

**Prospectus**

**Robototoman**

(Technical Report)

**"Smart Transportation"? Transportation Justice**

(STS Research Paper)

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree Bachelor  
of Science, School of Engineering

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Fall, 2017

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**Introduction**

As time moves forward, we will be given the opportunity to use new technology and engineering in order to make our lives easier. We now have the knowledge and capabilities to make it easier to manage life both inside and outside of our homes. Through both engineering and

research, I plan to improve the quality of life for the residents of Charlottesville. My team and I are building a smart furniture prototype called the Robottoman, which will enable people to move their furniture and home appliances with the touch of a button. The prototype will consist of an Android Bluetooth mobile application that connects to a microcontroller that powers four different wheels. This allows an ordinary ottoman to be able to move over any flat surface. This project will utilize my team's electrical and computer engineering skills to create a new product that can improve life for disabled and elderly people and convenience for all. In addition, I am evaluating the Charlottesville Public Transportation using the framework of Transportation Justice. BY conducting interviews, site visits and surveys I hope to create a plan on how Charlottesville can achieve Smart Transportation for its diverse population.

## **Technical Topic**

The Robottoman is the first prototype in a series of smart furniture that will change the way people live and work. By placing the furniture on top of a remote-control movement system we will be placing the power to redesign your home at the tip of one's fingers. This will increase autonomy for elderly and/or disabled people who want to feel in control of their houses and lives,. Additionally it would provide businesses a cost-effective non-labor-intensive way of organizing and reorganizing their workspaces.

The Robottoman is controlled by a simple pipeline that transfers the command sent by the user to the ottoman's motors. Firstly, we are designing an android app using Android Studio in order to create the front end. This user interface has 7 different commands. One for each cardinal direction, two for clockwise and counterclockwise rotations, and one to stop the Robottoman. These 7 buttons will be pressed by the user to change the Robottoman state.

After pressing the button, the App will then connect to an HC-05 Chip that is installed on the Robottoman. This Chip has a very simple set up. It can be connected to the Android phone through the phone's Bluetooth settings. Once discovered bytes can be transfer to the HC-05. The chip then automatically sends the signal over wires connecting it to our MSP430.

The MSP430 is the main control for our Robottoman. It takes the signal from its UART port and then interprets it with C code that we will install on it with Spy Wire. This code will power different output pins on the MSP. These output pins will be connected to the motor drivers. These motor drivers can either power the wheels forwards or backwards.

The real magic in our project is our mecanum wheels. These wheels Can move our Robottoman in the four cardinal directions and create rotation without turning. This is accomplished by putting the wheels at 45-degree angles. Powering different wheels either forwards or backwards can make the Robottoman move in any direction without turning the wheels. We will be mounting the wheels and motors inside of a chassis that will also hold the battery and pcb board, which houses the MSP430 and the HC05, as well as the motor drivers.

There are many concerns when discussing the Robottoman. The first concern is the speed that it will run at. We do not want the Robottoman to hurt anyone, so we will be limiting its speed to only around one foot per second. This will be very important when we expand to other bigger furniture. We do not want any large objects moving too fast. Safety is something the Robottoman

team highly values. Another concern is the battery that will be powering the Robottoman. We want to be environmentally conscious, and therefore will be using a reusable battery to reduce waste.

Another factor we needed to consider when selecting wheels was the weight of the prototype. We needed to get wheels that could handle enough weight.

Another cool part of the design of the Robottoman is that we plan on hollowing out the inside so that someone could put books, movies, or maybe some refreshing beverages inside. We want the Robottoman to be fun for the entire family.

This project will tie together content that we have learned from many classes. The front-end app development was taught to us by our CS electives, while the knowledge to do the msp430 coding was gained in Intro to Embedded programming. Making the pcb and soldering everything was learned in our Fundamentals of Electrical Engineering 1, 2, and 3 classes. Finally building the chassis and putting everything together can be done thanks to our introduction to engineering courses, as well as our physics classes.

## **STS Topic**

### **Introduction**

Public transportation is a very complicated issue and when focusing specifically on the Charlottesville public transportation system, even more intricacies arise. This is especially true when considering different socio economic and racial groups. For example, according to the American Public Transportation Association [1], while White people make up 63% of all Americans, they only represent 40% of transit riders. Caucasian's are the only group in the four largest racial groups in America, the others being African Americans, Hispanic Americans and Asian Americans who see their percent of transit riders drastically decrease from their percent of the overall population. African Americans make up 12 percent of all Americans, but represent a total of 24 percent of all transit riders. Hispanics see their representation increase from 17% to 19% and Asian Americans increase from 5% to 7%. Going beyond pure statistics, in my research this semester I searched for local Charlottesville citizens that I could speak with to learn more about smart transportation. After being rejected by my fair share of potential subjects I was introduced to a teacher at a local Charlottesville school. One extremely interesting point that arose from our discussion was a lack of mobility not just for students getting to school, but their parents. She said that some parents are unable to make it to school for parent teacher conferencing which is a vital part of a child's early education. She then had to travel across town herself to meet with the parents. This issue seems to be affecting mostly minority students, as the educator stated that the two students, she had performed at home visits for this year were both minority immigrant children, while all of the Caucasian families were able to make it to school. The preliminary interview has led to the following research question that I intend to study in my STS thesis: How effective is Charlottesville at providing transportation justice and what ways can transportation justice be improved?

### **Literature Review**

As part of my initial research I searched for scholarly articles to aid my understanding of transportation justice. I searched for articles that could help me create a framework through which I can evaluate Charlottesville's Transportation system to see if it is succeeding or failing its citizens. In "Where Do We Go From Here" by Joshua F Inwood the history of transportation justice is

examined in order to provide context for the next steps in the ongoing battle for transportation equity and equality. The Public Transportation system is deeply tied to United States civil rights. Civil rights leaders like Martin Luther King Jr. fought very hard to increase minority mobility and create a space of equality rather than segregation. In an essay published after his death in 1986 King stated that the layout of public transportation essentially determines which jobs are going to be available to poor and minority workers. He argued that an effective and just public transportation system was crucial for allowing minorities to enter mainstream society. Now that we have established how important Transportation Justice is, the framework of Transportation Justice must be established. According to "The Social Justice of Movement" by Gerard Wellman, Transportation Justice encompasses three main points. These are transportation equity, environmental justice, and economic development/mobility. Transportation equity refers to how the benefits and costs of public transportation are distributed amongst society. Environmental Justice refers to the responsibility the city has to make sure its transportation services are using resources efficiently and not being wasteful. Economic development and mobility are the criteria that transportation ought to provide access to jobs, healthcare, and education. These are necessities that a transportation system ought to provide to its low-income users to be considered just. Using these three general measuring sticks we can evaluate how a public transportation system achieves transportation justice.

## **Methods**

Next semester in preparation for my STS thesis I will investigate how Charlottesville meets these three requirements of equity, environmental justice, and economic mobility. I will gather data on these fields with three primary research methods. The first will be in person interviews. Like the local teacher I interviewed in preparation for writing my prospectus, I will need to sit down and hear the stories of other members of the Charlottesville community. My second research method will be surveys to be distributed to Charlottesville public housing. I hope to speak with the public housing coordinator to try to get out a survey on how residents feel transportation is providing access to education, work, and healthcare. My final research method will be on site visits. I plan on personally seeing a lot of Charlottesville transportation sites to see how adequate the system's amenities are.

## **STS Framework**

In order for Charlottesville to achieve "Smart Transportation" we need some way to evaluate what that means. For my undergraduate thesis I want to answer this question using the framework of transportation justice. As described in my literature review above, using the two scholarly articles "Where Do We Go From Here" and "The Social Justice of Movement", I have established a list of aspects Charlottesville needs to offer in order to achieve transportation justice. These characteristics are transportation equity, environmental justice, and economic mobility. Using my previously established research methods I am excited to see how Charlottesville is succeeding or failing at transportation justice.

## **References**

(2017). *Who Rides Public Transportation*. Retrieved from <https://www.apta.com/wpcontent/uploads/Resources/resources/reportsandpublications/Documents/APTA-Who-RidesPublic-Transportation-2017.pdf>

Quamie, L. (2011). Transportation Equity a Key to Winning Full Civil Rights. *Race, Poverty & the Environment*, 18(2), 59–60.

Wellman, Gerard C. The Social Justice (of) Movement: How Public Transportation Administrators Define Social Justice

Inwood, Joshua. (2015). “Where do we go from here?” Transportation Justice and the Struggle For Equal Access. *Southeastern Geographer*.