Human-Powered Vehicle
(Technical Paper)

Solution development to the challenges of autonomous vehicles
(STS Paper)

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Introduction

The technical project the team worked on was manufacturing a human power vehicle (HPV) to attend the contest held by the American Society teams of Mechanical Engineers (ASME) in April 2020 in Michigan State. UVA has two HPV team-orange team and blue team. My team built a recumbent Tadpole HPV.

The Self-Driving car

A self-driving car (sometimes called an autonomous car or driverless car) is a kind of vehicle that uses a combination of sensors, cameras, radar and artificial intelligence (AI) to travel between destinations without a human operator. To be qualified as fully autonomous, a vehicle must be able to navigate without human intervention to a predetermined destination over roads that have not been adapted for its use. (Margaret Rouse, 2018)

The emergence of Self-Driving vehicle is unavoidable for several reasons. Six billion car accidents happen each year. Forty percent of those accidents happen due to alcohol; 30 percent of those accidents happen due to speeding, and 33 percent of accidents are due to reckless driving. Twenty-three times more likely to crash while texting and driving, and 40 percent of American teens say that they have been in a car when the driver used a cell phone in a way that put people in danger. Those accidents happen primarily due to human factors: humans are inclined to make mistakes. In a presentation to a seminar on the future of travel, Dr Dia said human error was to blame for up to 90 percent of the 1.2 million deaths that occur each year from car accidents around the world. (Swinburne, 2017) On the contrary, "By midcentury, the penetration of AVs (autonomous vehicles) and other ADAs (advanced driver-assistance system) could ultimately cause vehicle crashes in the US to fall from second to ninth place in terms of their lethality ranking among accident types," the report, from US consulting firm, McKinsey & Company, concludes. (Crew, 2015)

Working mechanism:

Self-Driving cars throw out electromagnetic waves in the form of radio waves and laser beams, and they also emit sounds and record the reflection of the sound waves off of objects. Using radio waves is known as RADAR (Radio Detection and Ranging), using laser beams is known as LIDAR (Laser Illumination Detection and Ranging), and using sound waves is known as SONAR (Sound Navigation and Ranging). RADAR can determine the location and shape of the object, but not that accurate. RADAR and SONAR help determine the velocity of the objects. GPS is also installed to navigate the vehicle. Once the car receives input about the location of surrounding objects, the car’s computer continuously maps out the surrounding environment and the computer use the map to make decisions, such as when to stop, when to brake and when to change lanes, based on the algorithms. (Rouse, 2019)

Purpose

This paper investigates various kinds of normalized deviance in the phase of designing the self-driving vehicle and how to utilize the frameworks of trading zones and interactional expertise to prevent those normalized deviances.

Normalized deviance of Autonomous vehicle

Normalized deviance:

The normalization of deviance is defined as: "The gradual process through which unacceptable practice or standards become acceptable. As deviant behavior is repeated without catastrophic results, it becomes the social norm for the organization." (Boe, 2013) In the case of self-driving vehicles, accidents can still occur in spite of the precise AI embedded in the car. Normalized deviance happens in the phase of designing autonomous vehicles for serval reasons. The 2019 installment of AAA's annual autonomous-vehicle survey found that 71% of people surveyed would be afraid to ride in fully autonomous vehicles -- down slightly from the 73% of respondents in 2018 and up substantially from the 63% of respondents who said that they would be scared to be a passenger in a driverless vehicle in 2017(N.A ,2018) . Even though the general public claims not accepting self-driving vehicles yet, it will eventually come to be an embraced technology once it proves its safety and efficiency due to the susceptibility of human to an accident. Under this assumption, the high demanding for autonomous vehicles keeps exerting pressure on the engineers. The engineers are more inclined to overshadow the defects of the vehicles because of the intense schedule. As a result, the normalized deviants of autonomous vehicles eventually lead to traffic accidents in one day. When those kinds of defects on vehicle design occur, engineers should not hide those defects but ought to bring them to the potential drivers and work to improve them.

Also, the ethical standards stand behind autonomous vehicles should not be solely determined by vehicle engineers, the group of people who design the vehicle. Engineers' judgments are not always most wisely. For example, assuming someone suddenly appears in front of a high-speed autonomous vehicle, and the only thing the vehicle can do is to turn and hit the light pole or to hit the walker since everything happens so instantly. In the first case, the driver is hurt. A question comes to mind: does the passenger have the right to decide on their lives? Whatever decision the engineers program the vehicle to make, it is not the will of the passenger. Do passengers make the "right" decision if they have the right to make the vehicle behave to their will? What is the middle ground decision, the most ethical one, in this case, and how should that decision be made? Since every accident involves not only the vehicle from drivers' perspective, but also another party, either pedestrian or another vehicle, can engineers ensure the outcome of the interaction between the moralized decision made by the autonomous vehicle and the decision made by the other party is the most acceptable one? This paper does not provide the answer to those questions but analyzes the framework applicable to answer those questions.

Another reason for normalized deviance to occur is the culture of vehicle enterprise or the perception of society. The autonomous vehicle engineers regard some deviances as commonplace while the engineers with different backgrounds regard those deviances as precarious. In the case of Chernobyl, one reason for the nuclear explosion is using cheap control rods. Engineers were too afraid to bring up this fact to the public, considering it's inappropriate

to accuse the government of making the risky design. Besides that, the leading engineer of the Chernobyl reactor commanded his fellow engineers to raise the temperature of the reactor through increasing the power and extracting the controlling rod. This command is not following the safety protocol and is made out of the leading engineers' irresponsibility and overconfident. Engineers with robust academic background predilect to regard their autonomous vehicle designs as unimpeachable and not accepting others' critiques. This kind of attitude unmistakably endangers the safety of autonomous vehicles.

Moreover, the importance of vehicle is not consistent in every state. For example, per 1000 people in New York State has 539 vehicles, while per 1000 people in Wyoming have 1140 vehicles. (Capitol) The statement that more cars mean more accidents (New Straits Times) also implies people living in New York State may benefit more from automated vehicles than people live in Wyoming State. New York State has more vehicles than Wyoming State does, and autonomous vehicles highly reduce the like hood of accidents occurrence. Even though there's statement saying " It might seem odd that countries with fewer cars are riskier places for road travel, but "Smeed's law" of traffic says that deaths per vehicle decline strongly as roads get busier – it is empty roads that are so lethal."(Spiegelhalter,2012), it only discusses the deaths per vehicle but not taking the number of vehicles into account. The variance of the degree of benefits brought by autonomous vehicles depends upon the number of ownership of vehicles in each area. Also, Engineers can not take for granted that autonomous vehicles will be popular for every area. Autonomous vehicles will be expensive and not affordable for most families in the era of its emergence, just as the advent of computers. The inflation-adjusted price of Apple I introduced in 1976 is $2949, which is twice higher than the cost of the mainstream laptop nowadays (Comen, 2018), while the average selling price of personal computers in 2019 was $632. (Holst,2019) Even though the trend that the price of the autonomous vehicle will decrease is unavoidable because the autonomous technology will be mature enough to bring the price down, same as computer technology, the autonomous vehicle engineers cannot hastily assume that the autonomous vehicle is required everywhere at the edge of its emergence.

Unforeseen situations are another example of normalized deviance. In the challenger disaster, Forecasts for January 28 predicted an unusually cold morning, with temperatures close to −1 °C (30 °F), the minimum temperature permitted for launch. The Shuttle was never certified to operate in temperatures that low. The O-rings, as well as many other critical components, had no test data to support any expectation of a successful launch in such conditions. (Berkes,2012)(Bergin,2007) The unforeseen condition may also happen in autonomous vehicle designing progress. For example, the system of autonomous vehicles developed by the united states does not apply to other countries, considering the difference in traffic law and social environment. Australian drive on the left lane and the control algorithms of the autonomous vehicle are different for autonomous cars in those areas. Moreover, the big city pedestrians don't follow the traffic laws as pedestrians do in small cities. The sensibility of autonomous vehicles needs to be adjusted when a vehicle enters the crowded area. For different areas, the vehicle operating algorithm should be adjusted accordingly and engineers should not be overconfident in predicting the conditions of those areas.

Utilizing trading zone and interactional expertise

Trading zone:

Trading Zone refers to the situation where different parties with different backgrounds come together to exchange their thoughts. The main reason for the occurrence of normalized deviance is the limitation of the people to realize deviance. Introducing trading zone of various people with sufficient background on their fields helps people to discern deviant. In the case of the autonomous vehicle, several parties from the trading zone and their impacts are discussed:

Social experts:

Social experts provide the most insightful suggestions on making ethical decisions. Social experts help the engineers to find the optimal resolution for the walker and the most acceptable result for the driver. Social experts understand the psychology of the general public. Their opinions prevent engineers from making deviated decisions and from being overconfident in making decisions.

Vehicle engineers with different backgrounds:

As mentioned before, the autonomous vehicles designed in one area may encounter unforeseen situations when they are transferred to another area. Vehicle engineers from other countries, such as Australian, provides information about the way vehicles operate in their countries so that the autonomous vehicle designers can focus on making a comprehensive vehicle.

Autonomous vehicle inspection company:

As mentioned before, the high demanding of the autonomous vehicles enforces vehicle engineers to increase the yield of the vehicles while compromising the quality of the. Introducing an autonomous vehicle inspection company, specifically for autonomous vehicles, can ensure the quality and prevent quality deviance. Also, the government can mandate a vehicle inspection annually on certified stations to make sure the autonomous vehicles are safe for usage, same as what DMV is doing now.

Vehicle department representative:

The communication between autonomous vehicle engineers and DMV representatives is crucial. Every autonomous vehicle needs government documentation, just as what DMV is doing now. DMV representative is capable of informing the engineers whether the car is suitable for the traffic. To optimized the autonomous vehicle, engineers need thoughts on which party should be responsible for an accident: the autonomous vehicle company or the non-autonomous vehicle driver. DMV representative has thorough insights into the traffic laws and knows which party takes response under which circumstances. Suggestions from DMV representatives reduce the loss of autonomous vehicle enterprise and perfect the vehicles.

Interactional expertise:

Interactional expertise refers to people with backgrounds in various fields. Finding interactional expertise helps autonomous vehicle engineers to identify deviance as well, and the development of autonomous vehicles is not solely constrained to a single party. Interactional expertise understands more about the vehicle construction and knows how to implement those

necessary changes to the vehicle with their technical background, comparing with the parties from trading zones. Interactional expertise is a scarce resource compared with trading zone parties. Compared with the trading zone, hiring interactional expertise secures the patent of autonomous vehicles since the autonomous vehicle enterprise is not showing the technology to a third party.

The computer science engineer with sociology-related backgrounds is one kind of interactional expertise. They know the optimal decision an autonomous vehicle should make and the skills to program the vehicle to make that decision. Vehicle engineers with global working experience is another kind of interactional expertise. They know the culture and legal difference between different countries or regions and provides feedback on how to make a vehicle suitable globally. Vehicle quality engineers preside knowledge of the working mechanism of the autonomous vehicle and the quality standard of the vehicle.

Trading zones consists of interactional expertise mentioned above is the most optimized system to prevent normalized deviance of the autonomous vehicle. Computer scientists, engineers, social scientists and users can share their perspectives and concerns about automated vehicles and work together on improving the system. The secrecy of technology can also be ensured in this way.

Conclusions

Various kinds of deviance could be normalized when designing an autonomous vehicle, including ethical deviance, design deviance, deviance due to cultural, ethical deviance, etc. Introducing frameworks of interactional expertise and trading zone can prevent those deviances from occurring. Trading zone includes social experts, autonomous vehicle inspection companies, vehicle department representatives, and vehicle engineers with various backgrounds. Interactional expertise includes computer science engineers with sociology-related background, vehicle engineers with global work experience and vehicle quality engineers. To prevent each occurrence of potential normalized deviance from happening, the targeted trading zone or interactional expertise should be applied. Trading zone has the advantage of being accessible compared with interactional expertise. Interactional expertise has the advantage of securing privacy compared with the framework of trading zone.

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