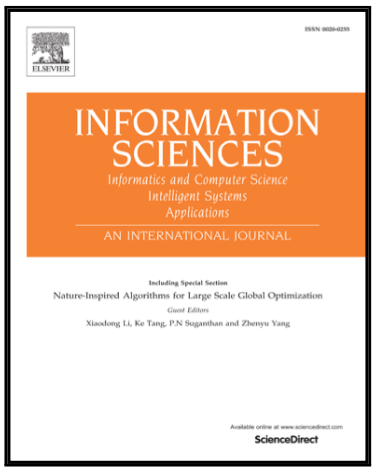

3D Multi-resolution Wavelet Convolutional Neural Networks for Hyperspectral Image Classification

Cheng Shi , Chi-Man Pun

PII: S0020-0255(16)30793-9
DOI: 10.1016/j.ins.2017.08.051
Reference: INS 13055

To appear in: *Information Sciences*

Received date: 7 September 2016
Revised date: 12 June 2017
Accepted date: 13 August 2017

Please cite this article as: Cheng Shi , Chi-Man Pun , 3D Multi-resolution Wavelet Convolutional Neural Networks for Hyperspectral Image Classification, *Information Sciences* (2017), doi: 10.1016/j.ins.2017.08.051

3D Multi-resolution Wavelet Convolutional Neural Networks for Hyperspectral Image Classification

Cheng Shi and Chi-Man Pun*

Department of Computer and Information Sciences University of Macau, Macau, China

e-mail: cmpun@umac.mo

Abstract

Hyperspectral images contain abundant spectral information, and three-dimensional (3D) feature extraction methods have been shown to be effective for classification. In this paper, we propose a hyperspectral image classification method that uses 3D multi-resolution wavelet convolutional network (3D MWCNNs) in which wavelets are first characterized by their time-frequency and multi-resolution. Then, the 3D-MWCNNs extract features from coarse to fine scales. In addition, 3D-MWCNNs work stably and effectively for approximation. In the conventional implementation of wavelets, empirical parameters must be determined in advance and the feature extraction process is not adaptive. Convolutional neural networks (CNNs) have strong adaptive learning capabilities and can extract features from low to high levels; however, they lack the theoretical underpinnings to perform multi-resolution approximation for filter learning. Therefore, by combining the CNNs framework with multi-resolution analysis theory, a model called 3D MWCNNs is proposed to extract the 3D features from different scales and different depths adaptively. 3D MWCNNs model is better at feature representation and approximation from 3D cube data; therefore, they capture the spatial and spectral features more discriminatively to improve the classification accuracy. Experimental results on three well-known hyperspectral images demonstrate that the proposed framework achieves considerably higher classification accuracy than do several state-of-the-art algorithms.

Keywords: Hyperspectral image classification; 3D multi-resolution wavelet; Convolutional neural networks; Feature extraction.

1. Introduction