

Thesis Project Portfolio

Development of a Novel Fetal Heart Rate Triangulation Algorithm for Multiple Gestation

Pregnancies

(Technical Report)

A Technological Politics Analysis of OxyContin's Role in the Opioid Crisis

(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, 2024

Department of Biomedical Engineering

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Sociotechnical Synthesis

In prenatal care, the Doppler ultrasound device plays an important role in shaping patient outcomes. The evolution of fetal heart rate (fHR) monitoring devices exemplifies how technology not only responds to medical needs but also establishes frameworks that influence healthcare practices. This interaction between technology and its societal impact is the foundation of my studies in both my technical capstone and STS research project. To gain insight into the technological politics of the current fHR monitoring devices, my STS research examines the role of power dynamics in the development and implementation of technologies in the medical realm.

In my technical project, my team and I focused on improving the accuracy and usability of Doppler ultrasound devices for monitoring the heart rates of multiple fetuses. This effort addresses gaps in current medical practices, particularly the challenge of distinguishing individual fetal heartbeats in twin or higher order pregnancies. By developing a triangulation algorithm that is able to isolate fetal heartbeats from combined acoustic signals using filtering and frequency analysis techniques, we were able to refine how these devices differentiate between fetal heart rates. Specifically, we did this using Fast Fourier Transform (FFT) for signal decomposition, peak detection to identify heart rate frequencies, and Butterworth bandpass filters centered on these frequencies for signal isolation. Our triangulation method used Time-Difference-of-Arrival (TDOA) estimation and optimization-based source localization to accurately determine the positions of fetal hearts, reducing the risk of incorrect diagnoses and unnecessary interventions.

My corresponding STS research explores Langdon Winner's concept of technological politics as a framework to explore the social and ethical impacts of OxyContin within the

healthcare system. Winner's theory, which claims that technological artifacts have inherent political properties, serves as a lens to analyze how the design of OxyContin has influenced power dynamics within medical practices. By examining the political nature of this pharmaceutical, I argue that OxyContin deliberately shaped medical protocols and patient interactions, and also deepened existing social and economic disparities.

Through my analysis of technological politics as it relates to OxyContin, I have come to understand that Doppler ultrasound devices do not merely serve as neutral tools for monitoring fetal health, but actively influence medical standards and the interactions between healthcare providers and patients. Working simultaneously on the technical project of enhancing fHR monitoring technology and my STS research project has brought value to my capstone by allowing me to thoroughly understand how technologies shape healthcare practices, thereby bringing greater perspective to my own design efforts. The STS project prompted me to analyze the assumptions underlying technical practices and innovations that are related to prenatal care and fetal heart rate monitoring in particular. This gave me a better understanding of the broader implications of technological developments in this realm, ensuring a more thoughtful approach to my code that considers ethical and social factors in tandem. With this perspective, I was able to develop a final product that I believe is not only innovative, but also equally responsive to the needs of the mother, babies, and doctor.