Chapter 25

Texture-Based Land Cover Classification Algorithm Using Hidden Markov Model for Multispectral Data

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ABSTRACT

In this chapter, the concept of stochastic optimal control is well explored using hidden Markov model (HMM) in classifying land covers of remotely sensed images. The features of land covers can be colour, shape, and texture. Texture is a useful feature in land cover classification. A texture-based land cover classification algorithm using HMM has been proposed. The local derivative pattern (LDP) texture descriptor for gray level images has been extended as multivariate local derivative pattern (MLDP) for remotely sensed images in this chapter. Experiments were conducted on IRS P6 LISS-IV data and the results were evaluated based on the classification accuracy and compared against the three existing methods such as wavelet, MLDP and colour gray level co-occurrence matrix (CGLCM). The results indicate that the proposed algorithm achieves a classification accuracy of 88.75%.

INTRODUCTION

The term land cover refers to the biophysical attributes of the surface of the earth. Land cover classification involves classifying the remotely sensed image into various land cover types such as land, vegetation, and water. Texture is a measure of variation in pixel intensities existing in the local neighbourhood of a digital image. Texture analysis includes texture classification, segmentation and edge detection. Texture analysis is useful in biometric recognition, medical image segmentation and land cover classification. Texture-based techniques are classified into statistical, spectral, structural, and model-based techniques. For characterizing texture in the local neighbourhood of a digital image, statistical techniques compute the statistical properties of gray levels, spectral models decompose the gray levels into spectral coeffi-

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cients, structural models represent the gray levels in the form of a structural primitive called texton and model based techniques fit the gray levels into a model and estimate the essential parameters. HMM is one such probabilistic model-based technique.

BACKGROUND

A texture model is a means of transforming a window of an image into a set of numbers called the feature vector. Literature reveals that texture measures can capture micro and macro patterns, as they can be captured by varying the size of the neighbourhood. Land cover classification has to incorporate uncertainty in order to improve classification accuracy. The problem of uncertainty is effectively handled in probabilistic modelling. So it was planned to propose a texture based land cover classification algorithm using hidden Markov model.

MAIN FOCUS OF THE CHAPTER

Related Work

Many model-based classification algorithms have been proposed. The two-dimensional (2D)-HMM (Li et al. 2000) was proposed to improve classification by context. The 2D-HMM uses intra- and inter-block features that capture features in two dimensions. It was reported that if the states of two adjacent blocks (that lie above and to the left of the current block) were known, then the transition probability of the current block from a hidden state to a next state could be determined. In this study, the researchers subdivided an image block into 4×4 sub-blocks, for which Discrete Cosine Transform (DCT) based features and spatial features (statistical features such as mean and moment) were found as intra-block features. The inter block feature was the difference in average intensities between two blocks. It was concluded thereof that the 2D-HMM provided better and cleaner results than contemporary classifiers considered in the study. Various types of Markov models were successfully used for texture modelling and segmentation (Noda et al. 2002) because of their ability to model contextual dependencies and provide noise absorption (Pieczynski 2003). Promising results were obtained for texture analysis of Brodatz textures when the 2D Discrete Wavelet Transform (DWT) statistics (Fan and Xia 2003) of textures were used as features in HMM. Papila et al. (2003) performed segmentation of remotely sensed images using HMM. Their study parameterised HMM modelling each land cover class, using the mean and variance of wavelet coefficients of training samples. An algorithm using parallel HMM (Younis et al. 2007) was formulated and applied for co-segmentation and analysis of Three-Dimensional Magnetic Resonance Imaging (3D-MRI) and Magnetic Resonance Spectroscopic Imaging (MRSI) data. It was concluded that the segmentation time and accuracy were better when MRI and MRSI images were analysed separately. Boudaren et al. (2008) stated that the 2D-HMM was computationally complex; hence, several approaches preferred linear HMM for modelling 2D data. An approach combining supervised Extended Dependency Tree-HMM (EDT-HMM) and unsupervised segmentation (Boudaren et al. 2010) was proposed for classification of land cover pixels. In this algorithm, an auto-adaptive window size that depended on the position of pixel under consideration was found and applied. An HMM based classification technique (Leite et al. 2011) was developed for the temporal LANDSAT image sequence exhibiting varying spectral responses
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