Commentary
Volume 15:7, 2022

Journal of Computer Science & Systems Biology

ISSN: 0974-7230

Open Access

Spectral Bands Detection by Using Band Clustering and Dynamic Multi-Graph Constraints

John Hausman*

Department of Information Science, University of Melbourne, Parkville VIC 3010, Australia

Description

Unsupervised band selection has recently gained popularity due to the need to process massive amounts of unlabeled high-dimensional data in the domains of machine learning and data mining. This paper describes a novel unsupervised HSI band selection method that employs band grouping and an adaptive multi-graph constraint. To address the issue of missing strong correlations between adjacent bands, a band grouping strategy that assigns different weights to each group is used to construct a global similarity matrix. Unlike previous studies that were limited to fixed graph constraints, we dynamically adjust the weight of the local similarity matrix to construct a global similarity matrix. The model is built using a combination of significance ranking and band selection after partitioning the HSI cube into several groups.

After constructing the model, we used an iterative algorithm to solve the optimization problem by updating the global similarity matrix, its corresponding reconstruction weights matrix, the projection, and the pseudo-label matrix in order to improve each of them synergistically. Extensive experiments show that our method outperforms the other five cutting-edge band selection methods in publicly available datasets. Hyperspectral images (HSI) have multiple channels in spectral dimensions [1-3], as opposed to traditional RGB three-channel digital images. Because HSI has a high spectral diagnosis ability and can distinguish land-cover details, they are widely used in city planning, agricultural and forestry detection, topographic map updating, mineral exploration, and many other fields. HSI, on the other hand, provides spectral image information with large bands that is susceptible to noise. Furthermore, due to the high correlation among bands, high dimensionality causes significant redundancy in hyper spectral data, posing challenges to image processing, transmission, storage, and analysis.

Band selection is a popular dimensionality reduction technique that seeks a subset of all bands with as few bands as possible that have enough content to represent the overall spectral information. Band selection, like many other machine learning problems, can be classified as supervised, semi-supervised, or unsupervised based on the availability of prior information. In most cases, supervised band selection establishes a standard function to assess the similarity between the chosen band and the marked image. The goal of unsupervised band selection is to find a representative subset of bands that are unrelated to the labelled sample. An unsupervised band selection method for hyperspectral images based on band grouping and adaptive multi-graph constraint to address the problem of the ranking-based method and are inspired by robust unsupervised feature selection via multi-group adaptive graph representation (MGAGR).

We proposed the band grouping strategy in order to fully mine the effective information while avoiding strong correlations between adjacent bands [4,5]. Because band groups with high definition and abundant information are expected to be more significant, different weights are assigned to each group in order to construct the global similarity matrix. Hyperspectral images can be classified according to their spatial location. For example, hyperspectral images used to detect vegetation damage can be classified as non-vegetation (background), healthy vegetation, pest vegetation, water-deficient vegetation, and so on. Obviously, non-vegetation is not the most important information, but the others are.

To save information on the spatial dimension, we build a graph matrix using the correlation between pixels. The graph matrix constructed by each spectral group is defined as the local similarity matrix. We obtain the global similarity matrix by linearly combining multiple local similarity matrices in order to more accurately and comprehensively describe the spatial information. On this basis, we employ regularisation constraints to ensure classification accuracy. Our method with high classification separability accounts for spatial and spectral correlation while using a pseudo-label matrix concurrently and it has high classification separability. After establishing the model, we use an iterative algorithm to solve the optimization problem by updating the global similarity matrix, its corresponding reconstruction weights matrix, and the projection and pseudo-label matrix to synergistically improve each of them.

Acknowledgement

None.

Conflict of Interest

Authors declare no conflict of interest.

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How to cite this article: Hausman, John. "Spectral Bands Detection by Using Band Clustering and Dynamic Multi-Graph Constraints." J Comput Sci Syst Biol 15 (2022):422.

***Address for Correspondence:** John Hausman, Department of Information Science, University of Melbourne, Parkville VIC 3010, Australia, E-mail: jhausman@wc.edu*

Date of Submission: 07 July, 2022, Manuscript No. jcsb-22-78945; **Editor assigned:** 09 July, 2022, Pre QC No. P-78945; **Reviewed:** 23 July, 2022, QC No. Q-78945; **Revised:** 28 July, 2022, Manuscript No. R-78945; **Published:** 02 August, 2022, DOI: 10.37421/0974-7230.2022.15.422