THE FUTURE OF AUTONOMOUS VEHICLES

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Abstract

The next five years will present a rapid transformation of vehicle technology centered on the adoption of autonomous driving systems. These systems will transform the way our road networks operate. Roads will be safer, transportation more convenient, and cars more common among all walks of life as a mechanism for basic transport, benefiting society as a whole.

The Future of Autonomous Vehicles and  
Their Positive Effect on Society

Sitting behind a wheel and pedals is something all car owners are familiar with. Driving is baked into our society and car culture extends itself from high school parking lots to the largest box office films. While driving is an engaging experience for many, the result can sometimes lead to dire situations. Cars are risky machines and the system behind the conduct of our road networks does not always save us from operator error. In 2010, the Centers for Disease Control and Prevention (CDC) estimated that 33,000 fatalities were caused by motor vehicles. (CDC, 2011).

The future may be painting a different picture; one where cars no longer involve the operator, where there is no steering wheel or pedals, and potentially no fatalities due to user error. The automotive industry has grown to include major technology innovators like Google, who are now devising ways to apply smart software, radar, and camera technology to automobiles so that they can obey the rules of the road autonomously. Take the experience of Eresa Favuzzi into account. Eresa is a 54 year old woman who considers herself a careful driver. She was invited to try out Google’s self-driving car experiment on the top of a parking garage at the campus of the tech company’s headquarters in Silicon Valley. Her experience was incredible. She felt relaxed and comfortable inside of the pod, realizing that the technology was very capable of handling any unforeseen circumstance on the road that might have otherwise caused her some stress during her drive. Reflecting on the experience, Eresa said that she could benefit from this technology, as she gets older, because it would put her at ease during her normal commute (Monticello, 2016).

We are already seeing this technology in new models of vehicles today. Features like Lane Keeping Assist, Blind Spot Monitoring, Rollover Mitigation, and Adaptive Cruise Control have entered the vehicle market for 2015 as affordable add-ons for most vehicles. These features have already displayed their effectiveness on the road, so much that the Insurance Institute for Highway Safety (IIHS) and the National Highway Transportation Safety Administration (NHTSA) have agreed to mandate that automatic braking technology become standard by 2022 (Spector, 2016). The next five years will see rapid adoption of this technology in all vehicles newly sold thanks to the majority of the auto industry embracing it. Our society would greatly benefit from the adoption of self-driving vehicle technology, due to reduced accidents, improved efficiency, and a transformation of the human environment. Autonomous vehicles are the next big evolutionary step in transportation.

**The State of the Technology**

In early 2015, Google began testing a prototype self-driving car on public roads in Nevada, after receiving the first ever autonomous vehicle license granted in the United States. Pictured in Figure 1 is Google’s own take on developing an automobile with autonomous technology built in, from the ground up. As of their February 2016 report, they have produced 33 of these prototypes. In addition, Google has modified other vehicles like the Toyota Prius and Lexus RX450h. Currently, Google is operating more than 50 autonomous vehicles on public roads, logging nearly 1.5 million autonomous miles. During testing in February, a Lexus RX450h had a minor traffic accident with a public city bus while veering back into a lane on El Camino Real, a road near Mountain View, CA. The logic of the self-driving car assumed that the public city bus would yield to its intent to merge. Unfortunately, the Google car struck the bus (Google, 2016). This accident was minor and caused no injuries, providing a valuable lesson to the logic of the autonomous vehicle project, that larger vehicles including buses may not always yield to other traffic.

Figure 1: Google's Self Driving Car Concept (Shick, 2015)

October of 2014, Tesla Motors began shipping their Model S mid-sized electric car with a set of ultra-sonic sensors and cameras as part of a technology package priced at $4,500. One year later, the company unveiled their accomplishment of establishing a suite of features that would utilize this hardware to allow the vehicle to act as a semi-autonomous car. Coined Tesla Autopilot, the system is an extension of cruise control. It can read the lines of the road, speed limit signs, and the movements of other cars. While setting a static speed, it can speed up or slow down depending upon the flow of the traffic. There is a caveat though; Autopilot cannot be activated from a dead stop and it is better suited to highway use where speed is constant. Additional limitations include its effectiveness in rain, snow, or other hazardous conditions (Bradley, 2016).

In Germany, BMW and Mercedes-Benz are both working on prototypes of their vehicles which are similar in technological scope to the Google and Tesla systems. The German automakers have focused much of their attention on creating a system that can be placed into existing vehicle designs, as to not obstruct the look of the car. The key difference here is the use of Light Detection and Ranging (LIDAR) mounted cameras which rotate at a high speed to get an accurate view of the surrounding objects. These camera systems are very expensive, typically selling for more than $80,000. Google’s autonomous vehicles utilize this camera technology, which is what makes it so reliable compared to other systems. In 2013, the BMW and Mercedes-Benz systems were able to detect objects like the Google system, but with a lack of refinement, requiring the user to adjust in certain scenarios that the systems cannot cope with (Knight, 2013). This balance between determining the wide availability of advanced technology with price and fitment concerns is what has others skeptical about the future of the technology.

A board member of BMW, Klaus Froehlich expresses his concern stating that, “…at the moment, the technical and social challenges involved are still too great.” (James, 2016). Despite this comment, it seems that other industry players do not have this same perception about autonomous vehicle adoption. The progress made may take time until vehicles are fully autonomous, but the rollout of semi-autonomous vehicles is already happening. Some see vehicles having the ability to communicate with each other like networked computers, allowing for an exchange of information to prevent accidents. “[The] NHTSA believes that this technology—known as vehicle-to-vehicle communication, or V2V—stands to avoid or mitigate up to 80% of crashes among unimpaired drivers, even with error prone humans involved…” states an article in TIME magazine (Steinmetz, 2016). However, this brings up privacy concerns related to the ownership of vehicles and the protection of vehicle driving functions, leading to a legal grey area that may slow the progress of innovation.

**The State of the Current Legal Environment**

Legislation for fully autonomous vehicle testing has been passed on basis of state by state in the United States. Permits have been issued which authorize the testing of fully autonomous cars on public roads in California, Florida, Nevada, and Washington, D.C. for specific automakers and researchers (Richard, 2016). Autonomous vehicles represent disruptive technology, meaning that their effect on society requires for government and the people to agree on how they will become a part of daily life. So far, a limited number of states in the U.S. mention autonomous vehicles in any of their driving legislation. This presents a challenge because the considerations are limitless. The responsibility of the vehicle no longer lies in the hands of a human driver, so who is to blame when a fully autonomous vehicle is involved in an accident?

Volvo Motor Corp. has entered the legal discussion by stating that it will take full responsibility for the actions associated with a fully autonomous vehicle that it produces. Although this position is very progressive, Volvo’s CEO spoke about the fact that the U.S. may lose a key opportunity to lead the way in innovation and adoption if regulations do not outline the manner in which autonomous cars are liable on public roads (Korosec, 2015). Although Volvo took an aggressive stance, many manufacturers may not follow suit. The environment for legal liability can destroy a company’s reputation. This is why it is so important for the United States Federal Government to recognize the existence of fully autonomous vehicles and their impact on society.

In addition to government regulation, there must be a system in place for testing the effectiveness of the autonomous technology similar to how testing is employed on vehicles in crash scenarios. The NHTSA has openly welcomed the autonomous vehicle industry and has stated that it represents a greater opportunity to improve the safety of motor vehicles. However, they have not officially released a method or guideline which proposes testing and regulation of these efforts.

**The Networked Car**

Autonomous vehicles are loaded with computer technology, some of which is connected to the internet. There are many concerns over the security of these connected systems. In 2015, Fiat Chrysler model vehicles with connected car technology called UConnect came under scrutiny due to a hacking test that was successful in manipulating the throttle and steering inputs of the vehicle from 10 miles away. Charlie Miller and Chris Valasek were responsible for locating the vulnerability and helped the company to update their software to address the security flaws which they discovered. This raises the question about more advanced vehicles and the responsibility of owners to update software to prevent accidents or intrusions from hackers (Ashford, 2015).

Despite these concerns, there are many benefits of networking automobiles when considering the autonomous vehicle. The mobile app driven marketplace for cab drivers called Uber wants to utilize autonomous vehicles as in town transportation that can be beckoned by anybody needing a ride to a destination. By networking these vehicles, those using them will be able to locate them wirelessly on demand. This would provide for cheaper transportation because an operator will not be present, eliminating the liability on the physical driver (Dennehy, 2016).

**What the Future Holds**

Autonomous vehicles have the opportunity to transform the way our road networks have traditionally operated, allowing for technology to shift automotive transportation from the traditional model of ownership to a new model centered on transportation service. Google hopes that their investment into autonomous vehicle technology will pay off by the integration of their Android mobile services division to create a service similar to Uber where autonomous vehicles can be requested and utilized for a variable rate based upon mileage and other factors. Car ownership would become a thing of the past, relegated to only passionate driving enthusiasts (Dennehy, 2016). Some suggest that autonomous vehicles will transform cities by using big data collection to analyze traffic volumes, intersection state, parking data, and many other factors. These could lead to a significant improvement on our traffic congestion problems in major cities.

Autonomous vehicles and the technology development associated go hand in hand with the modernization of transportation. We are at a point where this technology has advanced so quickly, that the time for fully autonomous is just around the corner. Driving is a dangerous activity and if we can reduce user error, we can improve our road networks across the world. Autonomous vehicles, if adopted will reduce congestion, increase efficiency, and improve quality of life for their users.

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