

On the Road to an Automated Car

In this article, I will be discussing autonomous cars and the various pros and cons of deploying them. Autonomous(or driverless) cars are one of the next steps in the growing digital change. What led me to research this subject is that autonomous vehicles have the capability of reducing the fatality rate of vehicle-related incidents. However, there is still public resistance to automated vehicles. A study "Trust in Driverless Cars: Investigating Key Factors Influencing the Adoption Of Driverless Cars"

<https://www.sciencedirect.com/science/article/pii/S0923474817304253> states, "These concerns relate to security, trust, privacy, reliability and liability." We will explore these different concerns. We will discuss the various effects they have on public health. In the essay "Nomous Vehicles: Developing a Public Health Research Agenda to Frame the Future of Transportation Policy." It states, "automated vehicles posing both promise and risk to the public's health, it is imperative that public health considerations be taken into account and public health stakeholders." Considering the benefits and the negatives is imperative when implementing policy on any new technology. Creating policies and addressing public concerns cannot be done without understanding the decision-making process an automated vehicle undergoes while driving. Annual Reviews published the article "Planning and Decision-Making for Autonomous Vehicles." <https://doi.org/10.1146/annurev-control-060117-105157> The Article gives a structure by highlighting three approaches "sequential planning, behavior-aware planning, and end-to-end planning." "The automation of multiple vehicles creates a web; allowing cars to share information, this can help reduce crashes by creating another form of monitoring. The article "Internet of Vehicles: From intelligent grid to autonomous cars and vehicular fogs." <https://journals-sagepub-com.silk.library.umass.edu/doi/pdf/10.1177/1550147716665500> discusses fleet management, stating, "This efficient communications and distributed processing environment can be provided by a new network and computing paradigm specifically designed for vehicles—the vehicular fog." Automation is growing every day, understanding all of the various components that come to implementing new technology is a necessary process.

The public is not always accepting of new technology. The article "Trust in Driverless Cars: Investigating Key Factors Influencing the Adoption Of Driverless Cars" discusses two theories one the technology adoption model or (TAM) created by Fred D. Davis in "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology." 1989 the other is the unified theory of acceptance and use of technology or (UTAUT) by V. Venkatesh, M.G. Morris, G.B.Davis, F.D. Davis User acceptance of information technology: toward a unified view MIS Quarterly (2003), pp. 425-478 <http://www.jstor.org/stable/30036540>. These two theories state that adaptation of new technology relies on five factors "Reliability, Performance expectancy, Trust, Security, Privacy." We will focus on security, trust, and privacy as they are primary concerns in driverless car scenarios and provide examples of how we have dealt with these concerns in the past. Security includes things such as traffic accidents, malfunction equipment, remote access. This only names a few, and the details on how to fix these issues can be arduous. The article uses a past example of when we had similar problems

when implementing planes and how we were able to overcome them. "However, large-scale infrastructure can be protected successfully over a long period of time as demonstrated by the US which secured large critical national infrastructure systems, like power grid air traffic control systems." Although this does not provide an example of how to solve the current issue, it demonstrates that the United States has resources to handle large scale electronic infrastructure. Privacy has become an increasingly sensitive issue. Driverless cars pose many threats to our privacy, such as "Targeted Marketing, law enforcement or surveillance." Privacy is an unsolved issue in terms of data. the article states, "To prevent privacy invasion, privacy protection, to some extent if not to fully, must be incorporated at the design stage for autonomous cars." However, with our current issues in data privacy such as Facebook (recently was fined 5 billion dollars for mishandling data), we lack reliable examples of privacy protection on a large scale. When privacy is met, it also promotes trust. The section defines trust as "Three beliefs of ability, integrity and benevolence." Trusting an autonomous car is "to lose "choice and control" when behind the wheel." Trust is met when all other factors are fulfilled. Elements of trust are lost without reliability, performance expectation, security, or privacy.

Autonomous vehicles have varying effects on public health. The article "Nomous Vehicles: Developing a Public Health Research Agenda to Frame the Future of Transportation Policy." two significant effects are "Road casualty prevention" and "Labor market disruption." Death from automotive-related incidents is a tragedy. The article references a study from the world health organization that shows "1.2 million fatalities annually." The report continues to state that the majority of fatalities come from either "driver error" or "driver negligence". Monitoring autonomous vehicle death rates will help policymakers construct adjust initial policies during the transition to automotive vehicles. Many people rely on their cars for work. From uber drivers to truckers, many people's jobs include transporting goods or people. studies from the article indicate "unemployment negatively impacts both the physical and mental health of unemployed persons." Unemployment is essential because autonomous vehicles threaten jobs "As autonomous vehicles emerge as a disruptive technology, great potential exists for autonomous vehicle technology to displace taxi drivers, bus operators, delivery drivers, and freight truck operators worldwide." In streamlining autonomous vehicles, consideration of how to create policies that will protect people's jobs and reduce automotive fatality rates.

Automated vehicles use many different sensors and decision-making processes. The article "Planning and Decision-Making for Autonomous Vehicles." describes three different considerations when designing a driverless car. The first one is "Motion Planning and Control." There are three lines of thought when implementing motion planning and control. The first line of thinking is "space discretization with collision checking." the benefit to this example is "simplicity and effectiveness, especially in highway examples." The second line of thought is "randomized planning." the benefit to this method is "the probabilistic exploration of large state spaces." The third line of thinking is "constrained optimization and receding-horizon control." the benefit is "smoothness of trajectories and direct encoding of the vehicle model in the trajectory planning." The second consideration in designing and employing autonomous vehicles is "Integrated Perception and Planning." there are multiple different perception systems. The classical Perception systems "extract information in the form of manually designed features raw sensory data. "However, these systems are constricted " by the adaptivity to generic environments." The next method of perception is "semantic segmentation on high-resolution

images in real-time" this method is more accurate as high as "80% mIoU (mean intersection over union) in the Cityscapes data set." The downside to this perception is that it requires more computational power and time " takes multiple seconds to propagate on high-resolution images since they need a large number of floating-point operations." The last consideration the article discusses is "Behavior-Aware Motion Planning" this section deals with complex interactions between multiple people on the road. Standard approaches "use a state machine to switch between predefined behaviors" The issues with predefined rules is the inability to adapt to unknown situations. The article proposes three different ways to deal with uncertainty. The first is "Find a better description of dynamics of the environment" However, this still will not account for all possible scenarios and the machine will likely shut down. the next is "model cooperation based on a conditional formulation." However, this assumes too much control and may result in the robot being overly aggressive. the last is "model cooperation via joint distribution." This defines the robot as any other agent in the environment. In exploring these different fields, we slowly get further to fully automated vehicles.

Various automated cars linked together, via the internet creates the Internet of Cars. The article discusses a "vehicular fog" that provides many benefits to the autonomous vehicle. The first is V2V communication or vehicle to vehicle. In the previous section, we discussed the different complexities of vehicle perception. the article states, " V2V communications are necessary to avoid the formation of shock waves in a long column of AUVs when a slow down or accident occurs in front." The addition of this information creates a dependable means of information and backup redundancy in situations involving other automated vehicles. The second implementation is "vehicular traffic management." provides a navigator service agency the ability to " learn instantaneous traffic flows and patterns from the mobile fog, and can deliver differentiated route instructions to vehicles thus avoiding route flapping." It avoids the situation of everyone avoiding one route to take another creating traffic on that route. The other benefit comes from gathering information from multiple vehicle fog's. "Any fog member having content whose attributes match the query responds directly to the consumer. " Pulling information from these various groups creates monitoring abilities for a fleet of vehicles that can give detailed information with greater accuracy. Network-based approaches to vehicle manipulation create redundancy and back up that provides a system with more information to make decisions.

In conclusion, automated vehicles have a lot to offer society and if adequately implemented, do so in a safe manner. The ability to eliminate human error related vehicle fatalities is paramount. In implementing automation, there are drawbacks such as loss of jobs. However, we should not stifle innovation to hold on to old values. We continue to innovate and find solutions to new problems that arise. Understanding how these cars can help our lives without impeding us is the first step in building trust with this technology. Full Autonomy of vehicles is still far away, but as we explore the different methods, we get closer to making it a reality. Shortly after they are on the commercial market, I believe they will streamline onto the road and will be connected similarly as the internet is today.

