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Potassium-Phosphorus-Nitrogen Detection and Spectral Segmentation Analysis Using Polarized Hyperspectral Imagery and Machine Learning

Authors : Nicholas V. Scott, Jack McCarthy

Abstract : Military, law enforcement, and counter terrorism organizations are often tasked with target detection and image characterization of scenes containing explosive materials in various types of environments where light scattering intensity is high. Mitigation of this photonic noise using classical digital filtration and signal processing can be difficult. This is partially due to the lack of robust image processing methods for photonic noise removal, which strongly influence high resolution target detection and machine learning-based pattern recognition. Such analysis is crucial to the delivery of reliable intelligence. Polarization filters are a possible method for ambient glare reduction by allowing only certain modes of the electromagnetic field to be captured, providing strong scene contrast. An experiment was carried out utilizing a polarization lens attached to a hyperspectral imagery camera for the purpose of exploring the degree to which an imaged polarized scene of potassium, phosphorus, and nitrogen mixture allows for improved target detection and image segmentation. Preliminary imagery results based on the application of machine learning algorithms, including competitive leaky learning and distance metric analysis, to polarized hyperspectral imagery, suggest that polarization filters provide a slight advantage in image segmentation. The results of this work have implications for understanding the presence of explosive material in dry, desert areas where reflective glare is a significant impediment to scene characterization.

Keywords : explosive material, hyperspectral imagery, image segmentation, machine learning, polarization
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