Thesis Project Portfolio

The Squat Bot: A Minimally-Invasive, Low-Cost Exoskeleton for Sitting and Standing

(Technical Report)

Ethically Sourcing Raw Materials for Technological Trends

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

Leo Wang

Spring, 2024

Department of Mechanical Engineering

Table of Contents

Sociotechnical Synthesis

In the United States, the proportion of people aged greater than 50 is projected to be 25% by 2050. Due to better technology in healthcare, people are starting to live longer. Additionally, the technological advancements come at a cost, demanding a high volume of natural resources. These resources are the backbone of any technological supply chain from electric cars, to med-tech devices. Both my STS research topic and Technical Project aim to take a look or address particularly marginalized groups of elderly injured people, and those who are taken advantage of in the supply chain for battery technology.

The STS portion aims to take a closer look at what is happening in the Democratic Republic of Congo as they are supplying the world with raw materials for higher capacity batteries. The methods involved are unethical and unsustainable. The companies that are profiting off of this unethical labor are making large amounts of money, partly because consumers are being kept in the dark. The materials harvested from the supply chain are being purchased by so many technology companies that it is impossible to find batteries that aren't directly coming from the unethical slave labor. Big tech companies are purposely trying to hide this fact from the public and a step in the right direction would be to expose the extent of how unethical the mining activity really is. In terms of manpower, children as young as six years old are working in heavy metal mines. They are not given proper Personal Protection Equipment and they are also being forced to work with the threat of violence. Additionally, setting up the mines is disastrous to the surrounding ecosystem and the companies do not practice proper disposal protocols. They just dump waste wherever. This is an unsustainable cycle that consumers may have a say in, as long as it is transparent what is actually happening so they are aware.

The technical portion of my portfolio is a potential solution to the growing population of elderly people. Elderly people lose muscle strength, bone density, and joint mobility as they grow older. One significant way they get hurt is from falling when transitioning while standing up and sitting down. A rigid exoskeleton was designed to assist the knee and hip during the motion. Actuation was driven by high torque stepper motors. The paper properly explains the emergence of a new problem and one small solution in the sea of problems. The underlying weaknesses associated with aging branch into so many different problems that can obstruct everyday life and it is important that the advancing technology is used to help those who need it. Additionally, the design is very low cost compared to what already exists on the market. These design choices were made with the intent of being widely distributable.

Both sections share a theme of trying not to get swept away in the wake of technological trends. The increased implementation of electrical systems as opposed to fuel driven systems drive the need for high capacity batteries. This should not be at the detriment of those who are born in a bad situation. One such example is those that are forced to work unsafely in Cobalt mines. Additionally, the workforce that has driven so much of the advancements in biomechanics and mechanical engineering research should not be disposed of like a problem that needs to be dealt with. Rather, the recent years of technological advancements could be used instead to help them. Research that starts earlier will inevitably benefit neighboring fields of study and so it is important to work together to take care of everybody involved in a system or society instead of creating a dichotomy of exploiters and exploited.