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Inter-Spectral and Intra-Spectral Features for Effective Classification of Remotely Sensed Images

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Abstract

Feature selection and extraction are the crucial steps that help to achieve meaningful classification of remotely sensed images. This paper presents a novel work, which selects a high level set of features from the remotely sensed images, than the conventional methods. The new features introduced in this work are inter-spectral and intra-spectral features. It is observed that these features aid us to differentiate between the characteristic pixels of each class in the image. Different classifiers are fed with different types of features of the images and a comparison of the same is also presented in the paper.

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Keywords: Remotely Sensed Images, Classification, Features, Feature Selection

1. Introduction

Vast amount of earth observation data is now available through the satellites. The satellites obtain imagery in different resolutions depending on their sensors. The different satellite images belonging to different resolutions are classified as low resolution images, medium resolution images, high resolution images and very high resolution images. The common names of satellites heard include LANDSAT, MODIS, LISS, QUICKBIRD, WORLD VIEW and so on. This satellite imagery has turned out to be a big collection and even the analysis of the same is resulting in

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derivation of huge amount of information about earth, thus paving way to knowledge. To extract knowledge/information from this data, pixel analysis of the same has to be done. The first-hand information to be derived from satellite imagery, is the type of object/entity/class present in the image. All further knowledge can be derived from the first level understanding of the image using classification techniques of data mining [1].

In contrast to an ordinary image, each pixel of a satellite image contains a number of values. The number of values held by a pixel in a satellite image is proportional to the number of bands of the satellite in which the reflectance of an object is captured. For instance, in high resolution satellite imagery, the number of values in a pixel will be large in number, as the sensors of the satellite uses a vast number of bands. The classification of such satellite images into meaningful semantic classes is also challenging due to the fact, that a number of classes are present in a single pixel. The inter-class and intra-class variability of the pixels will help to perform the classification more accurately. On this line of thought, the work presented here performs an effective semantic classification of satellite imagery on high level features of the pixel, which measure the variance within a pixel and between pixels. New features introduced in this work mainly are called as Inter-Spectral Features and Intra-Spectral Features. They represent the variance of pixels in different/ same bandwidth. The extracted features are then used to perform classification using Support Vector Machines. It is observed that sufficient and appreciable accuracies are yielded for the classifier with the aid of the new features introduced. To enhance the effectiveness of classification using the newly introduced features, the same is also attempted with features like raw spectral values, Principal Component Analysis, Linear Discriminant Analysis and texture feature like Echoed Mean features. The classifier models are also varied, which includes, Bayesian Classification, Neural Networks and Support Vector Machines.

The paper is organized as follows. Section 2 gives an overview of related work in the classification of remote sensing images. The design of the proposed system is detailed in Section 3. The results of the experiments and the discussions are done in Section 4. The paper is concluded in Section 5.

2. Related Work

The classification of remotely sensed images is attempted from different types of features of the images. The conventional or traditional methods used as features for the remotely sensed images are the spectral reflectance values at different bandwidth. A combination of different band values can be used for finding the appropriate land-use/land cover class. These features are referred to as low-level features. The general low level features used for classifying remotely sensed images thus include spectral values [2], textural values [3], color values [4] or different hybrid combination of these [5]. Research has oriented towards more semantic level features than the direct low level features to improve the meaning of classification. There are even instances of sub-pixel mapping of the pixels in a remotely sensed images to improve classification. The sub-pixels help to establish the spatial distribution of land cover in a more accurate manner. A commonly used approach seen in the classification of remotely sensed images is the Bag-of-Visual Words method [6]. In this method the images are quantized as local features and the resultant histogram helps in classification. A concept called ‘partlets’ [7] are used for detecting object-parts in an image and the objects serve as discriminative functions, rather than the low-level pixel values. However, in this method, when the number of objects in an image increases, the computational cost for classification also grows exponentially. An attempt to build a multi-feature model [8] comprising of spectral and spatial features at pixel and object level is used to build the SVM classifier, wherein claiming more classification accuracy than the traditional ones.

The literature also points to attempts made to reduce the high dimension feature space arising from the number of bands, resulting in the high/very high resolution images. A set of indices [9] are proposed to reduce the features to a lower space, thus introducing a new set of high level features against the textural features, and resulting in an improved classification accuracy. The research orientation is also directed towards feature selection methods, which aids in selecting an effective subset of features that render better classification accuracy [10].