Thesis Project Portfolio

W.E.A.R. Bot - Wrist-Elbow Automated Rehabilitation Robot

(Technical Report)

Factors Influencing Societal Acceptance of Exoskeletons

(STS Research Report)

An Undergraduate Thesis

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Sociotechnical Synthesis

Wearable technology is a constantly evolving field. One of the up-and-coming technologies in this field is exoskeletons. They are engineered to work in tandem with the user to assist in transferring load or augmenting joint torque. My capstone and research delve into how to design exoskeletons and how they are accepted into society.

The technical portion of this research focused on designing and constructing a rehabilitative soft upper limb exoskeleton that targets paresis. Neuromuscular disorders, strokes, and spinal cord injuries can lead to patients experiencing varying degrees of paresis or paralysis. Passive movement therapy, where a therapist manually moves the targeted limb to induce neuroplastic change, is highly effective in activating the muscle-brain connection. Exoskeletons are designed to aid patients in achieving these movements without the direct assistance of a physical therapist. However, exoskeletons are not widely adopted because they are rigid, heavy, and expensive. Soft exoskeletons are a cheaper and more lightweight alternative.

The design of my exoskeleton focuses on aiding patients to regain mobility in an affordable and portable way. This exoskeleton includes a unique combination of flexion and extension in the elbow and wrist to support gross and fine motor skill development. Both the elbow and wrist components primarily consist of 3D-printed material and textiles. These materials are lightweight and affordable in comparison to the metal material the majority of exoskeletons consist of. The elbow motion is achieved using a pneumatic artificial muscle (PAM) fixed onto a 3D-printed hinge brace, which is then strapped onto the patient's arm. A solenoid will control the pumping and deflating of the pneumatic muscle creating an exercise sequence. The wrist motion is achieved using a servo motor on a custom 3D-printed wrist brace. Both the wrist and elbow incorporate a potentiometer as feedback control. This allows the

patients the ability to program and customize their therapy. This design will improve upon current exoskeletons on the market.

Exoskeleton technology is rapidly gaining momentum in the rehabilitative field. They offer a product that can truly help people affected with physical impairments. The end objective of exoskeletons is to integrate into society much like other wearable technologies. With how much exoskeletons physically affect the user, it is important to focus on how they will impact users and be accepted.

The research portion of this thesis focuses on the acceptance of exoskeletons in various industries. By identifying and exploring the various factors that may limit the use and effectiveness of exoskeletons, valuable insight is gained into how these devices are accepted and embraced within various contexts and where exoskeletons' integration with society is headed. The main sectors primarily investigated in this paper are rehabilitation, disability, occupational, and military. I examine the overall safety and efficacy of exoskeletons as well as this largely affects widespread assimilation. The Social Construction of Technology (SCoT) framework is used to analyze exoskeleton usage in each sector. There is an emphasis on usability, ergonomics/comfortability, and perception of the user.