Thesis Project Portfolio

Visualizing Position and Orientation in 3D Space Using Common External Controllers

(Technical Report)

Inertial Motion-Sensing Technology to Aid Rehabilitation and Development of People with Disabilities

(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

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Spring, 2023

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Executive Summary

Throughout my tenure at the University of Virginia, a key interest of mine has been the intersection of computer science and the real world. In classes with robotics and in my own time I have endeavored to engage in interesting projects exploring this intersection, especially the way that computers see the world through sensors. One such set of sensors I was particularly intrigued by are inertial measurement sensors. These sensors are a core component of my capstone technical project and STS paper through which I both work with the technology and analyze its potential impacts.

For my technical project, I designed and built an openly-accessible library to interface with common inertial sensing capable devices. Intertial measurement technology, and the systems that use it, have been around for years with a multitude of varied applications ranging from handheld devices to aircraft navigation. As a result, many of the modern devices that you would expect to find in the common home such as GPS systems, vehicles, or smartphones contain inertial measurement sensors. However, despite this, I found that there are currently few easily accessible ways to work with inertial sensing capable hardware. Using inertial sensors by themselves is incredibly difficult due to a number of prevalent and well-documented issues with the technology. Yet, the algorithms and methods implemented by most of the common inertial sensing capable devices to combat these issues are highly advanced and not publicly available for use. This combination of factors makes the use of inertial sensing technology in smaller or independent projects often prohibitively difficult. And so, I built the interfacing library in hopes of making this technology available to more users.

Among the many possible applications of inertial measurement technology, the focus of my project was on estimating the position and orientation of a device in 3D space. To this end,

the library is composed of three distinct components which each perform a specific task: reading the raw inertial data from the device's sensors, cleaning and interpreting the inertial data to compute position and orientation, and visualizing the computed metrics in 3D space. Due to the modular construction of the project, the library can be easily expanded to work with new environments and use cases. Thus, with my project, users are able to receive and visualize accurate position and orientation data of a device in whatever environment they need. By creating a tool for increasing accessibility of inertial measurement technology, I contributed to the proliferation of the technology and furthered its usage in independent projects.

In my STS research, I evaluated the potential use of inertial measurement technology in the field of disability rehabilitation and treatment. Continued development and research into inertial measurement technology has shown much promise in expanding the capabilities of disability treatment from a medical perspective. However, caution must be exercised when considering introducing a new technology to treat a vulnerable group so as to examine the social consequences of the technology. So, my research seeks to analyze and answer two primary questions. First, how might inertial measurement technology be useful in the treatment of disabilities and what form would that treatment take? And second, what are the social implications of this new technology and the potential new forms of treatment it may introduce?

To answer these questions, I compiled sources from past research and sought input from professionals in the field who work with disabled individuals to gain insight into the use cases of inertial measurement technology. This found that, from a medical usability perspective, inertial measurement technology showed much promise in a variety of treatment forms. The most prominent of these treatment forms was as wearable sensors that could continuously record data about the movement of the wearer. I then used STS frameworks and methodologies to analyze

the social implications of the technology. Namely, I evaluated the technology against past disability technologies, discussed its potential for misuse in diagnostics and marginalization, and addressed the concept of cure and disability dongles. Through all of these I found that inertial measurement technology is not immune to the negative social impacts that plague disability in society today. However, I also concluded that despite these shortcomings, the technology continues to show promise for use in disability treatment from a social perspective given it is handled with care. Thus, I discussed how the negative social impacts can be combatted and what the future of inertial measurement technology in disability treatment could look like.