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)

Turning to Artificial Intelligence as a Diagnostic Device in Orthopedic Medicine

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

Chronic ankle instability occurs in 20-40% of patients who suffer a lateral ankle sprain. Treatments include surgery, physical therapy, and other non-operative methods. To determine whether a patient should undergo surgery, the surgeon performs diagnostic tests, including two manual stress tests, which are subjective and rely on the physician's experience. My capstone project developed a device to quantify ankle ligament relative laxity indexes (RLI) to provide physicians with numerical results for these tests. We also demonstrated the importance of including two additional stress tests, the internal rotation and external rotation tests, which are less commonly performed, but can yield different results depending on the injury. We developed an application in MATLAB that utilized an inertial measurement unit sensor to collect acceleration and orientation data as the physician performs the tests. It processes the data, displays the results, and allows the user to compute the overall results for each patient while highlighting and categorizing the resulting RLIs into severity groups.

When developing any diagnostic technology, it is important to consider the impact of the device on human lives. Since humans are using the device, it must remain consistent between users and be easy to use, efficient, and accurate, and must be as unbiased as possible. Additionally, it is important to consider how the device may influence the lives of patients, as incorrect usage or inaccuracy could lead to unnecessary surgery or extending treatment length.

Star's infrastructure framework can be applied to this problem to understand how medical technologies fit into the larger medical infrastructure. These technologies demonstrate this framework's facets including linking with conventions of practice, embodying standards, and being fixed in modular increments. For my STS research I conducted a focused literature review of research articles, news articles, and regulatory guidelines to explore the potential for artificial intelligence-based diagnostic technologies to become a standard of care in orthopedic medicine. I specifically analyzed the way AI technology fits into the medical infrastructure by exploring the way the sources describe how it embodies Star's infrastructure framework. I found that these sources provided many examples of the potential for AI diagnostic technologies to become part of the medical infrastructure and to become incorporated into orthopedic diagnostic practices.

When considered together, this undergraduate thesis explores the potential for software based devices, like an application to quantify RLI to diagnose and treat chronic ankle instability, to be adopted in medicine. While my capstone project does not use AI, the data collected could be used in conjunction with AI to provide diagnosis and treatment plans. Additionally, both research projects originate from the need for better diagnostic technologies.