Thesis Project Portfolio

Designing Ultrasound Image Analysis Techniques for DC101-treated Tumors in Mice

(Technical Report)

Exploring the Technical and Non-Technical Actors Involved in the Derailment of Amtrak Cascades Passenger Train 501

(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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Table of Contents

Sociotechnical Synthesis

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My technical and STS projects are connected because they both explain how various unique factors must work together to produce technological success. In my technical project, I explain the importance of my team aiming to develop ultrasound imaging techniques that can work in combination with both lipid-based microbubbles and anti-angiogenic drugs. Without all three factors playing a role in the comprehensive plan, it would not be possible to treat tumors in this manner. My STS project uses Actor-Network Theory (ANT) to explore the various factors that contributed to the Amtrak passenger train derailment of 2017 in Dupont, Washington.

The goal of my technical project was to work with the Price Laboratory at the University of Virginia to develop ultrasound imaging techniques that would eventually aid researchers in designing more efficient chemotherapeutic drug delivery to tumors. Currently, the Price Lab is exploring how microbubbles can work with anti-angiogenic drugs to treat tumors. Microbubbles are tiny bubbles filled with air that can traverse systems and have their movements tracked through ultrasound. On the other hand, anti-angiogenic drugs are used to normalize a tumor's chaotic vasculature which would help improve blood flow. This is needed to make the delivery of drugs more productive. Therefore, improving current standards for ultrasound microbubble visualization would allow for the further development of localized chemotherapeutic drug delivery. First, my capstone team built a MATLAB program that is able to input ultrasound images over a range of time to produce valuable parameters such as video intensity and fractional perfusion area. This shows when microbubbles start to fill a significant portion of a tumor's vasculature. Next, we developed a 3D modeling system that inputs ultrasound cross-sectional images at different planes to visualize what a tumor and its vasculature look like. This provides researchers with a more comprehensive overview of what is happening with the tumor.

My STS project showed how negligence from various governing organizations, societal pressure, and political affiliations all contributed to the Amtrak passenger train derailment in 2017. While most of the initial blame was placed on the locomotive engineer who failed to slow down during a hazardous part of the track, I argued that this viewpoint does not offer a comprehensive analysis of the larger prevalent issues. I used ANT to explain that all the human, technical, and societal actors were interconnected where the failure of one actor lead to the downfall of other actors in the network.

Working on these projects at the same time gave me a new perspective on how systems-level analysis is necessary to understand the success or failure of any technological system. While developing the MATLAB imaging system and 3D modeling system for my technical project, I was often keyed in one aspect of the project at a time. However, I realized that that was not conducive to truly understanding the project. Furthermore, exploring how various factors worked together to produce a tragic train derailment pushed me to think more critically about related successes and failures. In summary, working on my technical and STS projects in tandem has allowed me to comprehensively analyze and understand how different factors may play a role in any success or failure.