Gesture Controlled Robotic Vehicle

The Current and Future Impacts of Motion-Controlled Technology on the Disabled Community

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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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Introduction

For my STS paper, I want to do research and write about the impacts of motion-controlled technology in our society specially the disabled. My main research question is "How is motion controlled technology currently impacting the disabled in our society and how will it impact in the near future?" The reason I chose this as my STS paper and research topic is because me and my team are making a Gesture Controlled Robotic Vehicle for our Capstone project. The idea is to build a glove that one can wear to control a robotic car through their hand and finger gestures while receiving signals from the vehicle at the same time. The community this project might appeal to consists of people who are interested in driving remote controlled cars or flying drones, but we are trying to take this one step above. Rather than controlling a machine through a physical remote, we will try to control a machine through our hands and fingers. Even though this is mostly for entertainment purposes, there are a lot of practical usage for this technology for certain communities such as people with physical disabilities, which is going to be the core research for my STS paper.

Technical Project

This project is a gesture driven robotic car targeted for teenage tech enthusiasts. There are two major components to this project: a glove that is worn by the user and a toy car which the user is controlling. The glove will sense the gestures through a gyro sensor connected to a Raspberry Pi Pico W. The data will be transmitted through a Bluetooth connection to another Raspberry Pi Pico W on the car. The vehicle will then interpret that data as movement

instructions. The vehicle's motors will be driven by two motor controllers through commands from its Raspberry Pi Pico W. The vehicle will also send information back to the glove that will drive the haptic feedback motor on the glove depending on the car's object detection capability through the ultrasonic sensor. The glove will have a hall effect sensor that will trigger the car to either spin or strafe left and right. The car will also have a camera attached to the front of it which will transmit its data to an external monitor. The glove will be powered by a 9V battery, while the car will be powered by a 9V and a 12V battery. The project will have 2 PCBs for each half of the project that will supply power and connect everything. This project is designed to have all components on the glove fit comfortably in the limited surface area of the hand. All components are readily available and easy to manufacture, making the project fit for mass production. The low cost of components will allow the car to be sold for reasonable prices to similar toys. Additional components can be integrated to enhance user experience.

The user first wears the glove on their hand. The glove will have a gyro sensor, a hall effect sensor, a vibration motor, a Raspberry Pi Pico W, a custom PCB, and a battery. The gyro will be attached to the back of the hand while the hall effect will be placed on the thumb. The gyro will measure the pitch and roll of the hand which correspond to the throttle and the turning of the car respectively. The hall effect sensor will measure the position of the magnet on the index and middle fingers to make the car enter spinning or strafing mode. The Pico accepts data from the gyro via I2C (Connect MPU 6050 To Raspberry Pi Pico W.). The custom PCB on the glove supplies power to all the components through the battery and connects everything on the glove. The car will have a camera with an adjustable transmitter, an ultrasonic sensor, four motors with two motor controllers, a Raspberry Pi Pico W, a custom PCB, and two batteries. The Pico on the glove is connected to the Pico on the car via a Bluetooth connection. The information

provided by the gyros of the glove is transmitted to the car where it is interpreted as instructions that drive the car's movements. Based on the instructions, the Pico on the car sends signals to the motor controllers to appropriately supply power to the motors. While the car is moving, it collects information about its environment through the camera and ultrasonic sensor. The camera is placed facing forward on the camera so the user can see from the car's point of view. The ultrasonic sensor is placed backward on the car to sense objects as they approach the car from behind. The information from the ultrasonic sensor is sent back to the glove via the Bluetooth connection. This information is used to send signals to the glove's Pico that drives the haptic feedback vibration motor. This allows the user to feel objects near the car that are not seen by the camera (Ohnishiki, 2010, Page 16 – 19). The camera has an analog transmitter that sends data to a video receiver near the user. This data passed through can be converter that can output to any monitor. The custom PCB on the car supplies power to all components through the two batteries and connects everything on the car.

The largest challenge we foresee is the speed with which the system functions (Iwasaki, 2012, Page 32 – 40). For this project, as of now, we are writing Micro Python code that runs on Raspberry Pi Picos. The Pico on the glove needs to process outgoing gyroscope and hall effect sensor data as well as incoming ultrasonic sensor data with motor instructions. The Pico on the car needs to process outgoing ultrasonic data, incoming gyroscope, and hall effect sensor data with motor instructions. This load may cause delays between instructions being given by the user and the instructions being executed by the car. If this becomes an issue, we will need to investigate optimizing the code for processing and potentially switching to programming in C since Raspberry Pico has a C/C++ SDK (Rasberry Pi Ltd.). Another challenge we have is providing power for all of the devices. From a voltage perspective, two 9V batteries (one on the

glove and on the car) are enough to satisfy the requirements of the system. However, the current perspective is quite different. The Picos have a higher-than-normal current consumption when they are engaged in Bluetooth connection. The camera also has significant current demand. To mitigate this, we plan on using certain regulators that provide the necessary voltage and current.

From a one-dimensional point of view, this seems like a project that is designed mostly for entertainment, but it can easily be used for political purposes as well. This technology or application can be quite handy in warfare, e.g., motion-controlled drones. With just the movement of the hands or fingers, anyone on the battlefield could control a self-moving machinery. In extreme cases, because of the small size of this technology, the sensor or controller to move the machine could be attached to the soldiers' hands so that they don't end up losing the controller amid the war. This relates to Winner's "inherently through their very nature" concept of political usage of technology. This technology also allows individuals to achieve a mischievous goal with very minimum effort. For example, a sensor in the form of a ring can break a lock when the finger performs a certain gesture. With very slight movement of the finger, someone could easily open some lock without anyone noticing. As a result, crime rates will spike up through jail breaks, bank robbery, etc. This falls under Winner's "through use" concept of political usage of technology. Now, technology being used politically does not have to be for the sole purpose of chaos as Winner said, "But to recognize the political dimensions in the shapes of technology does not require that we look for conscious conspiracy or malicious intentions." (Winner, 1980, Page 125). Technology most of the time is influenced and promoted only if it benefits most of the population or the community and I believe there is a lot of potential to benefit that lies within such a technology as Sismondo pointed out "The key issues for Science,

Technology and Society are about reform, about promoting disinterested science, and about technologies that benefit the widest populations." (Sismondo, 2009, Page 10).

STS Paper

My first step to undertake this research topic would be to figure out what already exists out there that is being used to help the less fortunate in our society. Once I get an idea of the current technologies that already exist (Bose, 1993, Page 902 – 909), I will do research on the advancements made to this technology and likewise the future implications of this technology (Harashima, 1994, Page 1107 – 1111; Ruderman, 2020, Page 41 – 55) on the disabled community. These kinds of technology can have a huge positive impact on people's day to day lives, but I will also account for any "harm" that might be caused to some group of people. At the end of the day the benefit to harm ratio for most technologies might seem greater, however, politically speaking, because this technology can cause both benefit and harm at the same time, this could lead to a separation in the population either in favor or not in favor of this technology. Additionally, what happens to the developers of this technology? Depending on how politics work around regarding this technology, it would also impact the people who are working for this technology. For my STS Paper, I want to tackle such questions using the STS methodology, Actor Network Theory (Callon, 2001). One of the key premises of Actor Network Theory is that everything coincides in a network or in some relationship and that every actor is as important as the other. Likewise, in my STS Paper, I need to consider the target users for whom the technology in question is being made for. I will talk about any sort of limitations, assumptions, or biases towards the users factoring in race, sex, culture, age, type of disability, etc. Furthermore, I

will also talk about the challenges and disadvantages of the technologies themselves (Šabanović, 2017, Page 107 – 116).

A potential example of such a technology is a hand gesture-based wheelchair movement control for disabled person using MEMS (Pande, 2014, Page 152-158). This paper proposes a solution to a technology of detecting hand movements and gestures and translating them to a human-robot interface between a user and an intelligent wheelchair. This is one of many examples where such technologies are made or being proposed to benefit the disabled people in our community. Taking this specific gesture-based wheelchair technology, the following paragraphs show an example of how I will conduct the research to answer my STS research question. First, I will figure out what this technology currently is and to whom and how it is benefiting. Next, I will look into future scopes and proposed improvements to this technology. I will also investigate the limitations and assumptions made by this technology. Moreover, I will try to see if the said technology has any disadvantages or challenges specifically to any targeted or non-targeted customers. Lastly, I will connect the creators of this technology, the users of this technology, and the technology itself with Actor Network Theory concluding the impact of this technology on everyone in the present and the future.

This is a proposed solution to a wheelchair that is designed to operate with the gestures of one's hands and fingers. People with physical disabilities who need a wheelchair but are not able to operate one on their own will greatly benefit from such a product. The paper mentions what components can be used to make such a device, but it also gives suggestions on how this technology can be further improved in the future: "To enhance the speed of the wheelchair dc motors can be replaced by servomotors." (Pande, 2014, Page 158). There are a few limitations to

this technology. First is that the target audience for whom this technology is designed are people specifically with disabilities in their lower limbs as Pande and his team pointed out that “It is necessary to use devices like wheelchairs that offer a means of displacement for patients with motor problems of the lower limbs.” (Pande, 2014, Page 153). Secondly, the assumption made by this technology is that even though a person is physically disabled, their hands and fingers need to function properly because the paper says, “Accelerometers are attached to the fingertips and the back of the hand.” (Pande, 2014, Page 152). Third, this is designed for people who are of a certain age or older with a minimum intelligence level because to operate such a technology, one needs to understand how it works as the paper mentioned “The gesture-based wheelchair is suitable for the elderly and the physically challenged people who are unfortunate to have lost ability in their limbs due to paralysis or by birth or by old age.” (Pande, 2014, Page 152). This technology’s biggest challenge might be the complexity of it. Some users might find it difficult to operate a device using gestures. Depending on the sensitivity of the accelerometers, users might find themselves moving the wheelchair at unwanted or inappropriate times if their hands or fingers move even slightly. This will specifically affect those with less education or less familiarity with technologies in general.

Through the actor network theory, there are three actors in this case. First are the researchers who wrote this paper suggesting the creation of this technology. These researchers are highly knowledgeable of what technologies already exist, and how they can be made better. Being able to use their knowledge and expertise in science and technology for such a good cause is what matters the most to them, and this ultimately led to the innovation of this product. The second actors are people with physical disabilities in their lower body. They are the sole reason why researchers are even thinking about such a technology. These people do not really care

about where this high-tech wheelchair comes from, who makes it, and how it is made. All they care about is whether this technology is helping them. The third actor is the wheelchair, the technology itself. The main goal for this technology is just to exist, and without the researchers or the users, this technology has no chance of existing. Hence why this makes the gesture-based wheelchair, the researchers behind this wheelchair, and the disabled users who will be using this wheelchair all actors who coexist in a network because of one another. The researchers are researching because this technology is an opportunity for work and research and because they want to help the disabled community. The disabled users will be using this technology only because the researchers invented this in the first place and because the technology will benefit them. The technology exists solely because the researchers and the creators will be creating them, and the disabled users will be using them. Every one of these actors is related to one another and are as important as all the other actors.

Aside from some limitations, a technology like this could be beneficial to the current disabled community specifically to people of physical disabilities in the lower body. There is room for improvements in this technology, which upon implementation, could benefit these people even more in the future. Overall, this technology seems promising and is a fine advancement for motion-controlled techniques.

Conclusion

My goal for the STS Thesis paper is to first figure out the practical usage of technology through motions along with its limitations, biases, advantages, and disadvantages. Then through

the completion of my Capstone Project and doing extensive research, I wish to gain enough knowledge about this technology to be able to answer my STS research question and figure out how this technology is currently impacting the disabled people in our community and how it might do so in the future.

Key Texts

Motion-control techniques of today and tomorrow: a review and discussion of the challenges of controlled motion by Michael Ruderman, Makoto Iwasaki, Wen-Hua Chen is a document that talks about the status of motion-controlled technology and the possible advancement of this technology in the future. This is relevant to my technical project because my project is a wireless motion controlled robotic vehicle which is currently just made as a prototype but could be made to a more advanced level in the future. It is built with currently available technology and components and could be made better with high functioning and better technology. This is relevant to my STS paper because this would explain to me the possible prospects of this technology and what the future for such technology might look like.

Actor-Network Theory by Michel Callon is a reading that goes deep into the concepts of Actor Network Theory. This is relevant to my STS paper because this will give me a good understanding of Actor Network Theory. Actor Network Theory is the STS methodology I am using to help me answer my STS research question. I will need to understand how all the actors in a given scenario are connected and how they are impacting each other, and this will be a good resource to help me achieve that.

Challenges in motion control systems by Asif Šabanović is a paper solely focused on challenges faced by motion-controlled technologies. This is relevant to my technical project because my project is a wireless motion controlled robotic vehicle where some users might struggle with the control of the car through certain hand gestures. This is relevant to my STS paper because this will give me ideas on the challenges and disadvantages of motion-controlled technology which is another aspect of my STS topic: to be able to figure out the downsides of such technology.

Hand Gesture Based Wheelchair Movement Control for Disabled Person Using MEMS by Professor Vishal V. Pande, Nikita S. Ubale, Darshana P. Masurkar, Nikita R. Ingole, Prapati P. Mane is a paper written to introduce an idea and the solution for a gesture-controlled wheelchair technology designed for disabled people. This is relevant to my STS paper because this gives a practical example of how such a technology might be used to benefit the disabled people in our society. It goes over the solution for such a technology in detail along with some suggestions for future improvements. It also states the target audience clearly and how this technology might benefit them. And thus, it is a really good resource for my STS Thesis paper.

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