Thesis Project Portfolio

Electroencephalogram Controlled Rehabilitative Exoskeleton

(Technical Report)

The Analysis of the Ethics and Accessiblity of Medical Treatments and Medical Robotics Within Low-Income Societies

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

In the technical report, the use of an electroencephalogram (EEG) is investigated as a potential method of human interfacing with medical robotics for rehabilitative purposes. An EEG is a medical device that, when worn on the users skull, allows for brainwave data to be collected. These brainwaves contain information that may point towards specific user intentions or thoughts. By focusing these intentions or thoughts on specific motions, it is theorized that EEG's are able to display brainwaves that are linked to intended motions. Through using data collection methods that focus on thoughts regarding motions in tandem with an EEG and a deep learning algorithm, it becomes possible to classify specific thoughts into intended motions. These classifications can be particularly useful for medical professionals in determining potential rehabilitation programs for those suffering from neuromuscular disorders.

Within the report, a deep learning algorithm is developed to determine the classification of three motions of a human arm using EEG collected brainwave data. These motions consist of moving a human arm right, left, or holding the arm still. After testing and comparing numerous deep learning algorithms, it is found that a Convolutional Neural Network (CNN) deep learning model yields the highest motion classification accuracy. Given that EEG data contains copious amounts of noise during recording, it is imperative to apply pre-processing filters to allow for the most relevant data to be used. In using the CNN model and applying specific filters, it allows for more flexibility in data input and classification, leading to an overall higher motion classification accuracy as a result. The developed CNN model is then applied to a real time EEG data stream collection program that allows for real time classifications to be made. These real time classifications in tandem with a mechanical exoskeleton allow for limb actuation, which assists patients in regaining specific motions in their targeted limb free of muscle strain.

In the STS Research Paper, the connections between accessibility in medical treatments and an individuals' socioeconomic status are examined. Current research indicates that given any medical treatment, whether it be medications or rehabilitative technologies, enormous costs are applied to the patient. This creates an environment where those without access to affordable, effective healthcare plans are forced to incur crippling debt, often leading to major lifestyle changes for the patients or even causing bankruptcy in some cases. Due to the severity of how these incurred costs can affect a given person's life, the question arises, are there any ethical and accessible medical treatments for those who reside in low-income regions without access to effective healthcare plans? If not, is it possible to develop treatments or robotic rehabilitative plans that would allow those without proper healthcare to achieve adequate care? From asking these individual questions, one can identify the specific causes of this disparity in access of affordable medical treatments between those in low-income regions and those in high-income regions, determining potential solutions along the way.

The issue that has been a major contributing factor to these inaccessible medical treatments is seen to lie within the inaccessible healthcare and health insurance plans offered to American citizens. These plans are often seen to have high monthly premiums and seem to be primarily offered through wealthy workplaces. This leaves countless individuals within low-income regions without any means to assist them with medical costs. Not only this, but medical treatments, especially those pertaining to medically rehabilitative robotics, are expensive to develop and distribute to care providers, leaving few options of affordable non-insurance treatment plans. Potential solutions investigated by this paper include the following: shifting healthcare policy focuses to those residing in low-income regions, implementing and developing ethical, low-cost alternatives to medically rehabilitative practices, and developing and

maintaining low-cost-of-entry gyms that specialize in rehabilitative services. These solutions are all seen to have been proved to work in different scenarios but differ in difficulty of implementation.

By intersecting both the STS topic and technical topic, it becomes possible to attack both technical and social purposes simultaneously. From developing a low-cost, accessible rehabilitative device as depicted in the technical paper, it allows for potential developments to erupt within the social dilemma that are present in the STS paper. When analyzing the social aspects of the STS paper, improvements in technical developments may sprout as a result of investigating the social implications of accessible rehabilitative devices.