Thesis Project Portfolio

Soft Robotic Exoskeleton for Elbow Assistance

(Technical Report)

The Societal Impact on the Development of Wearable Technology

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Wearable electronics is a quickly developing technology that has made many recent advancements in both the medical and entertainment fields. While commercialized wearables are easily evolved and introduced into the market, the design and development of medical wearables are more complicated and require a more complex process to enter the public. Through my research this year, I learned a lot about the process of designing a wearable and the societal impact that influences this process.

The technical portion of my research was designing and constructing a lightweight wearable robotic upper-limb exoskeleton that will aid arm mobility for patients with neuromuscular disorders, specifically focusing on use of artificial muscles in the elbow. Soft robotic technology provides a lightweight and flexible alternative to bulky motorized exo-skeletons. The robot senses electromyographic signals from the muscles in the wearer's arm and responds accordingly with assistive motion to help the wearer achieve their intended motion. The design of the exoskeleton is textile-based and actuated by pneumatic artificial muscles, specifically McKibben actuators. This technology is simple to manufacture and can be used to produce more organic motion than motors as it more closely imitates real muscle fibers. Since this design has limited precedent, especially concerning the rotational degree of freedom of the forearm, my group built and tested many different actuators in order to determine the most effective design. After establishing and constructing the muscles for the elbow, we combined efforts with the shoulder group in order to finish the completed exoskeleton.

For my STS research, I examine the societal impact on development of wearable technology, specifically examining the commercialization and medical applications. Since commercialized wearable electronics are made for average daily use and require little regulation

to enter the market, companies have more incentive to design and advance wearables for entertainment purposes. However, wearable technology was initially developed for medical uses, which have become more difficult to obtain in recent years. This change in application can be attributed to the Social Construction of Technology, which demonstrates the intertwining of society and technology. By examining products like the Fitbit or the Apple Watch, one can see the shift of wearables from health-related devices to purely entertainment accessories. This comes from the interest and demand of society, specifically the stakeholders that have the most input.

Overall, the research and work done this year was productive. Although the McKibbens in the exoskeleton worked efficiently for full success of the supination/pronation movement, the flexion/extension degree of freedom needs more work to provide for the full extent of motion. Moving forward, one could use actuators that lengthen instead of contracting, as the McKibbens do. However, with the time and resources provided, my team created a successful prototype and learned a lot about the process of building medical wearables. More prototyping and testing by real patients could be done in the future to develop the design and further understand the process of integrating a wearable device into a hospital, and therefore society.