Thesis Project Portfolio

Delivering Effective Physical Therapy Remotely via a Wearable Sleeve and Mobile App

(Technical Report)

The Necessity for Ubiquitous Motion Capture Among Athletes, Coaches, and Society

(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

Evan Magnusson

Spring, 2021

Department of Electrical and Computer Engineering

Table of Contents

Sociotechnical Synthesis

(Executive Summary)

The motivation for this thesis is to ultimately develop and distribute lightweight human motion capture in a wearable form-factor to the athletics space. Both the technical and STS portions of the project promote the work of my startup Brave Virtual Worlds that I co-founded with two of my engineering peers during our time at the University of Virginia. The technical portion of this thesis was to apply my computer engineering skills to develop the physical electronic hardware for the lightweight human motion capture wearable that will be distributed to the athletics industry, as well as an iOS mobile application to serve as the user-interface for the wearable. The STS portion of this thesis was to succinctly summarize the research that I have done in order to prove that there is a need for lightweight human motion capture, from both inevitability and design perspectives. As an entrepreneur and an engineer, it is important to not only know how to develop a specific technology, but to also understand the needs of those who will use the technology and the ethical implications for all of the stakeholders involved.

The technical portion of my thesis involved the creation of the electronic hardware for the lightweight human motion capture wearable, including the embedded software ran on the device. This was done using the techniques learned throughout the computer engineering curriculum, which had us create PCBs for specific purposes as well as write the embedded code for hardware to accomplish specific tasks, including communication between devices. As a member of a larger group, I was responsible for implementing the Bluetooth communication protocol for the device, which relayed the recorded sensor data between the wearable and the user's iOS device. Part of the technical project included developing an iOS mobile application written in Swift, in which I

was in charge of delegating tasks and implementing the Bluetooth communication and database storage.

The STS portion of my thesis focused on analyzing the need for the lightweight human motion capture hardware developed during the technical portion of my thesis. The technology was originally developed with the intention to improve the physical therapy space, but over the course of the project, there was a greater pull factor from the space of athletics with less regulatory hoops to jump through as well. Much of the STS research involved analyzing statistics, research papers, and most importantly, customer discovery interviews with potential end-users of the technology. As per a research framework that looks at a specific technology from the point of view of inevitability and a point of view of design focus, the STS portion of my thesis supports that there is a necessity for lightweight human motion capture in the space of athletics.

My thesis, including both the technical and STS portions of the project, has enriched each other as one focused on developing a technology that is now a product while the other focused on solidifying a target market for the product. As an entrepreneur and an engineer, this is a very ideal outcome to have, especially as someone who is committed to working on this startup full-time after graduating. This project as a whole exemplifies the themes of STS that the University of Virginia seeks to teach aspiring engineers, as before developing this lightweight human motion capture wearable, there has been ample research into whether anyone actually wants this specific technology.