A Call For Research: Ethical Dilemmas of Autonomous Vehicle Manufacturers

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1 Introduction

While autonomous vehicles accounted for about 31.4 million vehicles on the road in 2019 (Placek). They have continued to flood the market and have a projected growth to 58 million in just 8 years from now (Placek) As well as a market cap in the billions of dollars. Even the comparatively new AV company Tesla has over 3 times the market cap value of the leading non AV brand Toyota (Market Cap) who are also working toward AVs as well, like their level 2 teammate driver assistance. Following Moore's Law, as technology continues to improve, their social impact and ethical problems increase (Borenstein et al.) - [7]. 90% of all accidents are caused by human error (Martínez-Díaz and Soriguera); Currently, vehicles in the US caused around 42,915 deaths in 2021 alone (NHTSA). By increasing the use of autonomous vehicles we could save millions of lives over the course of the spread of AVs (Borenstein et al.)-[16]. We find humanity in a "new world" where vehicles will soon be able to make decisions that have a direct effect on who lives or who dies (Awad, Edmond, et al.). However, the goal of AVs is that they will never initiate a dangerous situation and therefore never cause an accident (Martinho et al.) - (Mobileye,n.d).

The concept of autonomous vehicles is generally referring to “the replacement of some or all of the human labor of driving by electronic and/or mechanical devices”(Faisal et al.). Usually, this is accomplished through use of GPS, ultrasonic sensors, RADAR, Lidar, etc (Rosique et al.). These functions work together in order to determine the vehicle’s current surrounding area or its location on the road. There is also some discussion into the future of these vehicles using data shared with other autonomous vehicles to make decisions rather than relying solely on their own (Chen et al.). In the purpose of possibly helping answer what differences inherently explains the moral difference between two options (Himmelreich).

The ethical discussion of autonomous vehicles, which will from this point on be discussed as AVs is an actively growing research area, there was significantly less available data than the actual functionality of AVs. Given this “restriction”, the research was expanded beyond simply the largest journals to include more experimental and ethical perspectives. As we near the adaptation of millions of autonomous vehicles, a serious consideration of algorithmic ethicality is urgently needed (Himmelreich).

2 Methodology

As mentioned throughout the introduction, this review is meant to discover the potential research areas to drive future research into ethics of autonomous vehicles. Originally the data was restricted to a few major research journals. However, given that this is an emerging field, the availability of data through these was rather limited; So, the domain was expanded to include other reliable sources. Since the vast majority of research is relatively new, there was no restriction based on the date of publication. However, given IEEE size, they do account for a significant amount of the publications used. Articles used referenced Autonomous Vehicles,

Ethics, Self-Driving Car, and Trolley Problems. These articles primarily focused on decision making, security, and liability/accountability.

3 Major Theme 1: Decision Making and Applications

For manufacturing, the actual decisions being made will most likely need to follow what society deems as the correct course of action in order to continue the exponential growth of autonomous vehicle sales. Even so, many consumers of AVs would rather drive AVs that would protect them and have others drive AVs that would implement utilitarian perspectives (Awad, Edmond, et al.). Essentially, people would like cars to be moral unless they are the one driving (Himmelreich). Several papers discuss the importance and/or use (Greene) or even overstated relevance in (Himmelreich). Trolley problems are "idealized situations in which an agent has to decide between two actions that lead to different distributions of unavoidable harms."(Himmelreich). As experiments, Trolley Problems allow AV manufacturers to examine a set of relevant considerations (Himmelreich).According to (Awad et al.) there are many categories in decision making with significant impact on potential consumer decisions in use of these "Trolley Problems". These would be age, status, size/weight, law abiding, animals, etc (Awad et al.). Globally there is a significant relationship between sparing a group of people and age. This is followed up by the (Bergmann et al.) which also uses age and person count in a VR environment; While also accounting for position to gauge importance of situations to potential users. In (Bergmann et al.), children are chosen over an older age group 90% of the time, linking a global +0.6 probability to a localized study increasing their validity and use. There forms an increasingly large ethical issue when AV manufacturers are deciding life and death before the

potential situation arises and the extent to which this should be allowed or should be allowed (Himmelreich).

4 Major Theme 2: Liability/Accountability and Security/Usability

As millions of vehicles are soon to be implemented with autonomy, a serious consideration for algorithmic Ethicality and accountability is extremely urgent (Karnouskos). However, these aspects of AVs have relatively few in-depth discussions. Given that in most car accidents, the driver is considered to have some form of control, they are usually responsible for the vehicle's fate (Taeihagh and Si Min Lim). With the new frontier of AVs current aspects of liability laws could become inapplicable. This will affect what (Cohen et al.) considers to be stakeholders; Which could include AV manufacturers, software developers, AV consumers, insurance companies, passengers, policy makers, and lawmakers(Alawadhi et al.). A large aspect of liability comes from the average user being unable to understand the performance of an AV based on observing one (Geistfeld). Being liable for an action usually requires control of the situation in at least one way (Martinho et al.). This would in turn open up a large amount of legal uncertainty for AV manufacturers as users would have no control over decisions being made. A manufacturer should only be held responsible for a crash if a fault was found in the design or compliance with legal regulations (Alawadhi et al.). There have been conflicting opinions on this topic in the field of research as (Lohmann) argues that given the adoption of AVs, only manufacturers should be held accountable as the occupant has no significant choice in the decision making. While, (Borenstein et al.) argues that people who knowingly use a form of technology are morally responsible for that use. A question arises here of if manufacturers are the ones solely liable, will this slow the growth of the AV industry or even prevent it

entirely?This would also begin to affect insurance premiums for consumers as insurance companies are unsure of whether to raise or lower rates for AV users (Abdullah). Some have considered using humans/Drivers as the final decision maker in a dilemma-esk situation; However, “humans are poor fallback systems (Martinho et al.). Another issue arises for if a shared liability is brought into play. For instance, if weather hazards are ignored by the user and directions are given to the vehicle, who is then liable if an accident occurs. (Alawadhi et al.) Brings up the point of how long should AVs be tested until they are considered reliable or safe for societal use?

Usability may become a larger issue as multiple studies conclude that, if a significant rate of AVs were to be introduced into traffic then congestion would increase (Martínez-Díaz and Soriguera), thus forming the use of CAVs or Connected Autonomous Vehicles (Martínez-Díaz and Soriguera)(Uhlemann). Should manufacturers begin use of these, data would have to be shared from vehicle to vehicle in order to create a relatively fluid traffic pattern. This information would have to be secure against hacker or terrorist attacks (Martínez-Díaz and Soriguera). AV’s currently use one or a collaboration of technology such as Lidar(Light Detection and Ranging), radar, cameras, etc(Uhlemann) not communication with other vehicles even within the same company. There has been a proposal for use of a deep neural network to act as a intrusion detection system (Liu and Liu)to assist with the inherent for securing AVs.

5 Discussion

Given the data gathered from experimental studies, a general implementation of a utilitarian perspective could be justified in regards to mass production (Bergmann et al.). Utilitarianism is defined as "...the doctrine that the greatest happiness of the greatest number should be the guiding principle of conduct" (Oxford English Dictionary), this would further be backed ethically by consequentialism ("S is obligated to do x iff the outcome of S's doing x is better than the outcome of S's refraining from doing x"(Nair)). More research is needed on the impact and societal opinion on implementing a generalized moral decision making process to AVs On the legal side, Trahan v. State of Louisiana, Department of Transportation & Development. Trahan found a driver guilty of negligence because they engaged and disengaged the cruise control function on a winding road and eventually could not stop in time to prevent crashing into a tree (Ball). Based on this, legal precedent could lean toward primarily holding users at stake if a function is being misused if manufacturers have specified a use for the function. Issues for accountability increase further as consumers would, 90% of the time make the decision to ignore traffic rules in order to save a greater number of people (Bergmann et al.). This adds another layer of user preference to be taken into account for development; Which may lead into future need for new laws for AV manufacturer protection or add to the dilemma of decisions for manufacturers. If manufacturers decide to implement a user takes over approach, the issue becomes if a manufacturer had unethical intent, there is the possibility for implementing functions that are covered in an end user license agreement and use this precedent in order to weasel out of liability. The ethicality of EULA (End User Licensing Agreements) is to be discussed further as they can limit consumer rights (Zmurchyk). All of this hinges on if manufacturers can implement a human-like intuition into the decision making algorithm. A possible issue that could occur while trying to implement this situational decision making is that

current developed systems lack this human-like intuition and flexibility (marthinho et al). This is commonly known as Maravec's Paradox, which summarized says that it's easy to teach AI to do things we consider complex but simple observational skills require a large amount of computing power. Compounding this principle, is that while there major advancements in technology being used tools being used by manufacturers still have aspects being unaccounted for by vehicles being unconnected; such as lidar being able to spot a vehicle but unable to determine its intentions (Uhlemann). My research concludes that there is a drastic need for further investigation into AV decision making and application; As well as the Ethicality of using CAVs and how AV manufacturers are going to secure consumer data from AV use.

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