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Quantitative detection of settled dust over green canopy

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The main task of environmental and geoscience applications are efficient and accurate quantitative classification of earth surfaces and spatial phenomena. In the past decade, there has been a significant interest in employing hyperspectral unmixing in order to retrieve accurate quantitative information latent in hyperspectral imagery data. Recently, the ground-truth and laboratory measured spectral signatures promoted by advanced algorithms are proposed as a new path toward solving the unmixing problem of hyperspectral imagery in semi-supervised fashion. This paper suggests that the sensitivity of sparse unmixing techniques provides an ideal approach to extract and identify dust settled over/upon green vegetation canopy using hyperspectral airborne data. Atmospheric dust transports a variety of chemicals, some of which pose a risk to the ecosystem and human health (Kaskaoutis, et al., 2008). Many studies deal with the impact of dust on particulate matter (PM) and atmospheric pollution. Considering the potential impact of industrial pollutants, one of the most important considerations is the fact that suspended PM can have both a physical and a chemical impact on plants, soils, and water bodies. Not only can the particles covering surfaces cause physical distortion, but particles of diverse origin and different chemistries can also serve as chemical stressors and cause irreversible damage. Sediment dust load in an indoor environment can be spectrally assessed using reflectance spectroscopy (Chudnovsky and Ben-Dor, 2009). Small amounts of particulate pollution that may carry a signature of a forthcoming environmental hazard are of key interest when considering the effects of pollution. According to the most basic distribution dynamics, dust consists of suspended particulate matter in a fine state of subdivision that are raised and carried by wind. In this context, it is increasingly important to first, understand the distribution dynamics of pollutants, and subsequently develop dedicated tools and measures to control and monitor pollutants in the free environment. The earliest effect of settled polluted dust particles is not always reflected through poor conditions of vegetation or soils, or any visible damages. In most of the cases, it has a quite long accumulation process that graduates from a polluted condition to long-term environmental hazard. Although conducted experiments with pollutant analog powders under controlled conditions have tended to confirm the findings from field studies (Brook, 2014), a major criticism of all these experiments is their short duration. The resulting conclusion is that it is difficult, if not impossible, to determine the implications of long-term exposure to realistic concentrations of pollutants from such short-term studies. Hyperspectral remote sensing (HRS) has become a common tool for environmental and geoscience applications. HRS has promoted new opportunities for exploring a wide range of materials and evaluating a variety of natural processes due to its detailed, specific, and extensive information on spectral and spatial disseminations. Hyperspectral unmixing (HU) is the technique of presuming the category type, which constitutes the mix-pixel, and its mixing ratio (Keshava and Mustard, 2002). In general, the task of unmixing is to decompose the reflectance spectrum of each pixel into a set of endmembers or principal combined spectra and their corresponding abundances (Bioucas-Dias et al., 2012). This study suggests that the sensitivity of sparse unmixing techniques provides an ideal approach to extract and identify dust settled over/upon green vegetation canopy using hyperspectral airborne data. Among the available techniques, this study present results of seven linear and non-linear unmixing algorithms: 1) Non-negative Matrix Factorization (NMF), 2) L1 sparsity-constrained NMF (L1–NMF), 3) L1/2 sparsity-constrained NMF (L1/2–NMF), 4) Graph regularized NMF (G-NMF), 5) Structured Sparse NMF (SS-NMF), 6) Alternating Least-Square (ALS), and 2) Lin's Projected Gradient (LPG). The performance is evaluated on real hyperspectral imagery data via detailed experimental assessment. The study showed that in certain compression tasks content-adapted sparse representation is provided by state-of-the-art solutions. The NMF algorithm estimates endmembers that are used to remove spurious information. If computationally feasible, it should include interaction terms to make the model more flexible. The optimal NMF algorithms, such as ALS and LPG, are assumed to be the simplest methods that achieve the minimum error on the test set. In summary, this work shows that sediment dust can be assessed using airborne HSI data, making it a potentially powerful tool for environmental studies.

References

Keshava, N., Mustard, J. (2002). Spectral unmixing. IEEE Signal Process. Mag., 19(1), 44–57.

Chudnovsky, A., & Ben-Dor, E. (2009). Reflectance spectroscopy as a tool for settled dust monitoring in office

environment. International Journal of Environment and Waste Management, 4(1), 32-49.
Brook, A. (2014). Quantitative Detection of Settled dust over Green Canopy using Sparse Unmixing of Airborne Hyperspectral Data. IEEE-Whispers 6th Workshop on Hyperspectral Image and Signal Processing: Evolution in Remote Sensing, 2014, Switzerland, 4-8.
Keshava, N., Mustard, J. (2002). Spectral unmixing. IEEE Signal Process. Mag., 19(1), 44–57.
Bioucas-Dias et al. (2012). Hyperspectral unmixing overview: Geometrical, statistical, and sparse regression-based approaches, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 5(2), 354 –379.