Robottoman

(Technical Paper)

Why is the government introducing autonomous vehicles into Charlottesville?

(STS Paper)

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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I. Introduction

Charlottesville has higher rates of poverty and car ownership than the rest of the United States on average. This may allude to the fact that the public transportation system is not equipped to adequately handle the population of Charlottesville. By updating public transportation in Charlottesville, the need to own a car would decrease which would save the residents of Charlottesville money.

This paper analyzes public transportation in Charlottesville and theorizes how and if autonomous public transportation will change the current transportation landscape of Charlottesville by using the triple helix model of innovation.

II. Technical Topic: The Robottoman

The Robottoman is a rolling ottoman that can be controlled using a phone application. The project consists of a phone application that sends Bluetooth signals to a circuit board that then controls the speed of the motors and the direction of the wheels. My group and I chose this project to assist people in moving heavy furniture. The idea came to us after one of our grandparents expressed discontent after having to move an ottoman. Additionally, remote controlled furniture may find use in theaters where sets need to regularly be moved and shifted.

The Robottoman consists of a user interface, bluetooth connectivity, embedded coding, PCB design, and mechanical construction. As the electrical engineer of the group, I am taking the lead on PCB design and assisting in the mechanical construction. These two parts are being developed simultaneously because power requirements for the PCB depend upon wheel sizing and weight constraints. As such, it makes logical sense for me to work on both aspects.

We are currently creating the user interface in Android Studio and java code. The app consists of six buttons: four for forward movement, backward movement, leftward movement, and rightward movement and two for clockwise and counterclockwise rotation. These buttons call the HC-05 Bluetooth terminal to receive data.

As stated, we are achieving Bluetooth connection through the HC-05 Bluetooth chip. After the app detects a button press, the app transmits ASCII values to the HC-05 chip through UART. The bluetooth receiver then process these values and outputs different digital signals depending on the button pressed. The output signals are then processed by an MSP430 that is mounted on the PCB.

Depending on the signal received, the MSP430 powers eight different output pins. Two output pins are required to power a single motor driver of which we have four for a total of eight output pins. We are loading code onto the MSP430 through a spy-bi-wire.

The main purpose of the PCB is to regulate the voltage supplied to the MSP430 and motor drivers and pass the output of the MSP430 to the motor drivers. We are achieving consistent voltage through bypass capacitors and feedback from the motors. We designed the Robottoman to move at a constant speed, so maintaining proper voltage and current is essential.

The PCB houses the MSP430 and motor drivers with many input and output pins for the HC-05 Bluetooth chip and the four motors.

The final part of our project is the mechanical construction. The main focus is constructing a wooden chassis to house our circuit boards with motor mounts on the bottom. The motors connect to Mecanum wheels. Mecanum wheels are capable of eight directional movement, forward, backward, leftward, rightward, and diagonally at forty-five degrees, as well as rotation with nine different centers of rotation. For our project we are only using forward, backward, leftward, and rightward movement and rotation about the center of mass. The mechanical construction integrates our software with our hardware in order to create our final project.

Constraints that we are worried about are safety, cost, and parts availability. We have taken great precautions in mitigating these potential setbacks. Another concern is the danger of Robottoman collisions, so the max speed will be limited to keep Robottoman collisions from doing actual harm to people or things. We are also worried the user may lose connection to the Robottoman. In this case, we will have built in safeties that stop the Robottoman should the user lose connection. There will also be a lock button that the user can press to prevent the ottoman from being moved. We will also take special considerations regarding the batteries to maintain safe operating conditions. We will also take care to not purchase and use treated wood as the chemicals used to treat it are toxic when breathed in during the cutting and drilling process.

One potential future implementation of the Robottoman includes embedding the circuitry and wheels inside a piece of furniture and descend onto the floor only when called upon. Other ideas have surfaced with the idea that the ottoman be hollowed or replaced with another item, such as a mini fridge. The generalized chassis allows the movement technology to be mounted onto most furniture. These ideas serve as complementary and secondary to our main goal of empowered those who struggle to move their furniture.

III. STS Topic: Why is the government introducing autonomous vehicles into Charlottesville?

While autonomous vehicles seem to be getting ever increasing media attention, only 41% of consumers say that they would ride in someone else's self-driving car (Self-driving cars). While these vehicles boast improved safety and reduced emissions, the public is currently unwilling to fully adopt self-driving vehicles. Last year, Perrone Robotics announced a $600,000 joint investment with Albemarle County and Jaunt, Inc to create an autonomous shuttle service for the county. Their goal is to create "zero-emission transit service (that) brings the promise of reduced parking needs and greater use of green technologies" as well as increased mobility for those unable to operate motor vehicles (Autonomous Shuttle Service Announced!). However, the aforementioned statistic begs the question of should the government be investing in technologies that only 41% of residents are willing to use? Additionally, should the government be investing in developing technologies that may or may not find use while the current system could benefit from that funding? Government sponsored autonomous vehicles could have far reaching benefits; however, their creation and lack of adoption by the community raises numerous questions. I will be evaluating these questions through the triple helix model of innovation.

I will be attempting to answer a set of research questions in order to better understand if this technology has a part in the future of Charlottesville. Firstly, why did Perrone Robotics pick Charlottesville to introduce their product? How will TONY, the name of their autonomous vehicle, serve the Charlottesville community? If Charlottesville involves itself with a private company, it is necessary to ensure that company shares proper values that will best serve the community members. Will the implementation of self-driving buses and vans leave many bus drivers without a job? By funding the creation of autonomous public transportation, the government will essentially be transferring the salary of bus drivers to the engineers who created the product. By removing the need for these relatively low skilled jobs, we would be creating a higher barrier for entry into the work force as well as decreasing the demand of relatively low skilled labor. However, are people willing to ride in a bus without a bus driver? Will Charlottesville need to hire these engineers while still maintaining the jobs for bus drivers in order for people to feel safe while riding autonomous vehicles? If so, will this lead to an increase in taxes? Who is most likely to use these autonomous vehicles? Who is least likely? Are there demographics that are more opposed to using these vehicles than others? These questions are of utmost importance when considering replacing existing public transportation. While many of these questions do not have easy answers, they are crucial to a proper discussion of self-driving vehicles in Charlottesville.

In order to evaluate these questions, I will be using the triple helix model of innovation or THMI. THMI focuses on the interaction between industry, academia, and government. I chose this framework because Perrone Robotics has partnered with UVA and Albemarle county towards the goal of creating autonomous public transportation. The strength of the interaction is dependent upon the dominating force in the triangle. In the statist model, government drives interaction between the three in a top-down implementation. In the laissez-faire model, industry drives interaction between the three leading to weaker ties that allow the three to function more independently than in the statist model. I believe this interaction falls more in line with the statist model than the laissez-faire model, but that may change as development continues. Notably, THMI excludes the community as a part of its discussion. This is, in my opinion, a flaw in the statist model because government is supposed to serve the people. However, in the case of public transportation in Charlottesville, the government serves the people by force because there is no competition in the form of private buses. This is in contrast to the laissez-faire model where industry creates competing products that people can choose between. As such, community is built into the laissez-faire model but not the statist model. Because I will be using the statist model of the triple helix model of innovation, I find it necessary to get increased community input in order to put their interests first.

Although there are many ethical questions raised by autonomous vehicles, the potential safety benefits are undeniable. 94% of serious crashes are due to human error. 37,133 people died in motor vehicle-related crashes in the U.S. in 2017 (Automated Vehicles for Safety). There is insufficient data currently to prove that self-driving vehicles are significantly safer than human drivers; however, these cars have huge potential safety benefits as the technology improve. Additionally, a NHTSA study showed “motor vehicle crashes in 2010 cost $242 billion in economic activity… and $594 billion due to loss of life and decreased quality of life due to

injuries" (Automated Vehicles for Safety). A fully autonomous commuter system has the potential to save 1,000s of lives and billions of dollars a year.

Looking into next semester, I will spend the first month and a half or so interviewing Perrone Robotics and similar self-driving vehicle companies about why they are creating these products, how they are working with academia and government in order to implement their creations, who these products will best serve, and if any community groups are unable to use their products like people in wheelchairs. I will also interview the associated UVA department that worked with Perrone Robotics in their creation of TONY. Finally, I will interview the associated government personal in Albemarle county that partnered with Perrone Robotics; however, it is unclear as to the extent of their involvement. After that, I will spend the rest of the semester interviewing and polling community members about their perceptions and concerns of self-driving public vehicles and if they believe these vehicles will better serve the community than the current infrastructure. Additionally, I will be using this time to study the relevant existing legislation in Virginia. Starting in 2019, several self-driving vehicle tests have taken place in Virginia (Frangoul). As these tests are in their infancy, there will likely be legislative changes as people draw conclusions from the results. Additionally, I will study related autonomous vehicle legislation of different states and countries that have already acted upon the topic of autonomous vehicles. Ideally, I will be able to uncover how vehicle tests lead to legislation which, in turn, leads to changes in the standards and practices of self-driving vehicles.

Self-driving vehicles boast improved safety and reduces emissions. However, these vehicles may reduce the need for a bus driver. Additionally, the disabled and/or elderly may find it difficult to use TONY or similar products. While the future of these vehicles seems bright, it is vital that these vehicles create an environment that does not exclude those already marginalized by our society. It is the role of the government to form a symbiotic relationship between industry and academia in order to create a better future for all. To implement or not implement public autonomous vehicles is a topic that becomes more present with every passing day.

IV. Bibliography

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