Significant Research Experience Essay Example

Prompt: Please describe your significant research experiences. (AMCAS MD/PhD Section)

What this essay does: *Covers two distinct research experiences with a clear transition sentence explaining why the applicant moved between them. Names specific computational and engineering techniques alongside clinical instrumentation. The final paragraph links the engineering work to a specific patient outcome the applicant witnessed, which is the strongest closing move available in this essay type.*

Research in the Pennesi Laboratory at the Casey Eye Institute at Oregon Health and Science University focuses on the development and validation of advanced retinal imaging technologies for the diagnosis and monitoring of degenerative retinal diseases. I joined the Pennesi Lab in the summer between my sophomore and junior years, initially as a volunteer and subsequently as a Fight for Sight Summer Student Fellow, under the supervision of Dr. Mark Pennesi. My work in the lab has spanned two parallel projects involving optical coherence tomography and adaptive optics imaging.

My first project involved characterizing the progression of retinal degeneration in mouse models of retinitis pigmentosa using a Bioptigen spectral-domain OCT system. I learned to operate the instrument on anesthetized mice, acquiring cross-sectional retinal images at multiple timepoints to track layer thinning in the outer nuclear layer and photoreceptor segment loss. More significantly, I developed a set of Matlab algorithms to automate the quantification of retinal layer thickness from OCT image stacks, a task that had previously required manual measurement by a trained technician and took approximately four hours per image set. My automated pipeline reduced processing time to under twelve minutes per set with a measurement error of less than three percent compared to manual ground truth, validated against 200 manually measured images provided by Dr. Pennesi's clinical team. The algorithms I developed were subsequently incorporated into the lab's standard analysis workflow and have been used in two published studies from the group.

My second project moved from the animal model to the clinic. I joined an ongoing effort to validate a flood-illuminated adaptive optics camera for measuring cone photoreceptor density in patients with inherited retinal dystrophies. My contribution was the development of a second Matlab pipeline, this one designed to automatically detect and count individual cone cells in high-resolution adaptive optics images using a combination of intensity thresholding and Voronoi tessellation. Counting cone density manually from these images requires a trained reader and produces results with significant inter-rater variability. My algorithm achieved intraclass correlation coefficients above 0.94 relative to expert manual counts across a validation set of eighty image montages. Results from this project were

presented at the 2025 Association for Research in Vision and Ophthalmology annual conference in Nashville.

The moment that clarified why I want to pursue an MD/PhD occurred during my second summer in the Pennesi Lab, when I was present for a clinical visit from a 12-year-old patient with X-linked retinitis pigmentosa who was enrolled in a natural history study. Dr. Pennesi used the adaptive optics system I had helped validate to image her cone mosaic, and the image showed a preserved central island of cone photoreceptors surrounded by complete degeneration. He showed her and her mother where her remaining functional photoreceptors were and explained that the goal of the research was to develop gene therapy protocols that could target exactly that region before the degeneration reached it. The algorithm I had written was, at that moment, a clinical tool. I had not appreciated until then how close the distance was between an engineering problem and a patient outcome. That distance is the space I want to work in for the rest of my career.