Prospectus

Human Powered Vehicle

(Technical Report)

Ethics and Social Implication of Intelligent Transportation System

(STS Research Paper)

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I. Introduction:

Humans are not perfect. In terms of decision making of intelligent transportation systems, factors such as ethical, social and technological constraints may come to picture, of which some may lead to discriminatory or biased actions. The amount of data that flows in a smart city is unfathomed by any human power, and the availability of this vast amount of data increases the possibility of misusing and unethical behaviors for those who have access to it. In order to control and manipulate this data, its usage and behavior need to be examined not only from technical realm (accessibility, security, privacy, etc.), but also from an ethical perspective. Except for that, misconduct behavior of ethical issues is not restrained to just humans: autonomous systems that are capable of making their own decisions can lead to misbehavior as well. Thus, it is critical to ensure the appropriate use and limit ethical and technological misconduct of data processing in order to achieve a vital and intelligent city.

As stated above, the Science, Technology and Society (STS) portion of this thesis will examine the ethics, social and technological implications of Intelligent Transport System (ITS) by comparing two smart city leaders---the United States and China. The technical portion of this paper focuses on designing a Human Powered Tricycle that is commercially friendly, and offers an alternative sustainable transport that is more ergonomic, more efficient and more intriguing than conventional bicycle.

II. Technical Topic: Human Powered Vehicle:

Human-powered transportation is often the only type available in undeveloped or inaccessible parts of the world, and if well designed, can be efficiently viable form of sustainable transportation. ASME's Human Powered Vehicle Challenge (HPVC) is a competition to demonstrate the application of pure mechanical engineering design principles in the development of sustainable and practical transportation alternatives. The project involves the collaboration of frame, steering, fairing, drivetrain and innovation teams. The design will be a three-wheeled Tadpole recumbent trike, meaning there would be two wheels at the front for steering and one at the rear for controlling speed and brakes. Even though bicycle is undoubtedly the most efficient human-powered transport, recumbent trike offers a much more ergonomic and comfortable way of commuting. The position of seat and pedals are much more comfortable than a normal bike thus increases endurance, especially during long trips [WHPVA, 2019].

The project is collaborated with twelve fellow Mechanical Engineering students, and the initial idea is to create a lightweight and sturdy vehicle that maximizes efficiency and practicality, minimizes cost and material while ensuring rider safety. The project requires extensive teamwork and construction skills which extends for a whole year. Current schedule for fall semester can be seen from Fig.1 below.

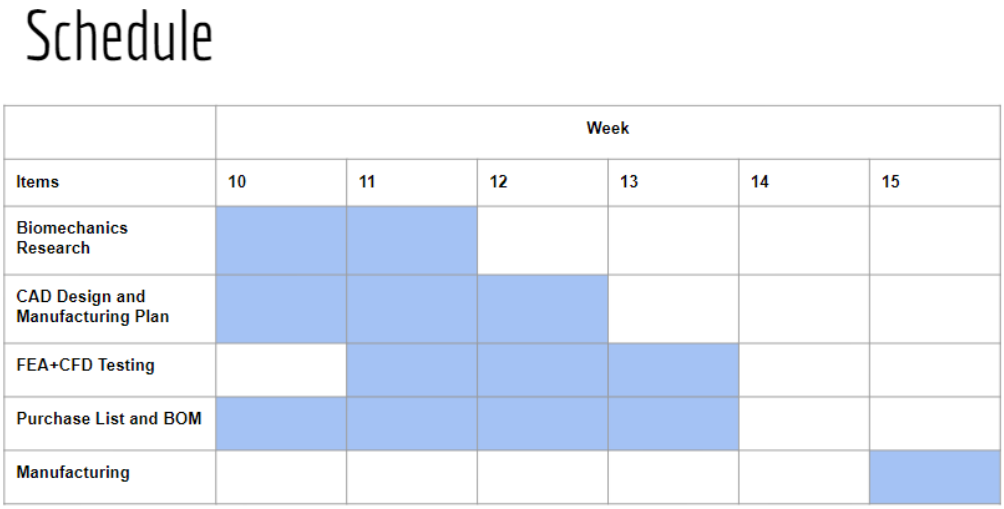


Fig.1 Human Powered Vehicle Fall Schedule

1. *Frame*

As for subteam division, frame team created a functional frame with 4130 steel pipe, which would involve welding and waterjet machine in the future. In addition, team members have performed initial Finite Element Analysis, analysing distortion based upon ASME requirement if a 500 lbf force is applied to the top bar of roll cage.

2. *Fairing*

Fairing team decided to create a fully enclosed faring which provides aerodynamics and reduces drag during the competition. In addition, fairing team has performed tests on foam to observe thermoformability of various samples of foam, in addition to continued development of fairing designs. Computational Fluid Dynamics simulation has been applied to existing design to recreate similar wind and weather conditions in real test.

3. *Drivetrain*

Drivetrain and Frame members revisited recumbent bike shop in NoVa, and drivetrain members decided on purchasing mesh seat and larger rear cassette, decided on pedal attachments and chain pat. In addition, Biomechanics tests have been conducted in order to find the best seat position to minimize torque. Tests were performed using Biodex isometric testing for full 360 degree range for optimized seat positions for each rider.

Fig 2a. Biodex testing position

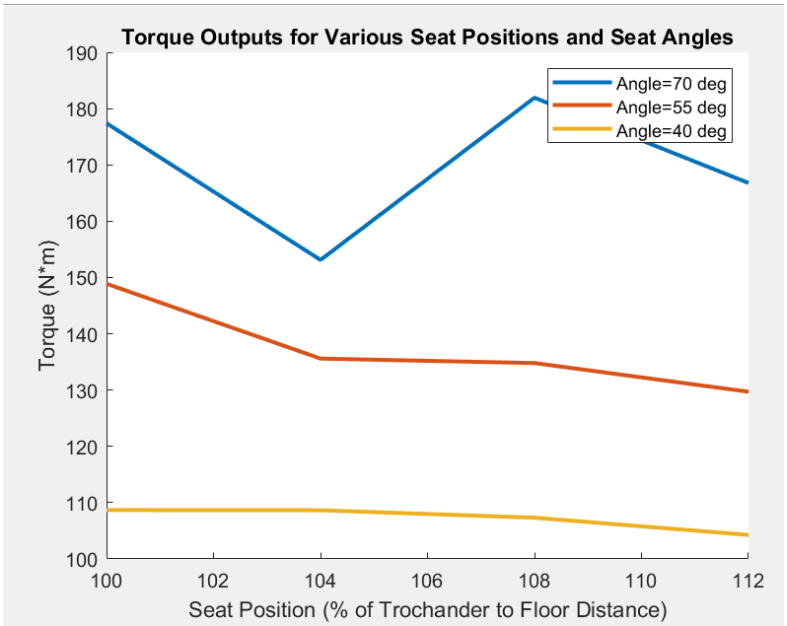
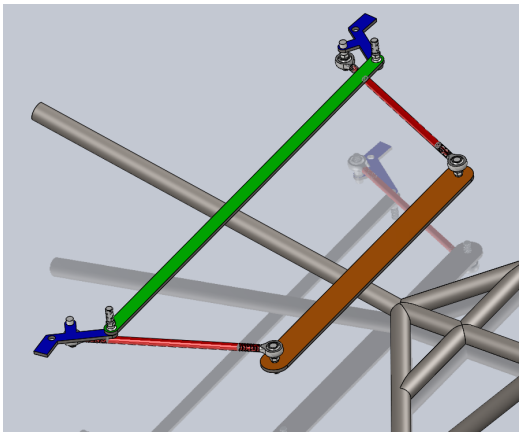


Fig 2b. Compiled data from all trials for 1 subject

4. *Steering*

Steering team has communicated with frame and drivetrain to relocate steering system and recognized the need for more clearance, try to implement mcmaster carr ball joints into existing CAD. After 2nd iteration, steering successfully implemented Ackerman Steering system which includes a long bar, a short bar, two T-shaped bars, two 4130 steel rod connection tubes and several ball joints for rotation and swivel [Mark, 2017]. Clearance has been controlled to be 2.87 inches and total mass of steering system excluding front wheels is 7.11 pounds as shown in Fig 3b.



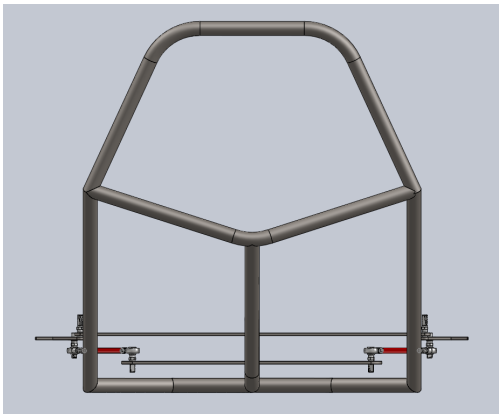


Fig 3a. Steering isometric view

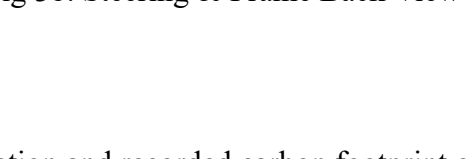


Fig 3b. Steering & Frame Back View

5. Innovation

Innovation team contacted Carbon Fund Organization and recorded carbon footprint of Human Powered Vehicle raw materials. Innovation team also started to research on recycled parts and potential locations to retrieve free materials for our vehicle.

6. Budget

All subteams are working on proposing purchase lists of materials, and making estimation on raw materials, potential backup components in case of emergency and asking fundings from University Organizations and UVa parents fund.

III. STS Topic:

In many developed countries, transportation accounts for six to twelve percent of a nation's Gross Domestic Product. The cost expenditure of traffic congestion alone is estimated to be more than $200 billion in four nations: the United States, the United Kingdom, France and Germany [Huawei,2016]. Thus solving traffic congestion issues is imminent in many nations. In China, a recent survey reported that 74 percent favored "the rapid transportation of automated driving in their country". On the other hand, implementation of smart transportation systems in other countries received more resistance. For instance, according to a study from Bosch, in Germany, 33 percent of Germans prefer self-driving cars and only 31 percent of Americans supported the rapid expansion of autonomous vehicles in the United States [Bosch,2017].

I. Autonomous Vehicles

One potential solution aries to solve traffic problem is autonomous vehicles. Tech magnates like Google, Uber and Tesla are currently experimenting potential usage of such systems. A report from U.S. News points out that 94% of transportation accidents are caused by human error(US News), which makes self-driving vehicles a favorable alternative for private transportation. However, some recent incidents have posed doubts on the ethical and safety measures of autonomous vehicles. For instance, a self-driving Uber car killed a woman crossing street in Arizona in March 2018 [Wakabayashi,2018]. The incident brings up an ethical question: Who is liable in a self-driving vehicle accident? Is the programmers who created the software culpable? Is the back-up driver who wasn't in control of the vehicle responsible for this accident? These questions are still left unknown. Another dilemma that autonomous transportation faces is how to choose who or what to crash into when an accident is unavoidable [Clever,2018]. No matter how much ethical instructions those systems carry, judgements and

skepticism will arise after such incidents, which would eventually transform into constraints that limit the development of autonomous systems. It is extremely important to make sure autonomous systems are unbiased towards pedestrians or vehicles and are incapable of learning discriminations when confronting ethical dilemmas.

II. Vehicular Communication Systems

Vehicular Communication systems focuses on sharing data in a limited space in order to analyze and predict road conditions and improve traffic efficiency. For this type of application to work properly, the exchanged data is required to be accurate, relevant, and meaningful during the communication. However, this open source of data makes it vulnerable to cyberattack on data integrity. For instance, a hacker could perform numerous transmission with different cookies location and platform keys to represent multiple vehicles, thus falsifying data and force certain drivers into traffic jams. Another issue arises as authentication problem. When multiple vehicles are exchanging information, there's no way to instantaneously prove the accuracy of this big data, thus leaving ethical and legal issues unanswered. On the other hand, China has a more positive attitude towards the experimentation of vehicular communication systems. Most of the decisions involved in ICT construction are pushed forward by country legislatives from a top-down perspective. In February 2017, the State Council of China released the "13th Five-Year Plan for Modern Comprehensive Transportation System Plan". It calls for the large scale installation of ICT systems onto transportation systems in order to create a safer and more integrated commute system. Tech companies and city councils that don't respond well to the national summoning will receive low funding for infrastructure construction while communities that react positively from a bottom-up approach will receive more funding for city planning.

III. GPS

Geographical Positioning Systems has become the most common and acceptable way of smart cities development which offers traffic condition sharing and location-monitoring functions. Thus it becomes imminent to examine who is able to use location sharing data and how much information can be retrieved from those devices. GPS tracking has raised ethical concerns, since the technology has become so mature that it is capable of providing precise and personalized tracking information [Elmaghraby,2014]. This data is used mostly instantaneously but the traces it left behind can be stored and retrieved long after the data was collected, thus creating potential threats of breaching of privacy. The Supreme Court has forbidden the use of GPS tracking by law enforcement unless there's lawful and appropriate reason to do so. However, the definition and condition of "appropriate reasons" is still ambiguous which may lead to infringements of overusing this power.

IV. Legislative resistance

In the United States, smart cities proponents need to deal with fifty state rules which may differ dramatically. According to Chris Urmson, CEO of the start-up company Aurora Innovation, since 2015, 23 states have introduced 53 pieces of legislation that affect self-driving cars—all of which include different approaches and concepts. Five states have passed such

legislation, and although all were intended to assist the development of the technology in the corresponding state, none of those laws shared common definitions, licensing structures or sets of expectations for what manufacturers should be doing [Urmson, 2016]. In order to meet the regulations of the National Highway Traffic Safety Administration, state legislators in America still have a long way to go. Considering safety and economic benefits and new regulations for autonomous vehicles, manufacturers generally are given five to ten years to adjust to new safety standards. On the other hand, due to the particular political situation in China, execution of smart transportation system becomes fairly easy. To better address the interdisciplinary coordination for the development of smart transportation, vehicle connection system and autonomous driving industries, China has set up a special committee to set up standards and boost connection across industries. It is responsible for advancing the development and application of the integration of 5G technology with the connected vehicles; and optimizing security management to ensure defence capability.

To further understand big data's ethical, social and technological constraints in smart transportation development, further research needs to be accomplished.

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