Portable and Modular Spectral System for Material Characterization

Prabhakar, Ashwin (School: Bob Jones High School)

Spectral imaging technologies that combine conventional imaging and spectroscopy techniques to acquire spatial and spectral information from objects have gained significant traction over the past decades for investigating material properties in a non-destructive manner. However, most of these systems are either bulky, expensive, or rely on instrument specific software for operation hindering their widespread use. The goal of this project was to design, develop, and demonstrate a low-cost, portable, and modular spectral platform based on a single-shot imaging system. The system was designed in CAD, 3D printed, and developed by integrating optical components and electronics in communication with a single-board computer. A customizable light source was used to illuminate the materials of interest and the imaging parameters were controlled using Python scripts. The system was calibrated using industry standard reflectance color spectrums and tested using solid and liquid materials in both pure and mixed formulation. Dimensional reduction and multivariate analysis successfully demonstrated qualitative and quantitative identification and classification of similar and unique features representative of the materials. The modular nature of the system allows rapid switching of components to suit a wide range of applications for material characterization. Combined with machine learning algorithms, the developed portable, low-cost, and modular system lays the foundation for future applications integrating machine learning for automated analysis of materials.

Awards Won:
Office of Naval Research on behalf of the United States Navy and Marine Corps: The Chief of Naval Research Scholarship Award of $15,000