An Innovative Microcontroller-Driven Illumination System to Correct Moderate to Severe Color Vision Deficiency

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Color Vision Deficiency is the most common genetic disability, affecting over 400 million people in the world, and currently has no cure. There are attempts to mitigate the effect of color vision deficiency through the use of optical filters, however, none of the proposed solutions have proven effective for the color vision deficient. Last year, I identified an effect where color contrast is created based on dynamically modifying the wavelength composition of illuminating light. The original device, however, was very limiting, and the goal for this project is to create a more advanced and compact system that a researcher or general user can use to control illumination, frequency, and spectral composition to specifications necessary. The device was created using LED grid controlled by microcontroller and programmed using CircuitPython, with a 3D printed structure designed for ease-of-use. Ability for the device to control different parameters of illumination such as luminosity, frequency, spectral composition and accessible gamut was analyzed through series of designed experiments. The ability of device to improve color recognition was tested on Color Vision Deficient observer diagnosed with Severe Deuteranopia, using standard Ishihara Test Plates that were randomized for each test. Test was conducted with and without dynamic illumination, with flicker frequency controlled by the new device. Recognition rates for different experimental settings was analyzed with Fisher's Exact test, and results indicated a statistically significant increase in color recognition as pulse frequency reached 31.5 Hz ($p=0.0278$), with 100% recognition accuracy at frequencies 21.4 Hz or below ($p<0.00001$).

Awards Won:
Third Award of $1,000
SPIE, the international society for optics and photonics: Third Award of $1,000