Keshav Anand — RSI Application

1. Why did you choose these research fields?

Prompt: Articulate why the research fields chosen on the previous page are intriguing and exciting to you. For each sub-field, state what you perceive as the one or two most interesting questions or problems in this area. Explain why these sorts of questions interest you. Your responses are shared with mentors. Please respond with clarity and specificity, including what specific prior research/coursework/etc experiences have prepared you to "hit the ground running" in these fields at RSI.

- Field 1: Computer Science — Machine Learning for Signal Processing
- Field 2: Robotics/Mechatronics — Autonomous Motion Planning

Limit: 5000 Characters

Firstly, I find Computer Science deeply intriguing as it is the perfect crossover between my two passions of mathematics and problem-solving. The ability to optimize a computer chip to solve a pratical problem has always fascinated me, and the rising popularity of Machine Learning and Artificial Intelligence further piqued my interest during the COVID-19 pandemic. My research project from 2024 - 2025, GaitGuardian, started my journey with signal processing, as I had worked on a project to predict Freezing of Gait (FoG) episodes in Parkinson's Disease patients using a belt-mounted IMU sensor and machine learning algorithms. In addition to building an end-to-end hardware embedding with a custom PCB, I also developed a strong understanding of signal processing techniques. My novel pipeline involved using fourier transforms, z-score normalization, and wavelet denoising to filter out noise from the raw IMU data. Unlike existing approachs that used time-domain features, I fed the cleaned time-series data into a 1D CNN, acting as an automatic feature extractor (with no flattening). This was passed into a hybrid biLISTM with temporal and spatial attention mechanisms, allowing for segmented windows to be read both forwards and backwards, and a final dense layer would output the boolean state of whether a FoG episode was occuring in real time. The learning I gained from this research led me to pursue other related signal processing tasks to boost the final product for Parkinson's patients. Researching other Parkinsonian symptoms led me to explore tremor detection (uncontroleld shaking of the hands), and I implemented a real-time tremor detection model that involved a bandpass butterworth filter to isolate tremor frequencies between 4-6 Hz, followed by an FFT to extract frequency-domain features. These features were then fed into a lightweight 1D CNN, resulting in state-of-the-art 99% accuracy while limiting false positives. I also looked into signal processing within my FTC robotics team, realizing that IMU data could be used to improve odometry and localization. I implemented a custom Kalman filter to fuse IMU data with wheel encoder reading, significantly reducing drift during autonomous navigation and reducing error buildup over time. (2268)