BENCHMARK STUDIES ON SPECTRAL UNMIXING OF MULTI-SENSOR HYPERSPECTRAL IMAGERY

A thesis submitted
in partial fulfilment for the degree of

Doctor of Philosophy

by

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February - 2024

ABSTRACT

Spectral unmixing-based estimation of material abundances in hyperspectral imagery has a variety of applications in mineralogy, environmental monitoring, agriculture, food processing, pharmacy, etc. A substantial body of literature is available on different inversion algorithms, optional pre-processing such as dimensionality reduction, and algorithms for endmembers extraction. The quality of abundance estimation depends on the number of materials, size, the geometrical orientation of materials, the source of endmembers, and the inversion algorithm used. However, there is a paucity of studies on theoretical aspects such as one-to-one assessment of retrieval of abundances under various scenarios of spectral material distributions, the spatial resolution of the imagery, source of endmembers, and the demonstrating different evolving precision remote sensing application templates. The hardware prospects of acquiring multi-perspective benchmark hyperspectral datasets (ground, drone, and airborne) coupled with pixel-to-pixel ground truth data enable a comprehensive assessment of the first principles of spectral unmixing from a verifiable experimental perspective and undertaking various precision remote sensing applications.

This research aims to assess the potential of spectral unmixing for detecting and mapping materials from both theoretically driven proof of concept and application scenarios. Considering select precision remote sensing applications such as (i) targeted materials detection under various forest-landscape settings, (ii) within-canopy abundance of soil and plant material, (iii) multiple crops mapping, and (iv) microplastics detection, the research work presented in this thesis has generated and analysed distinct hyperspectral datasets acquired from laboratory, in-situ, terrestrial (ground), drone, and airborne platforms from the proof-of-concept (PoC) perspective. These application assessments encompass various land surface scenarios – a complex forest, built-up, agricultural landscape, and marine beach environment.