

**S.U.R.E. : SOFT UPPER-LIMB REHABILITATION EXOSKELETON
AI AND HEALTHCARE: A CASE STUDY ON GOOGLE DEEPMIND'S USE OF AI TO
DIAGNOSE ACUTE KIDNEY INJURY**

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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

My technical project is concerned with stroke rehabilitation, specifically designing a soft exoskeleton for upper arm rehabilitation with a team of people. According to the Centers for Disease Control and Prevention, stroke is a leading cause of serious long-term disability and reduces mobility in more than half of stroke survivors who are 65 or older. As a solution to this problem, my technical project aims to design a lightweight, wearable, robotic device that can assist victims of stroke with regaining their mobility in the upper arm. My STS project is about the use of artificial intelligence in the medical field, specifically its use by Google DeepMind in diagnosing acute kidney injury, commonly abbreviated as AKI. Artificial intelligence is trained by data that is fed into machine learning algorithms, thus how well AI can perform is subject to the quality of data it was trained on. Data collection and use has always been a point of controversy due to patient privacy and incidents of data breaches by major corporations (Basu et.al). My STS project aims to address this point of controversy by determining what type of data is being used by Google DeepMind and how it affects the efficacy of their artificial intelligence.

My technical project and STS project do not necessarily share a connection with one another, however both projects address important issues of the reality that we live in. My prospectus will elaborate further on both projects by detailing how my rehabilitation robot is designed and then investigating my STS topic. In order to conduct an analysis of my STS topic, I will employ the Actor-Network theory framework. In doing so, I will identify both human and non-human actors involved with Google DeepMind and how the relationship between these two entities connect with one another.

Technical Project

My technical project deals with stroke rehabilitation for patients who have lost mobility of their upper limb by creating a soft exoskeleton rehabilitation robot, which my team and I have termed S.U.R.E; an acronym that stands for Soft Upper-Limb Rehabilitation Exoskeleton. As stated above in the introduction, S.U.R.E. is designed to assist with regaining mobility of the upper arm. Additionally, S.U.R.E. is designed to be an affordable alternative as opposed to receiving treatment at a clinic or a hospital which can be very expensive. A research paper published in the Journal of Rehabilitation Medicine estimates that the average cost for inpatient and outpatient stroke rehabilitation was \$70,601 and \$27,473, respectively. This is well above what the average U.S. citizen can afford even after assistance from insurance companies, that is if they even have health insurance. S.U.R.E. is designed to be affordable, specifically aiming to be under \$300.

S.U.R.E differs from existing technologies by combining fine motor assistive technology with upper limb assistive technology to create a more comprehensive solution with 2 degrees of freedom. Additionally, S.U.R.E is designed to be lightweight in order to reduce the physical stress on the wearer. The current design consists of a backpack, two arm cuffs, and a glove. The backpack contains the circuit board that houses the Arduino microcontroller and motors for extending and contracting the Bowden cables. One cuff will be worn above the elbow and the other at the wrist. A Bowden cable will run along the length of the arm, anchored at the cuffs. Another cable will run from a motor on the back of the hand, to the inside tip of the middle finger. The fingers on the gloves will be sewed together to move the fingers simultaneously. Both cables will be retracted using motors controlled by an Arduino microcontroller. Points where the

exoskeleton makes contact with the wearer i.e. the backpack, arm cuffs, and the glove will be made from fabric and adjustable to fit patients with a variety of arm sizes and body types.

STS Project

My STS research topic aims to address the ever-growing advent of technological advancement within American society. Recently, the use of artificial intelligence has become more popular amongst the masses. This is predominantly due to the release of ChatGPT, a large language model-based chatbot that can formulate responses to a given prompt, to the general public in November of 2022. However, AI has been incorporated into our daily lives long before November 2022, it just was not available for use by the general public. With any new technology there are concerns with the efficacy of the technology and the ethics behind employing it within our daily lives. With regards to AI, these concerns are rampant as ever because AI is the bridge between humans and computers and most are highly skeptical of a computer's ability to mimic that of a human's. One use of AI is of that in the medical field for diagnosing patients. I will be investigating the use of AI by Google DeepMind, a British-American artificial intelligence research laboratory, to diagnose acute kidney injury.

The distinction between artificial intelligence and machine learning is significant as the terms are used interchangeably but are not synonymous with one another. An article by California Institute of Technology defines artificial intelligence as the ability of computers to mimic human thought and perform tasks like a human would, while machine learning is a technique applied to computer systems to refine or train its artificial intelligence. There are many machine learning algorithms used to train AI, but the significance is the data that is being fed into these algorithms. AI systems make decisions based on external data fed into training algorithms by looking for patterns and relationships much like a human would. The drawback is

these systems are not able to make decisions outside of the bounds of the data. An article in the *Annual Review of Biomedical Data Science* writes, “For instance, recent work has demonstrated that state-of-the-art clinical prediction models underperform on women, ethnic and racial minorities, and those with public insurance” (Chen et.al). From the quote, it can be deduced that the efficacy of machine learning models cannot be trusted for a variety of groups of people, typically minorities, but that does not prevent the algorithms from being used. In the case of Google DeepMind, the data that was being used came from an agreement between DeepMind and the Royal Free London NHS Trust in which Google DeepMind was given access to healthcare records of 1.6 million patients. However, the data Google DeepMind had access to was not exclusive to kidney functions as one would presume would be used in an algorithm for diagnosing AKI. Rather, the data included information about patients who were HIV-positive, had drug overdoses, abortions, and all patient records from the past five years (Hodson). The amount and quality of data given to Google DeepMind has very powerful potential for bias and inaccurate results due to confounding factors, needless to say it is a massive breach of privacy. Additionally, the data is especially of concern for racial and ethnic minorities and women since they are most likely to be underperformed on as stated by Chen et.al.

I will expound on the use of artificial intelligence by Google Deepmind to diagnose AKI by using Actor-Network theory. By employing Actor-Network theory, I can identify both the human and non-human actors involved, analyze how they form a network with one another, and determine how this network allows certain relationships and events to manifest. The human actors involved are the hospital patients, Google DeepMind, and the Royal Free London NHS Trust. The non-human actors involved are the patient records, the Google AI and the machine learning algorithms used to train the AI. The Royal Free London NHS Trust is a hospital where

patients are admitted and this is the hospital that gave access to patient data to Google DeepMind to use. By analyzing the relationship between Google DeepMind and the Royal Free London NHS Trust, I will determine how these two actors came to an agreement and formed the network that incorporates everything above.

Key Texts

I will use 4 primary texts to supplement the analysis of my STS topic. To begin I will use *An Introduction to Science and Technology Studies* by Sergio Sismondo. Specifically, I will be using the chapter on Actor-Network Theory. In this chapter, Sismondo details the intricacies of the Actor-Network theory and explains how to properly create a network between human and non-human actors. In addition, Sismondo explains the shortcomings of the Actor-Network theory and I can use this to gain insight into how my analysis might be limited or what it does not take into account.

The second text that I will be using is *Rebooting AI: Building Artificial Intelligence We Can Trust* by Gary Marcus and Ernest Davis. This book is written by two researchers who have dedicated their careers to AI and it explains what is needed to develop trustworthy AI without having to be fearful of harmful side effects. I will use this text to explain how the data gathered by Google DeepMind can have a lot of repercussions to the AI it was attempting to develop, regardless of it being a massive invasion of privacy.

The third text I will be employing is *Principles of Neurodynamics: Perceptrons and the Theory of Brain Mechanisms* by Frank Rosenblatt. Rosenblatt was a psychologist who is most famously known for the invention of the Mark I Perceptron, the first hardware implementation of machine learning. It was designed to be able to identify and classify images. I will be using this

text as a historical approach to map out how AI has evolved from what Rosenblatt envisioned it to be and how it is being used as in the case of Google DeepMind.

The fourth and final text I will be using will be a transcript of a legal review of Google DeepMind by the global law firm Linklaters. By using this transcript, I will analyze what Google DeepMind intended with their actions and whether or not their actions were legal or not. In addition, this document will provide insight to who Google DeepMind was associating with and whether or not there is something larger at play.

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