Chapter 57
Sugeno Fuzzy-Inference-System-Based Land Cover Classification of Remotely Sensed Images

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ABSTRACT

Accuracy of land cover classification in remotely sensed images relies on the features extracted and the classifier used. Texture features are significant in land cover classification. Traditional texture models capture only patterns with discrete boundaries whereas fuzzy patterns need to be classified by assigning due weightage to uncertainty. When remotely sensed image contains noise, the image may have fuzzy patterns characterizing land covers and fuzzy boundaries separating land covers. So a fuzzy texture model is proposed for effective classification of land covers in remotely sensed images and the model uses Sugeno Fuzzy Inference System (FIS). Support Vector Machine (SVM) is used for precise and fast classification of image pixels. Hence it is proposed to use a hybrid of fuzzy texture model and SVM for land cover classification of remotely sensed images. In this chapter, land cover classification of IRS-P6, LISS-IV remotely sensed image is performed using multivariate version of the proposed texture model.

INTRODUCTION

Texture based methods are widely used in applications like face recognition, content based image retrieval, pattern classification in medical imagery and land cover classification. Land cover refers to the biophysical attributes of the surface of the earth. Features of land covers include texture, shape, color, contrast and so on. Land cover classification involves classifying the multispectral remotely sensed image based on the knowledge inferred through the application of image processing techniques. Some of the application areas of land cover classification are town planning, conservation of earth's natural resources, studying the effects of climatic conditions and analyzing change in land forms. Sugeno fuzzy

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inference system (FIS) (Takagi & Sugeno 1985) has been integrated with the proposed fuzzy texture model in this work. The Sugeno FIS has been used for assigning discrete levels to neighbor pixels in the local neighborhood of an image that will subsequently be reduced to a number.

BACKGROUND

Texture is a surface property that characterizes the intensity variations in each local neighborhood of an image. For classifying a single pixel, in contrast to pixel based techniques that considers the intensity of the current pixel alone, texture based techniques operate on local neighborhood. The objective of the chapter is to propose a fuzzy texture model and hybridize it with support vector machine (SVM) for land cover classification of remotely sensed images.

MAIN FOCUS OF THE CHAPTER

Related Work

A variety of texture models have been proposed in literature. Texture models like gray level co-occurrence matrix (GLCM) proposed by Haralick et al. (1973) and Texture Spectrum proposed by He and Wang (1990) were used for characterizing pattern in gray level images. Later, local binary pattern (LBP), a texture model was proposed by Ojala et al. (2001). A comparative study of texture models in segmenting gray level images (Jenicka & Suruliandi 2008) was performed and LBP was proved to be better than GLCM and texture spectrum. A multivariate extension of the basic LBP model, multivariate local binary pattern (MLBP) was proposed by Lucieer et al. (2005) for remotely sensed images stating that the texture features of bands with their cross relations can register the pattern in the neighborhood. Algorithm using wavelet transform was proposed by Arivazhagan and Ganesan (2003) for performing texture segmentation of gray level images. They reported that co-occurrence features obtained from wavelet coefficients of image provided good texture discrimination. They (Arivazhagan et al. 2006) also used rotation invariant mean and variance features computed from Gabor coefficients of image for texture segmentation of gray level images and got promising results. To provide better pattern discrimination, advanced local binary pattern (ALBP) was proposed by Liao and Chung (2007) and they proved that ALBP characterized local and global texture information and was robust in discriminating texture. Local texture pattern (LTP) was proposed by Suruliandi and Ramar (2008) with three discrete levels (for characterizing the relationship of center pixel with its neighbors in a local neighborhood) namely 0, 1 and 9 for texture classification of Brodatz textures and it was later extended as multivariate local texture pattern (MLTP) (Suruliandi 2009). Dominant local binary pattern (DLBP) was proposed by Liao et al. (2009) for texture classification of standard textures. It was computed by finding the dominant patterns which contribute to 80% of pattern occurrences. Land cover classification (Suruliandi & Jenicka 2015) was performed using the multivariate texture models namely MLTP, MLBP, MALBP, Gabor and wavelet and it was proved that MLTP outperformed other multivariate texture models in giving high classification accuracy. A discrete texture model, multivariate discrete local texture pattern (MDLTP) (Jenicka and Suruliandi 2014) was proposed and its performance was proved to be better than the chosen models considered in the study. Two improved texture descriptors namely color Gabor wavelet texture (a unichrome feature) and color