Thesis Project Portfolio

Brave Virtual Worlds: Implementation of Motion Capture Methodologies for Predictive and Preventative ACL Rehabilitation
(Technical Report)

Biological Citizenship: The Effect of the Cross Section of Big Data and Healthcare on the Empowerment of the Citizen
(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

Dhyey Parikh

Spring, 2021

Department of Biomedical Engineering

Table of Contents

Sociotechnical Synthesis

Every year, there are around 200,000 to 400,000 anterior cruciate ligament (ACL) injuries in the United States alone with the most affected population being young athletes participating in medium to highly intensive activities. Thus, there has been a growing need to understand the mechanism of ACL injury and provide preventative solutions. The project analyzed the current state of the art preventative tools used to understand injurious movement patterns that can lead to an ACL injury and then created a wearable device paired with machine learning driven software to help young athletes understand their movement. With current tools using varying sorts of motion capture either via optical equipment (cameras) or on-body motion capture sensors, the focus has become the analysis of the data gathered from such devices. The project aimed to understand how such data can demonstrate deviations in typical movement behaviors that can lead to potential injuries, such as classifying the occurrence of a dynamic knee valgus collapse to determine the likelihood of an ACL injury.

The technical portion involved using a custom motion-capture wearable device engineered by a University of Virginia (UVA) Electrical Engineering research group to gather data on the dynamic knee valgus collapse. This was done by partnering with a team of doctorate physical therapy students at Mary Baldwin University (MBU) and conducting preliminary testing of the device prior to an IRB approved biomedical study. The data was then analyzed using various machine learning algorithms to determine the accuracy of classifying a knee valgus collapse versus a normal knee abduction (bending of the knee). The algorithms tested included K-Nearest Neighbors, Logistic Regression, and a Recurrent Neural Network (RNN) called a Long Short-Term Memory (LSTM). These algorithms were implemented in Python which then resulted in outputs demonstrating their accuracy, precision, recall, and time in classifying a knee valgus collapse.

The STS portion explored how the inclusion of Big Data in healthcare has changed the interactions between the biological citizenship of an individual and various socio-political actors. In the past, government-led programs or large research studies were the forerunners of demonstrating how data has caused a change in the empowerment or self-advocacy of a citizen on a biological level. Studies discussing the aforementioned phenomenon were then compared to the recent development of wearable technologies that have become disruptive by further strengthening the relationship between Big Data and biological citizenship.

The technical and STS portions both provided new insights into how wearable technologies are changing the way we look at ourselves. By opening up insights into something as fundamental as human movement, a motion capture based wearable provides both a tool to prevent injuries but also risk exposure of knowledge on details about ourselves were previously unknown to those around us. I would like to thank Professor Ferguson for his guidance in developing the STS research portion of my thesis. I would also like to thank Professor Barker and a UVA student startup, Brave Virtual Worlds, who provided assistance in developing the technical portion of my thesis.