Thesis Project Portfolio

Novel EMG-IMU Sensor Array for a 5-DOF Wearable Robotic Upper-Limb Exoskeleton
(Technical Paper)

Cochlear Implants and Brain-Computer Interfaces: How society reacts to revolutionary medicine
(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

The two reports presented in this portfolio are connected in by seeking to help improve the lives of those living with disabilities. The two projects are different in the approaches that they take towards the problem and the solutions that are developed, which allows for a more nuanced view of the goal of treating those with disabilities The STS Research Paper explores the social and medical model of disability with regards to treating deafness and other motor disabilities while the Capstone Project adheres to the traditional medical model of disability in developing a medical technology to alleviate the symptoms of paralysis. The social model seeks to help those with disabilities through social structures and environments that help accommodate and empower those with disabilities while the medical model treats disabilities as an ailment and seeks to construct treatments and interventions to alleviate symptoms or cure the condition altogether (*Medical and Social Models of Disability, n.d.*).

Recent advances in the field of medical treatment of paralysis have centered on creating a direct link between a person's brain and the external world, and this may have a monumental effect on the treatment of paralysis. In particular, brain-computer interfaces typically establish this link via a brain implant that conveys brain signals in the motor cortex to a computer or other digital device (Neuralink, 2021). From there, mechanical actuators and digital devices can be used readily through existing and well understood technologies. The promises of this technology represent a dramatic shift from the current methods of treating paralysis, which include physical therapy at best and assisted living in more severe cases. The STS research paper analyzes the effects of the introduction of such technology by comparison to the introduction of cochlear implants—a technology with similarly important ramifications for the treatment of deafness. Scientific studies and empirical data on the technology are used to understand the technologies

current state and associated challenges facing scientists, and social science papers and studies and well-documented accounts are used to understand inequities and social issues that plague both BCI technology directly and the case study of cochlear implants and deafness. BCIs are analyzed through paradigm shift as and coproduction frameworks in order to understand and predict conflicts and social issues that may arise so solutions may be prepared if such issues do manifest. A more seamless introduction of ground-breaking technology that will improve the lives of countless people living with paralysis.

Wearable upper-limb exoskeletons are medical devices which have been used for traumatic injury rehabilitation. The Capstone Project will design such a robotic exoskeleton to help restore five degrees of freedom of arm movement. Both electrical and mechanical solutions are required to compose the prototype. This report discusses the design for the electrical sensors of the exoskeleton. The electromyography (EMG) sensors are placed in eight locations on the arm on major muscles associated with arm movements. The inertial measurement unit (IMU) sensors will be placed in three locations on the arm to provide closed-loop motion feedback. The goal of the project is to use these sensors to understand the human motion intention, actuate the desired arm motion, and monitor the current state of positions and angles. This will allow those with incomplete paralysis to be able to move their arms so long as they have some degree of nerve activation (*What is a complete vs incomplete injury?*, n.d). The design is portable and wearable so as to emulate a fully-functional arm.

Exploring only one of these approaches diminishes the importance of the other and can give slanted views of the issues discussed. Both the medical models and the social models of disability have produced great strides in the care of disabled people. The ADA is a pertinent example of the success of the social model by encouraging care and accommodation of disability

while the cochlear implant proves that medicine can help provide new opportunities and avenues for people with disabilities. It also highlights some of the critiques of both approaches. The medical model is criticized by those in disabled communities who reject the assumptions that the medical model makes about living with a disability that their lives are of a lesser quality than a life without disability (Padden, 1998). The social model, on the other hand, operates on a broader, society-wide scale, offering fixes to large problems without solving the unique issues on an individual basis. This could make it especially difficult for those who acquire their disabilities later in life and must alter their daily routine (Belkacem, 2020). Studying both approaches shows that the best approaches to large enough problems must be dealt with by numerous groups and institutions.

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