LUISA: Learning urban image spectral archive

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Abstract

The ongoing urbanization affects the city size, urban structures and existing surface materials. Urban surface materials influences several urban processes such as urban microclimate or surface runoff. However, a comprehensive up-to-date acquisition of urban surface materials requires time- and cost-intensive fieldwork. Hyperspectral sensors provide very detailed spectral information for identifying surface materials. For material specific analysis of such data, detailed knowledge about the spectral characteristics of urban surfaces and scene-specific training data is often needed. Therefore, spectral archives or image based spectral libraries are commonly used to support automated image analyses. Existing spectral archives for urban areas are mostly incomplete due to urban complexity, the huge amount of various surface materials and regional differences.

In this study a learning urban image spectral archive (LUISA) has been developed, that overcomes the issue of incompleteness and can be used to derive scene-specific pure material spectra. It consists of an incomplete but well described starting spectral library (LUISA-A) and a tool to derive scene-based pure surface material spectra (LUISA-T). The concept is based on a three-stage approach: (1) Comparing hyperspectral image spectra with LUISA-A library spectra to identify scene-specific pure materials, (2) extracting unknown pure spectra based on spatial and spectral metrics and (3) provides the framework to implement new surface material spectra into LUISA-A. The spectral comparison is based on several similarity measures, followed by an object- and spectral-based ruleset to optimize and categorize potentially new pure spectra, and finally the integration of new labeled spectra with ancillary metadata in a spectral information system.

The results show that the majority of pure surface materials could be identified using LUISA-A. Unknown spectra are composed of mixed pixels and real pure surface materials which could be distinguished by LUISA-T.