is in line with the principle of fairness, as it helps to ensure that everyone enjoys similar security protection and is not affected by their personal characteristics or background. It can also bring some negative impacts, such as people in some impoverished or special areas not enjoying the benefits of this technology, which leads to social inequality. Unequal resource allocation may damage the company's reputation and sales.

For Inclusion, inclusive design can improve user experience, make technology easier to use, and be more friendly to people with physical disabilities, the elderly, and other special groups. This helps to attract a wider user base and improve user satisfaction. Developing and implementing inclusive sensor technologies may incur additional costs while targeting specific groups or market segments may bring market risks. If the market does not meet expectations, manufacturers may face risks of declining sales and poor investment returns.

Therefore, Sensor technology and autonomous driving technology are closely related, and their impact on manufacturers and the public can be mixed. Manufacturers need to strive to ensure that these technologies provide equal opportunities and protection for all levels of society, not limited to specific social groups.

Existing issues: Adversary Attacks/Examples

Adversarial Examples are specially designed input samples in the fields of artificial intelligence (AI) and machine learning, which intentionally add small, often imperceptible disturbances to make AI systems make incorrect judgments or behavior.In the realm of autonomous driving, the consequences of such attacks could be catastrophic, potentially leading to accidents, injuries, or worse. Malicious actors leverage these examples to exploit vulnerabilities in the AI's perception and decision-making processes.



Consider a scenario where an adversarial example manipulates the perception system of an autonomous vehicle, causing it to mistake the stop sign for a yield sign (figure a). If there is no explanation for the transparency provided by artificial intelligence, this misunderstanding may lead to vehicles making dangerous decisions, which may endanger lives. In another example (figure b), This is a description of potential physical attacks on the end-to-end auto drive system. Malicious actors cheat or interfere with the auto drive system through physical means. This type of attack mainly targets the perception system of vehicles, especially those based on deep learning and machine vision. For example, modifying or creating false road markings, such as lane lines, may lead the auto drive system to misjudge the road conditions or lane boundaries or make a stop sign be incorrectly identified as a speed limit sign by pasting stickers with specific patterns. Such attacks show the security challenges and hidden dangers that auto drive systems may encounter in the real world. They also emphasize to manufacturers that when designing and testing an auto drive system, they need to consider these potential security threats and take corresponding defensive measures.

Placeholder in government

In the landscape of autonomous driving, the government assumes a crucial role as a central figure, wielding substantial influence in shaping and regulating the deployment of autonomous vehicles. Government entities and relevant agencies emerge as both users and stakeholders in the developmental and implementation phases of autonomous driving technologies. A key facet of the government's role lies in its authority to regulate and establish the legal framework for autonomous vehicles. This involves the setting of standards pertaining to safety, performance, and ethical considerations, ensuring that autonomous systems adhere to established norms.

Stakeholder	**Government**
Description	Regulatory body responsible for overseeing autonomous driving within a jurisdiction.
Attributes	Authority to enact legislation, establish Safety Standards
Needs	Ensure public safety, Regulate the development, deployment, and use of autonomous technology

Skills	Legal expertise, Policy-making capabilities, Enforcement mechanisms
Role in Autonomous Driving	Setting and enforcing regulations to govern the safe and ethical integration of autonomous driving technology into the transportation ecosystem.

In order to perform regulatory functions on autonomous vehicles, the government must hire experts to fully understand the technology that supports autonomous driving and conduct regular inspections of autonomous vehicles. By analyzing and auditing existing autonomous driving systems, the progress of autonomous driving technology can be better maintained and monitored, and the public can understand the responsibility and safety of autonomous driving.

In addition, the government should take the initiative to assume some responsibility for autonomous driving accidents. Because the government allowed these vehicles to drive on the road during the audit process of autonomous driving, it acquiesced in the relevant responsibilities or ignored some possible dangers. The government's role as a stakeholder is encapsulated in its need for legal expertise, policy-making capabilities, and enforcement mechanisms to ensure the effective integration and regulation of autonomous driving within the broader societal framework. In summary, the government's multifaceted involvement, as both a regulator and a user, underscores its pivotal position in the advancement and governance of autonomous driving technologies.

Impact on government

The advent of autonomous driving technology brings about a substantial impact on government and related institutions. A primary consideration is the enormous volume of data generated by autonomous vehicles, encompassing details about their surroundings and passengers. In response, governments are compelled to institute robust data governance and privacy regulations. These measures are essential to strike a balance between safeguarding individual rights and facilitating the effective functioning of autonomous systems. Establishing clear guidelines for data management becomes crucial to address concerns related to privacy, security, and the responsible use of the wealth of information amassed by autonomous vehicles.

Another facet of impact involves the decision-making capabilities embedded in autonomous systems. With vehicles programmed to make split-second decisions in intricate scenarios, governments and regulatory bodies play a pivotal role in defining ethical guidelines for the algorithms governing these decisions. It becomes imperative to ensure that the algorithms align with societal values and legal standards, reflecting the government's responsibility to uphold ethical considerations in the deployment of autonomous driving technology. In essence, the impact on government extends beyond the regulatory realm to encompass the formulation of ethical frameworks and privacy regulations necessary to navigate the transformative landscape introduced by autonomous vehicles.

Concerns on Autonomous Driving (government)

In the dynamic landscape of autonomous driving, the interaction between government agencies and autonomous technologies raises a spectrum of concerns that warrant careful consideration. Foremost among these is the concern for fairness, emphasizing the need to ensure an equitable impact and distribution of benefits arising from the deployment of autonomous vehicles. This involves guarding against any disproportionate effects on specific societal groups or geographical regions, thereby promoting inclusivity in the benefits derived from this transformative technology (Divakarla, 2019). Transparency emerges as another crucial facet, demanding openness in the entire lifecycle of autonomous systems, spanning development, testing, and deployment. Establishing transparency is paramount for building trust among the public and regulatory bodies, fostering a sense of confidence in the responsible integration of autonomous driving technologies.

Addressing the challenge of explainability in autonomous systems is equally imperative. This pertains to making the decision-making processes of these systems understandable and clear, particularly in cases of accidents or unexpected behavior. Achieving clarity in how autonomous vehicles arrive at decisions is fundamental for instilling confidence and comprehension, both essential elements in fostering public acceptance.

Recommendations for Autonomous Driving

Yes, we should adopt and deploy this technology. However, adopting and deploying autonomous driving demands meticulous consideration of the ethical challenges involved and how to deal with the potential risk.

In 2021, the U.S. National Transportation Safety Board (NTSB) criticized the regulatory approach of the National Highway Traffic Safety Administration (NHTSA), believing that NHTSA is too lax in its supervision of driver assistance systems and autonomous driving technology . The NTSB paid particular attention to safety issues in road testing, citing Tesla and Uber crashes as examples. To this end we recommend adding detailed guidelines and standards to more proactively guide the entire regulatory process. We recommend introducing instruments for real-time recording of car status into the autonomous driving system to ensure that driving information can be saved for at least one month. This recording instrument should be able to capture various parameters of the vehicle, such as sensor data, vehicle speed, steering wheel angle, etc. This information can not only provide strong evidence when an accident occurs and help analyze the cause of the accident, but can also be used to locate and solve faults when problems occur in the system.

For fairness, it involves several strategic steps, including the collection and use of unbiased data, the implementation of inclusive design principles, regulatory oversight, and continuous monitoring for discriminatory outcomes. An example of addressing fairness in technology comes from the realm of AI in healthcare. Algorithms used for patient care and treatment recommendations have been scrutinized for fairness to ensure they do not inadvertently favor one group over another. This involves using diverse patient data and regularly reviewing outcomes for signs of bias. Such practices can be mirrored in the autonomous driving sector by using diverse driving data and monitoring for equitable performance across different populations and geographies.

Finally, to resist adversarial examples, interpretable AI is crucial. By making the decision-making process of artificial intelligence transparent, we can better understand how it is fooled by these examples and take measures to improve its resilience. Adversarial training is also an effective method. This means introducing adversarial examples during the training process of the model to enable it to adapt to these attacks. This can help the model better resist adversarial attacks and improve its performance in the face of threats. Moreover, manufacturers can use multiple types of sensors (such as cameras, radars, LiDAR) and fuse their data to reduce dependence on single sensor data. Multi sensor fusion can improve the overall perception ability of the system and reduce the risk of being deceived by a single type of adversarial attack.

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