ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.7

A Brief Review of Various Change Detection Techniques for Hyper Spectral Images

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Abstract:
Change detection is identifying variations that arise in the appearances of an object, over a period of time. Change detection is the method of routinely detecting and examining regions that have suffered spatial or spectral variations from multi temporal images. Remote sensing is the utmost proper technology used for change detection in numerous application areas. Hyper spectral remote sensing images deal with a huge number of wavelength bands as compared to single band or multispectral images. Thus plenty of spectral information provided by hyper spectral images present promising change detection performance. The main motive of this paper is the comparative analysis of various change detection techniques for hyper spectral images. This survey presents a review of advantages and limitations of existing change detection techniques.

Keywords: Image Differencing, Image Rationing, Change Vector Analysis (CVA), Principal Component Analysis (PCA), Independent Component Analysis (ICA)

1. INTRODUCTION

In many applications, remote sensing change detection has played a vital role. Remote sensing technology provides a large-scale view of landscape over a long period of time and has been demonstrated to be an efficient method for change detection. In many applications such as land-use/land-cover monitoring, ecosystem monitoring, disaster monitoring and urban development, change detection by remote sensing has been widely used. We have different existing methods which are used to detect changes under two categories supervised and unsupervised methods. Unsupervised approach considers only the raw multispectral images to generate further image. It performs preprocessing to make the input images compatible, which are then compared according to individual pixels or features. This leads to generation of the resultant image which is analyzed to detect changes. Different approaches in this category include change vector analysis (CVA),image rationing, expectation maximization, etc. [1, 3]. Supervised approaches make use of training sets for learning purpose. This allows easier statistical estimation of the types of changes occurred. Several change detection algorithms have been proposed in past some years. With change in time, several enhancements have been made in these algorithms by different researchers. An overview of these algorithms is being given below.

1.1 Image Differencing

Image differencing is one of the simplest and useful CD techniques. Image differencing involves subtracting of the intensity values at same pixel locations of two images collected at two different periods of time. The two co-registered images are compared pixel-by-pixel and pixels associated with changed areas produce values significantly different from those pixels associated to unchanged areas. The technique is simple, robust and easy to implement but same value may have different meaning because difference value is absolute.

1.2 Image Rationing

Image ratios or band ratios involve the same logic, except a ratio is computed and the pixels that did not change have a ratio value near 1 in the ratio image. The technique is simple and may mitigate problems with viewing conditions, especially sun angle [1].

1.3 Change Vector Analysis (CVA)

The Change Vector Analysis (CVA) technique generates two outputs: magnitude and direction of the change vector. The first step on this method is to eliminate any redundant information in order to focus on the change analysis in the features of interest. The next step is to calculate the magnitude of variation among spectral change vectors between the images pairs [5].

1.4 Principal Component Analysis (PCA)

Principal Component Analysis is a linear transformation technique and probably the most common of these techniques. The principle of the PCA technique is to use as input a set of images and to reorganize them via a linear transformation, such that the output images are linearly independent. The data is projected such that the greatest variance lies on the first axis or the first principal component and the second greatest variance on the second axis. This technique reduces redundancy but results are scene dependent and difficult to interpret [6].

1.5 Independent Component Analysis (ICA)

ICA concerns not only with second-order dependencies but also higher-order dependencies between variables. The aim of ICA is to linearly change the data such that the transformed variables are as statistically independent from each other as possible [8].

2. RELATED WORK

The research work performed in this field by different researchers is presented as follows:

Nan Wang et al. (2015) proposed a new hyperspectral unmixing approach with an abundance characteristic-based ICA model. Two characteristics of the abundance variables are explored, and the model is constructed by these characteristics. A corresponding gradient descent algorithm is also proposed to solve the proposed objective function [11].

Vikrant Gulati et al. (2014) this paper gives, a change recognition technique for multi-temporal multi-spectral remote sensing images, based on Independent Component Analysis (ICA), is proposed. The environmental changes can be detected in reduced second and higher-order dependencies in multi-temporal remote sensing images by ICA algorithm. Thus the correlation among multi-temporal images can be removed without any prior knowledge about change areas [8].

Sartajvir Singh et al. (2014) this paper gives a brief comparative analysis on CVA based change detection techniques such as CVA, MCVA, ICVA and CVAPS. The paper also summarizes the necessary integrated CVA techniques along with their characteristics, features and drawbacks. to evaluate the overall transformed information over three different MODerate resolution Imaging Spectro-radiometer (MODIS) satellite data sets of different regions remarks which is relayed on the experimental outcomes that CVAPS technique has superior probable than other CVA techniques [4].

MasroorHussain et al. (2013) this paper began with a discussion of the traditionally pixel-based and (mostly) statistics-oriented change detection techniques which focus mainly on the spectral values and mostly ignore the spatial con- text. After this a review of object-based change detection techniques was presented. The advantages and limitations of different techniques were compared. Lastly there was a image dealing out discussion of spatial data mining techniques and change detection from remote sensing data. [1].

Vijay Kumar et al. (2013) the author projected an technique for unverified change recognition technique on SAR data. Various traditional techniques are available to detect change on satellite images. Author used PCA technique which involves Singular Value Decomposition Method (SVD) method to process the images. After that the author compared the images pixel by pixel and found out the changed pixels and mapped those pixels to display the changed map [6].

M. Ilsever C.U et al. (2012) they present an techniques for recognition of hyper spectral images in this paper. the pixel-based change recognition methods They used such as Image differencing, Automated thresholding, Image rationing, Change vector analysis (CVA). The basic premise in using remote sensing data for change detection is that changes in land cover must result in changes in radiance values and changes in radiance due to land cover change must be large with respect to radiance changes caused by other factors [2].

Turgay.C et al. (2009) change detection in multi temporal satellite images using principal component analysis (PCA) and k-means clustering which is unsupervised paper presents a novel technique. In this paper, the difference image is partitioned into h × h no overlapping blocks. Then to achieve change detection the feature vector space is partitioned into two clusters using k-means clustering with k = 2 and then each pixel is assigned to the one of the two clusters by using the minimum Euclidean distance between the mean feature vector of clusters and the pixel's feature vector. The algorithm proposed by author is simple in computation yet effective in identifying meaningful changes which makes it suitable [7].

Zhang Shaoqing et al.[2008] in this paper, author does the comparative study of image subtraction, image ratio and method of change detection after classification. in change detection of city pedicted by author image ratio process is applicable to be used. Its disadvantage is that it cannot reflect which category is changed[3].

Xiao benlin et al. (2008) in the paper, author firstly introduced the algorithm for ICA, as the Fast-ICA algorithm. Then a Fast-ICA based image classification algorithm was proposed. Using this algorithm author made transformation on the original image and extracted some thematic information like vegetation, water bodies in advance, thus gave facilities for the next classification. Next based on Fast-ICA a new change detection model was presented [9].

Jin Chen et al. (2003)in this paper, a new method was proposed to improve CVA.The technique (the better CVA) consisted of two stages, Double-Window Flexible Pace Search (DFPS), which aimed at determining the threshold of magnitude of change, and direction cosines of change vectors for finding change direction (category) that combined single-date image classification with a minimum-distance categorizing technique[5].

Table 2.1 Findings of different authors regarding different CD Techniques.

No.	Change Detection Technique	Authors	Conclusion
1.	Independent Component Analysis(ICA)	Vikrant Gulati	Improved removal of correlation amongst components.
2	Principal Component Analysis(PCA)	Vijay Kumar	Effortlessly categorize the changed and unchanged area.
3	Image Differencing	M. Hussain	Easy to interpret results.
4	Image Rationing	Zhang Shaoqing, Xu Lu	Modest scheme to be used for change detection in urban areas.
		M. Hussain	Improved grips calibration errors.
5	Change Vector Analysis(CVA)	M. Hussain	Hard to classify land cover change trajectories.
		Sartajvir Singh	Good analysis of change direction and magnitude but problematical in choice of threshold.

3. CONCLUSION AND FUTURE SCOPE

Hyper spectral images have fascinated increasing consideration due to the wealth of information contained and the widespread range of potential applications. Traditional change detection methods and their improvements have been intensively studied; however, virtually all of them are centered on single-band or multispectral remote sensing images. The change detection techniques are mainly characterized into supervised and unsupervised techniques. In a supervised classification there is first an identification of the training classes, which are

then used to determine the spectral classes that represent those. This method is advantageous since it is robust and can process images from multiple sources. But the difficulty arises in availability and generation of suitable training sets required. The unsupervised classification does not start with a pre-determined set of classes as in a supervised classification.

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