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Self-Driving Cars

Self-driving cars are a staple of futuristic society, but with companies like Tesla and Waymo leading the way, the integration of this technology into the present day may be rapidly approaching. The largest draw of self-driving cars is improved safety through full automation, reducing injuries and fatalities caused by one of the most common methods of transportation. In addition, self-driving cars are believed to carry mobility, economic, environmental, and efficiency benefits as well (NHTSA, 2021). While there are still numerous engineering-related hurdles that must be overcome before cars become fully autonomous, there are also many other obstacles standing in the way. Before self-driving cars can be adopted, both engineers and users must answer questions regarding how safety should be defined, what it means to make ethical decisions on the road, and how this technology will carve out its role in society.

Self-driving cars operate using a mix of complex hardware and software. A wide variety of sensors, including radar, video, and LIDAR provide information on the car's surroundings, while software developed using sophisticated algorithms and machine learning guides the car. As of now, self-driving cars are not yet fully autonomous; they require some degree of human control under certain circumstances, and are classified as Level 3 autonomous vehicles. When they come across situations that they do not know how to deal with, the driver is expected to take control. Under these circumstances, a collision is nearly inevitable by the time the human can react. The ultimate goal, of course, is for the human element to be phased out completely, first in

controlled settings to achieve Level 4 classification, and finally in general use for Level 5 classification (Hern, 2021). Before this can happen, most of the technology backing self-driving cars must be analyzed thoroughly and improved. From a hardware perspective, there are questions regarding how much LIDAR interference from other self-driving cars will affect the car's steering, or how accurate sensors will be in the face of inclement weather. From a software perspective, engineers will need to figure out if their programs can handle the stress of bumper-to-bumper traffic conditions or the non-verbal cues associated with the average driving experience. As of now, human drivers serve as a fallback for these kinds of "edge-case" conditions, but when engineers manage to make full automation a reality, they will bring a host of societal benefits along with it.

In the current state of the world, cars are one of the most common methods of transportation, dominating daily activities, like commuting (Richter, 2022). At the same time, they are also one of the most dangerous ways to travel, causing an average of 11.7 deaths per 100,000 people in 2020 (IHS, 2022). Despite numerous advances in automobile safety, such as automatic emergency braking and electronic stability control, fatalities per motor vehicle have remained relatively stable over the past two decades, showing how large of a role human error plays (NSC, 2022). Even for self-driving cars themselves, human error is the largest obstacle. The most difficult hurdle for engineers to overcome in developing full automation is the unpredictable interactions between the autonomous vehicle and humans, both drivers and pedestrians (Hern, 2021). In an ideal world, full automation could be the ultimate safety measure, removing human flaws like slow reaction time and poor judgment from the road. Theoretically, added benefits may include increased mobility for those unfit to drive, improved traffic through reduction of stop-and-go conditions, and economic relief from the decrease in accidents

(NHTSA, 2021). Although the costs of development are clearly offset by the numerous benefits that self-driving cars offer, the philosophical implications of this new innovation are much harder to address.

As with most revolutionary technologies, the introduction of self-driving cars will force many related ethical and social considerations into the forefront of mainstream discussion. Perhaps the most infamous scenario related to self-driving cars is the motorcycle problem. While driving, the car comes across a situation with only two options: hit a motorcyclist on its left who is wearing a helmet, or hit a motorcyclist on its right who is not. Under these circumstances, the engineers need to decide which choice is more ethical. Even worse, this situation can be generalized into a variety of alternate scenarios. Cars may come across instances where they have to decide between a lone individual and a group of people or a homeless man versus a wealthier looking businessman (Kirkpatrick, 2016). In the same line of thought, the engineer also needs to make the ethical and practical decision of who to prioritize between the driver and other external entities (Maxmen, 2018). Looking beyond the decision-making of the self-driving car, there are also many issues regarding how they may fit into the current framework of society. Since cars have not reached full automation yet, accidents involving self-driving cars can technically be blamed on human error, shielding manufacturers from responsibility. However, the critical failures that result in the need for human intervention very rarely leave enough room for the driver to recover, so the entity truly at fault can become difficult to determine (Hern, 2021). Even once full automation is achieved, external human error can still affect self-driving cars. Due to this, it is clear that self-driving cars will be most effective when human-operated vehicles are off the roads. This brings up another issue in that the technology for self-driving cars is expensive, and their high cost will inevitably act as a barrier to their adoption. In order to fully

exploit the benefits of self-driving cars, society will need to address how to make them accessible to the wider population (Nunes, 2019).

The most pressing issue regarding self-driving cars is how they should be programmed to make decisions. In the motorcycle example, the car may choose to swerve left, hitting the motorcyclist with the helmet. This motorcyclist is significantly more likely to survive the collision, so from a utilitarian perspective, this would be the ethical choice. However, this would mean the programmer that makes this decision is indirectly punishing that motorcyclist for making the safe choice and wearing a helmet. They could avoid this by having the car swerve right, but that decision is more likely to cause a fatality. To add another wrinkle, the car could be right behind a large truck and can decide to simply rear-end the truck instead of swerving. Now, the decision becomes a matter of prioritizing the safety of the motorcyclists or the safety of the driver. Since motorcycles are significantly more vulnerable than automobiles, rear-ending the truck is least likely to result in a fatality, meaning the safety of others is prioritized. Despite this probably being the best option at the moment, this creates a situation where drivers have to buy-in to purchasing a car that puts their safety second (Kirkpatrick, 2016). This dilemma is explicitly addressed in a survey conducted in 2016, where respondents paradoxically said that they would prefer self-driving cars to prioritize pedestrians over the driver, yet would be reluctant to buy a car that behaves in this way (Maxmen, 2018). Many other ethical concerns can be investigated using the same framework, proving how critical decisions like this can be for the performance of self-driving cars. In reality, a single, correct choice does not exist for a majority of these problems. Instead, these decisions must be evaluated with the knowledge that people from different backgrounds value different things (Maxmen, 2018).

In these scenarios, the outcome would have been determined long before the incident, back when the engineers programmed the car and decided which choice to make. This creates a situation where the authority responsible for making the final decision is unaware of the exact circumstances surrounding that decision. The average self-driving car driver will not have a say in the decision-making process, despite the fact that they are the ones most vulnerable to the consequences of the decision. In order to make sure that these engineers act in the best interest of their users, it is critical that the decisions they make during development are made transparent for the public. Not only would this information keep engineers accountable, but it also serves to give drivers a more complete picture of the technology as a whole, and what to expect in the process of using it (Kirkpatrick, 2016). It would also allow drivers to be part of the ethical decision-making process, allowing all parties involved to utilize their own ethical frameworks.

Even if all the necessary preparations were to be taken, it is still difficult to determine who is at fault in the event of an accident. Since self-driving cars have not reached full automation yet, the blame is technically shifted towards the driver, since they are meant to be ready to intervene at any given moment (McCormack, 2022). However, in the event cars manage to become fully autonomous, this question becomes much more challenging to answer. Ideally, self-driving cars would eliminate crashes altogether, but it is likely unrealistic to expect perfect consistency. It hardly makes sense to blame the driver when they are not operating the vehicle, so the blame must be redirected to the manufacturer. In fact, even though manufacturers of modern self-driving cars explicitly identify the driver as the last line of defense against accidents, they still find themselves under fire when something goes wrong, as shown by the countless articles blaming Tesla's Autopilot for being the cause of numerous crashes (Boudette, 2022). This blame will only get more intense as self-driving car manufacturers continue to advertise vehicles with

less need for human intervention. Ethically, this seems like the most correct approach. If the engineers and manufacturers are the ones making each decision on the road, then it makes sense to hold them responsible when their product malfunctions. This also has the added benefit of influencing new regulations regarding topics like traffic laws and auto insurance, as the blame is directly connected to the introduction of the new technology. However, in taking this approach, other issues may arise. For instance, collecting and interpreting data on self-driving cars is challenging because of the presence of other vehicles on the road. This makes it difficult to determine if the self-driving car was even responsible for the accident, or if the situation would have been avoided with manual operation (Boudette, 2022). In situations like this, it is possible for neither the driver nor the manufacturer to be at fault, and society needs to be careful in how it handles these more complex situations. There are bound to be growing pains as self-driving cars are introduced into society, and while companies must rightfully be held accountable for solving them, the general public must be careful to give them enough leeway to drive the technology forward.

One possible solution to this dilemma is to separate self-driving cars from human-driven cars entirely. This should be the ultimate goal for self-driving cars anyways, since the unpredictable nature of human driving is the biggest obstacle in the way of autonomous vehicles realizing their full potential (Hern, 2022). In addition to creating a much safer driving environment, a roadway with exclusively self-driving cars would likely contribute to increased efficiency of traffic and improved economic conditions. The largest issue with this goal is the high cost of the technology that supports full automation, with some estimates projecting a retail cost of around $250,000 based on the technology and R&D put into the vehicle's development (LeVine, 2017). Even in today's world, where self-driving technology is far less robust than it

needs to be, self-driving add-ons can cost upwards of $15,000 (McFarland, 2022). These figures are completely unreasonable for the vast majority of car owners, considering the fact that new cars today cost an average of around $50,000 (Schulz, 2022). Thankfully, most projections predict that breakthroughs in the technology that supports autonomous vehicles will allow a rapid decrease in their price, allowing self-driving cars to be sold at only a slight premium to a conventional vehicle in the future (Ritchie, 2019). However, those that stand to benefit most from the improved safety of self-driving cars are those that cannot afford cars with modern safety mechanisms, and therefore still may not be able to pay the sizable $50,000 price tag (Nunes, 2019). While self-driving technology should theoretically become more accessible over time, it still remains to be seen how these socio-economic hurdles will be overcome.

Although there is only a limited sample size of autonomous vehicles on the road today, many experts in the industry have already begun to tackle some of these issues. Regarding the ethical decision-making of the programs controlling self-driving cars, some believe that the thought experiments are not practical and that explicitly addressing these choices would be overkill. Others believe that, although it is unlikely for self-driving cars to have to make choices of this nature, discussion on the topic is healthy and may reveal the kinds of risks society is willing to take. This information can then be used to calibrate the behavior of self-driving cars as a whole so that they better reflect society's wishes (Maxmen, 2018). As stated earlier, when it comes to accidents with today's automated vehicles, the driver exists to take some of the blame. However, since the drivers do not have the ability to improve the safety of the vehicle, the manufacturers are rightfully being forced to take much of the responsibility as well. For instance, crashes and fatalities related to self-driving cars caused the NHTSA to order companies to provide them with crash data and begin an investigation into their autonomous systems. While

experts disagree on how useful this process may end up being, most agree that it is a useful step towards making sure companies are more transparent with their development and can serve to start building legal precedents moving forward (Boudette, 2022). With regards to the widespread adoption of self-driving cars, it is likely that the majority of people will have to wait for the technology to become more accessible before the cost of a self-driving car is worth the investment. In the meantime, a popular solution is to introduce "robotaxis", which could theoretically provide the benefits of a self-driving car to those in need by providing autonomous vehicles that can be shared by the public. Studies show that this method is unlikely to be cost-effective without significant government assistance in the form of subsidies, but it can serve as a basis for accessibility measures in the future (Nunes, 2019).

Self-driving cars are the future of driving, removing unpredictable factors like poor judgment and unskilled drivers from the road, and saving tens of thousands of lives every year in the process. As with most major innovations, they will force society to rethink aspects of their ethical and legal framework, but the promise of significantly better transportation is well worth that sacrifice. Self-driving cars raise the same ethical questions that have been thought about for decades, and all of that thinking tells us that there will likely never be a single answer that can be considered "correct." The most common situations used to illustrate this dilemma are all thought experiments and will happen very rarely, if at all, in the real world. For this reason, it seems that the best way forward is to continue developing with the goal of making self-driving cars as safe as possible, for as many people as possible. With regards to the social implications of self-driving cars, holding manufacturers responsible for their own technology should be the highest priority. They are the ones that can most affect change and are most aware of the dangers their decisions may cause. For this reason, they must continue to be transparent in their

development and build trust among drivers so that the technology can be integrated into society as smoothly as possible.

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