Remote Sensing of Environment 210 (2018) 345–361

Contents lists available at ScienceDirect

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

Influence of reconstruction scale, spatial resolution and pixel spatial relationships on the sub-pixel mapping accuracy of a double-calculated spatial attraction model

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ARTICLE INFO

Keywords:
Sub-pixel mapping
Super-resolution mapping
Double-calculated spatial attraction model
Scale factor
Pixel spatial relationships
Spatial resolution

ABSTRACT

Mixed pixels universally exist in remote sensing images, and they are one of the main obstacles for further improving the accuracy of land cover recognition and classification. Since the concept of sub-pixel mapping (SPM) is proposed, SPM technology has rapidly become an important method to solve the problem of mixed pixels. To further improve SPM accuracy, this paper first proposes a double-calculated spatial attraction model (DSAM) combining the advantages of the spatial attraction model (SAM) and the pixel swap model (PSM). Then, based on the full validation of the proposed DSAM, how multiple factors affect the SPM accuracy is analyzed using the multispectral remote sensing (MRS) images. Finally, by analyzing the maximum variations in the ranges of the overall accuracy and the kappa coefficient under different multiple factors, the order of factors influencing SPM accuracy is determined as follows: reconstruction scale > image spatial resolution > pixel spatial relationships. The results can serve as a reference for other scholars in setting model parameters and selecting the appropriate remote sensing data, thereby helping them achieve more accurate SPM results.

1. Introduction

Mixed pixels universally exist in remote sensing images, and they are one of the main obstacles to further improving the accuracy of remote sensing classification and land cover recognition tasks (Tatem et al., 2002; Verhoeye and De Wulf, 2002; Mertens et al., 2004). The effects of mixed pixels make it difficult to meet the accuracy requirements for remote sensing classification when relying solely on the traditional hard classification methods (Yang et al., 2010; Nigussiea et al., 2011). In recent decades, spectral unmixing technology has been used to solve the problems of mixed pixels and to improve the accuracy of remote sensing classification and land cover recognition tasks. As a follow-up means of effective spectral unmixing technology, the sub-pixel mapping (SPM) technique, also called the super-resolution mapping technique, was first proposed by Atkinson et al. (1997) and mainly focused on thematic mapping at a finer resolution relative to the original spatial resolution of the input image (Meyera and Okinb, 2015).

Currently, SPM models mainly include the spatial attraction model (SAM), the pixel swap model (PSM), the neural network model, etc. Among them, many studies have focused primarily on SPM theories (Powella et al., 2007; Zhang et al., 2008; Tong et al., 2013; Zhang et al., 2015), model algorithms (Li et al., 2011; Luciani and Chen, 2011; Shao and Lunetta, 2011; Wang et al., 2014), error analysis (Liu and Wu, 2005; Muslim et al., 2006; Nguye et al., 2006; Ge et al., 2014) and accuracy evaluation (Kasetkasema et al., 2005; Boucher, 2009; Shi and Wang, 2015; Zhong et al., 2015). At present, the results of numerous SPM models and algorithms showed that the existing SPM models each have their own characteristics and advantages—as well as some shortcomings. Thus, it is difficult to obtain more accurate SPM results by relying on any single SPM model. The spatial correlation-based SPM models are an important type of sub-pixel level mapping technique that can be combined with a variety of simulation algorithms to map sub-pixels in a quick, simple and efficient manner. The SAM (Mertens et al., 2006) and PSM (Atkinson, 2005) are the mainstream models for SPM

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https://doi.org/10.1016/j.rse.2018.03.015
Received 13 April 2017; Received in revised form 9 March 2018; Accepted 11 March 2018
Available online 30 March 2018
0034-4257/