Thesis Project Portfolio

Application for Quantifying Ankle Ligament Laxity Using an Inertial Measurement Unit (IMU) Sensor to Assess Rehabilitation Progress During and After Treatment for Chronic Ankle Instability

(Technical Report)

A Utilitarian Analysis of EU's CE Mark for ChestLink: Autonomous Artificial Intelligence for Medical Diagnostic Evaluation

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

My technical and STS research projects are related because they both deal with the use of technology in medical diagnostics. My STS paper concerns itself with the use of artificial intelligence (AI) to help make diagnoses in chest x-rays. While my technical project does not involve the use of AI and is in the realm of orthopedics, it still connects to the ethics of AI. By developing a method and app that allows clinicians to quantifiably measure the laxity of ankle ligaments, we have laid the foundation for an AI tool to make diagnostic and treatment decisions. By detecting the laxity in ankle ligaments, tracking changes over time, and taking into consideration MRI results, patient injury history, and symptoms, AI could be used to learn how to make treatment recommendations based on clinical trial results. Both projects concern themselves with the future of biomedical engineering, where finding ways to use technology to enhance treatment decisions is paramount and the use of AI is emerging to take on this task.

My capstone partner, Maddie, and I developed a novel application for quantifying ankle ligament laxity. The application's design addresses the absence of a reliable quantitative method for evaluating ankle instability. It serves as a tool to determine the best course of treatment and allows surgeons to quantify the benefits of undergoing surgery for chronic ankle instability. The MATLAB application connects to an Inertial Measurement Unit (IMU) sensor. The IMU sensor is placed on the patient’s foot and is used to track the foot in 3D space while the clinician performs standard mechanical tests. The first page of our application provides a user-friendly platform for connecting the sensor, collecting, visualizing, and saving data. The second page is used for processing the roll, pitch, and yaw data using algorithms. The user can visually and numerically display the results of the patient’s ankle ligament laxity. Finally, the third page of the application allows the user to assess rehabilitation progress by viewing trends in the patient’s data throughout treatment and has the option to generate a PDF report of all the results.

In my STS research paper, I examined the European Union's (EU) decision to certify ChestLink as a Class IIb medical device. In March 2022, ChestLink became the first Artificial Intelligence (AI) tool to receive certification for carrying out medical diagnostic evaluations autonomously. I used utilitarianism to argue that the EU acted morally in their decision. I demonstrated that allowing ChestLink to be used in clinics would increase the livability of the environment and life-ability of the population, thus increasing overall happiness for the majority. Additionally, I considered the distribution of the cost and benefits of ChestLink and claimed that it provides a better opportunity for equity and access to accurate radiology reports.

Working on both projects simultaneously allowed me to think critically about the implications of my present and future work in biomedical engineering. For my STS paper, I did extensive research about patient trust in doctors and technology. This prompted me to incorporate features in our application that enhance both the patients' and doctors' confidence in the results. I was able to thoroughly understand the importance of quantifying results and demonstrating the reliability of technology, especially when it relates to medical decisions. I read about regulatory pathways for medical devices which helped to inform the avenue we would have to go if we were to market our application. Writing my STS paper through the lens of utilitarianism led me to reflect on the utility and potential for distributive justice of our technical project.