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A Hierarchical Framework for the Classification of Multispectral Imagery

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Abstract

Out of the abundant digital image data available, multispectral imagery is one which gives us information about the earth we live in. To gain knowledge from multispectral imagery, it is essential to classify the data present in the image based on spectral information. Classification plays a significant role in understanding the remotely sensed data obtained from the satellites. This paper brings out a new classification scheme based on a hierarchical framework. The hierarchical model proposed in this paper helps to understand the imagery at different levels of abstractness and concreteness to serve different applications like town planning, facility management and so on. The model depicts classification of the multispectral imagery on three abstract levels. The algorithm proposed outputs classification at different levels with an average accuracy of 72.6% in level 1 and 78.3% in level 2. The time sensitivity analysis of the algorithm shows that it outperforms the traditional SVM classifier. A detailed analysis of the algorithm proposed is detailed in this paper with respect to the parameters influencing the classification accuracy.

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*Keywords:*Multispectral imagery; Hierarchical; Image Classification

1. Introduction

The conventional method of environmental data collection and analysis is not efficient in delivering the

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necessary information in a timely and cost effectively fashion. Hence viewing the earth from satellites has become essential to understand the usage of land in the earth. Remote sensing images from satellites provide a feasible source of data from which land cover information can be extracted efficiently and effectively. Satellite remote sensing system periodically collects spectral data and provides information in understanding and monitoring the earth's surface. Land cover refers to the biophysical cover of the earth's surface which is either natural such as vegetation and water bodies or human induced such as settlements. Land use denotes the way in which and the purpose for which land and its resources are being used by humans. The land cover/land use classification can be done on the multispectral images at different levels of abstractions depending upon the resolution of the image. For very high resolution satellite images, the classification can be achieved on a very concrete level. There are applications like town management, road facility management and so on which require the classification to happen on an abstract level also.

This paper proposes a classification technique which provides the class labelling on a hierarchical level. Here the high resolution image is classified at different levels of concepts to support different applications. An algorithm is proposed which achieves this classification. The algorithm is supported by semi-supervised learning methods to enhance its performance. The method is analyzed in terms of accuracy, and it is observed that the technique is in par with the traditional classifiers. The algorithm outperforms other classifiers in terms of time sensitivity.

The paper is organized in five sections. Section 2 describes the current state of art in the field of multispectral image classification. The design of the hierarchical classification scheme and the algorithm is presented in detail in section 3. A summary of the results and the analysis of the algorithm is illustrated in section 4. The paper is concluded in section5.

2. Background

Resolution is the property of remotely sensed data most critical to their utility which refers to an imaging system's capability of resolving two adjacent features or phenomena. There are different types of resolution for remote sensing imagery, of which the most important one are spatial and spectral, radiometric, and temporal. Spatial resolution of imagery refers to its ability to distinguish two spatially adjacent objects on the ground. Spectral resolution refers to the ability of a remote sensing system to differentiate ground objects at different reflectance values. It is determined by the number of spectral bands used to record spectrally split radiant energy received from the target. Depending upon the need for which remotely sensed image is used, the appropriate resolution has to be chosen. Also the way to understand or classify the observed area depends upon the user's application needs. A fine scale classification presents every local detail inside the image. To understand/classify the image on a regional level, medium scale resolution imagery is sufficient. However to understand/classify the image on a global scale, a very large resolution imagery is enough.

The aspect of classification is changing from pure aspect to semantic mode to facilitate the applications so as to aid human understanding. This contributes to the motivation of such a work. Following literature describes the current state of art in image classification. A sub pixel based mapping strategy of the remote sensing images is presented which establishes the spatial distribution of land cover[1]. It is necessary to dip down into the sub pixel as the pixel is a mixed one, and hence the classification is achieved at a sub pixel level to give more semantics to the image under consideration. A semantic annotation of objects in the remotely sensed satellite image is done through deep learning methods [2]. In this paper, the image features are represented in terms of hierarchies, so that higher levels are formed by combining features in the lower levels. There exists also an efficient technique of combining Support Vector Machines and Support Tensor Machines to classify image data[3]. The decision boundaries and the margin functions are based on a ranking method. There are also classification techniques present in literature which uses mid level features for classification purposes [4], in which the mid level features are relevant patterns from dense low level features.

It is also observed that image classification on semantic level is highly supported by learning dictionaries [5]. Learning dictionaries are usually linear combinations of vectors which are stored in a sparse space to increase the learning capacity of the classifier. As and when the image becomes complex, graph based representation of the images are sought at to achieve image classification [6]. This work models images as graphs to integrate high level