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Classification of High-Resolution Remotely Sensed Image by Combining Spectral, Structural and Semantic Features Using SVM Approach

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Abstract

The resolution of remotely sensed imagery has become increasingly high in both the spectral and spatial domains, which simultaneously provides more plentiful spectral and spatial information. The accurate interpretation of high-resolution imagery depends on effective integration of the spectral, structural and semantic features contained in the images. In this project, we propose a multi model feature with semantic rules, unsupervised version and Active learning methods. Applying Semantic rules with a multifeature model for unreliable object's gain effectiveness of semantic processing .The Unsupervised version with multifeature model feature is used to recognize the specific target of an object. Unlike single feature classifier Active learning with multifeature ensemble model aims to multifeature model with unsupervised version semantic rules and Active learning provides more accurate classification results.

Keywords

Classification, feature extraction, high resolution, morphological, multi feature, object-based, semantic, support vector machines (SVMs).

I. Introduction

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object. The term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth by means of propagated signals. There are two main types of remote sensing: passive remote sensing and active remote sensing. Passive sensors detect natural radiation that is emitted or reflected by the object or surrounding areas. Active collection, on the other hand, emits energy in order to scan objects and areas where upon a sensor then detects and measures the radiation that is reflected or backscattered from the target. Remote sensing makes it possible to collect data on dangerous or inaccessible areas.

Orbital platforms collect and transmit data from different parts of the electromagnetic spectrum, which in conjunction with larger scale aerial or ground-based sensing and analysis, provides researchers with enough information to monitor trends such as El Niño and other natural long and short term phenomena.

A. Image Processing

An image is an array, or a matrix, of square pixels (picture elements) arranged in columns and rows. The RGB colour model relates very closely to the way we perceive colour with the r, g and b receptors in our retinas. RGB uses additive colour mixing and is the basic colour model used in television or any other medium that projects colour with light. It is the basic colour model used in computers and for web graphics, but it cannot be used for print production. The secondary colours of RGB – cyan, magenta, and yellow – are formed by mixing two of the primary colours (red, green or blue) and excluding the third colour. Red and green combine to make yellow, green and blue to make cyan, and blue and red form magenta. The combination of red, green, and blue in full intensity makes white. The range, or gamut, of human colour perception is quite large. The two colour spaces discussed here span only a fraction of the colours we can see. Furthermore the two spaces do not have the same gamut, meaning that converting from one colour space to the other may cause problems for colours in the outer regions of the gamuts.

B. Characteristics

A. Image Acquisition:

Image acquisition is the fundamental steps of digital image processing. Image acquisition could be as simple as being given an image that is already in digital form. Generally, the image acquisition stage involves pre-processing, such as scaling etc.

2. Image Enhancement:

Image enhancement is among the simplest and most appealing areas of digital image processing. Basically, the idea behind enhancement techniques is to bring out detail that is obscured, or simply to highlight certain features of interest in an image. Such as, changing brightness & contrast etc.

3. Image Restoration:

Image restoration is an area that also deals with improving the appearance of an image. However, unlike enhancement, which is subjective, image restoration is objective, in the sense that restoration techniques tend to be based on mathematical or probabilistic models of image degradation.

4. Colour Image Processing:

Colour image processing is an area that has been gaining its importance because of the significant increase in the use of digital images over the Internet. This may include colour modelling and processing in a digital domain etc.

5. Wavelets and Multi resolution Processing:

Wavelets are the foundation for representing images in various degrees of resolution. Images subdivision successively into smaller regions for data compression and for pyramidal representation.

6. Compression:

Compression deals with techniques for reducing the storage required to save an image or the bandwidth to transmit it. Particularly in the uses of internet it is very much necessary to compress data.

7. Morphological Processing:

Morphological processing deals with tools for extracting image components that are useful in the representation and description of shape.

8. Segmentation:

Segmentation procedures partition an image into its constituent parts or objects. In general, autonomous segmentation is one of the most difficult tasks in digital image processing. A rugged segmentation procedure brings the process a long way toward successful solution of imaging problems that require objects to be identified individually.

9. Object recognition:

Recognition is the process that assigns a label, such as, "vehicle" to an object based on its descriptors.

II. Applications

Possible applications of remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object. The use of aerial sensor technologies to detect and classify objects on Earth by means of propagated signals. Remote sensing applications include monitoring deforestation in areas such as the Amazon Basin, glacial features in Arctic and Antarctic regions, and depth sounding of coastal and ocean depths. Military collection during the Cold War made use of stand-off collection of data about dangerous border areas. Other uses include different areas of the earth sciences such as natural resource management, agricultural fields such as land usage and conservation, and national security and overhead, ground-based and stand-off collection on border areas.

III. Problem Description

Training samples are needed for the optimization and learning of the SVM. The effectiveness of the semantic processing which depends on the segmentation quality, and its blind application to all the objects decreasing the overall classification results. Knowledge-based rules by using C-voting and P-fusion algorithms are most crucial for the accurate interpretation of high-resolution images.

IV. Objective

The main objective of this project is to interpret high resolution imagery accurately. To address this objective, the training samples are needed for optimization and learning of SVM by using Unsupervised version with multifeature model. The standard semantic rule is applied to the knowledge based construction. These standard semantic rules library to be applied to for high resolution image interpretation. Then Active learning in Multifeature model is applied to choose the pixel in the candidate training pool for classification adaptation.

V. Related Work

Jon Atli Benediktsson, Martino Pesaresi, and Kolbeinn Arnason., suggested [11] there are two fundamentally different strategies for image segmentation, i.e., edge detection and region growing. Edge detection it is possible to consider a different morphological approach to the segmentation problem. The method is focused on image structural information, and this structural information is collected by applying morphological operators with a multiscale approach and by looking at the residues between the multiscale morphologically transformed image and the original one. Two commonly used morphological operators are opening and closing. The idea behind opening is to dilate an eroded image in order to recover as much as possible of the eroded image. The filtering properties of the opening and closing operators are based on the fact that not all structures from the original image will be recovered when these operators are applied. It is a common practice to use the opening and closing transforms in order to isolate bright (opening) and dark (closing) structures in images, where bright/dark means brighter/darker than the surrounding features in the images. After the feature extraction or selection, a conjugate gradient neural network with one hidden layer will be used to classify the data.

F. Dell'Acqua, P. Gamba, A. Ferrari, J. A. Palmason, J. A. Benediktsson.,suggested that [3] Hyperspectral data are an excellent input for urban remote sensing. Urban material characterization has recently been considered by means of the Multispectral Infrared and Visible Imaging Spectrometer, where it is shown that precise recognition of roof materials is possible. Furthermore, a database of dangerous roof tops for subsequent substitution and destruction was designed. Vegetation distribution, height, stress, and species have been derived from low-altitude Advanced Visible/ Infrared Imaging Spectrometer measurements for urban. Finally, heat island effects in urban areas were considered. However, classification of remote sensing data with very high spatial resolution in urban areas is a challenging problem. It is not only necessary to use the available spectral information but also to expoit the spatial information. Land cover mapping of urban hyper spectral data has been considered in some recent works.

Xin Huang, Liangpei Zhang, and Pingxiang Li., [10] suggested that Earth observation data are becoming available at increasingly higher resolutions. Very high resolution (VHR) satellite sensors such as QuickBird, IKONOS, and SPOT-5 provide a large amount of information, thus opening up avenues for new remote sensing applications. However, it seems evident that the new VHR images do create additional problems in terms of information extraction and automatic classification. The resulting high intraclass and low interclass variability's lead to a reduction in the statistical separability of the different land-cover classes in the spectral domain, and conventional spectral classification methods have proven to be inadequate for the VHR data. The introduction of spatial features is an effective method of addressing this challenge, and it is well known that combining spatial and spectral information can improve land use classification for VHR satellite imagery. Therefore, many spatial feature extraction methods have been proposed and tested. Some commonly applied spatial procedures include the gray-level co-occurrence matrix (GLCM), the wavelet-based spatial features the texture features based on Markov random field models and the technique of morphological profiles.

Saurabh Prasad and Lori Mann Bruce., suggested that for multiple data sources for robust automatic target recognition (ATR) and land cover classification. Data fusion in this context typically exploits multiple, independent observations of a phenomenon and performs a feature-level or a decision-level fusion for various recognition and identification tasks. For example, in Watanachaturaporn different types of data collected in the Himalayan region were fused for land cover classification.

VI. Existing System

In existing, it can be found that all the studies underline the important role of spatial information for the classification of high-resolution imagery. However it should be recognized that although various

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spatial features are currently available for high-resolution image processing, such as morphological features, structural feature set, PSI, wavelet-based texture, object-based features, and GLCM it is impossible to find one feature that is optimal for different image scenes. The traditional approach for addressing this issue is to use a vector stacking (VS) approach for the integration of multiple features, i.e., concatenate the multiple features and feed them into a classifier with a pre-processing of dimensionality reduction VS is frequently used for multifeature fusion as it is simple to carry out and is potential to enhance the separability between similar objects by forming a hyper dimensional multifeature space. Furthermore, the VS approach is often jointly used with an SVM classifier since SVM is not constrained to prior assumptions on the distribution of input data, and it enables the weighting of the different features.

VII. Proposed Algorithm

We propose an SVM-based multiclassifier system combining a series of spectral and spatial features for high-resolution image classification. It is able to take advantage of multiple features and overcome the Hughes effect and the over-fitting problem produced by the hyper dimensional stacked feature space. The multiclassifier system has been applied to classification of hyper spectral images multisource data, and high-resolution urban images. However, few studies use the multiclassifier system to simultaneously integrate the spectral, structural and semantic features at both pixel and object levels. The contribution of this study lies in a systematic combination of the spectral-spatial multifeature coupled with a series of SVM classifiers, as described in the following three algorithms.

A. Certainty Voting

According to the decision results of the single-feature SVMs, the pixels in an image are separated into reliable and unreliable ones. The labels of reliable pixels are identified by majority voting of the SVMs, while the classification of unreliable pixels is performed by comparing the classification certainty degree of the single-feature SVMs.

Fig. 1: Input Image

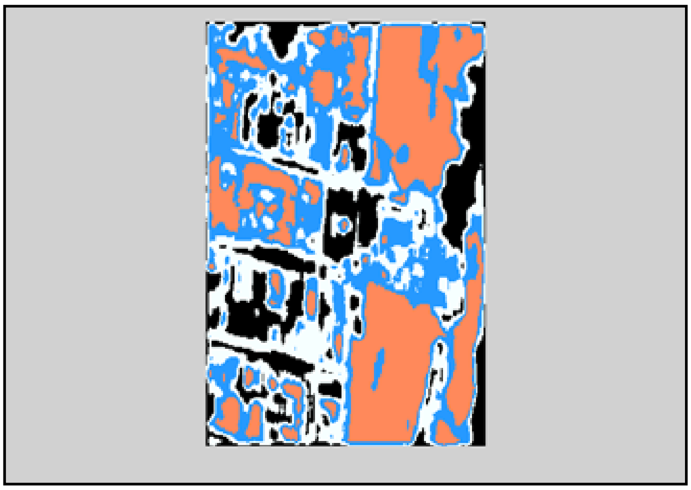

Fig. 2: C-Voting Image

B. Probabilistic Fusion

The certainty degree of each single-feature SVM is used as the weight of the probabilistic output of the SVM. Subsequently, the weighted probabilistic outputs of the SVMs are fused for the final classification.

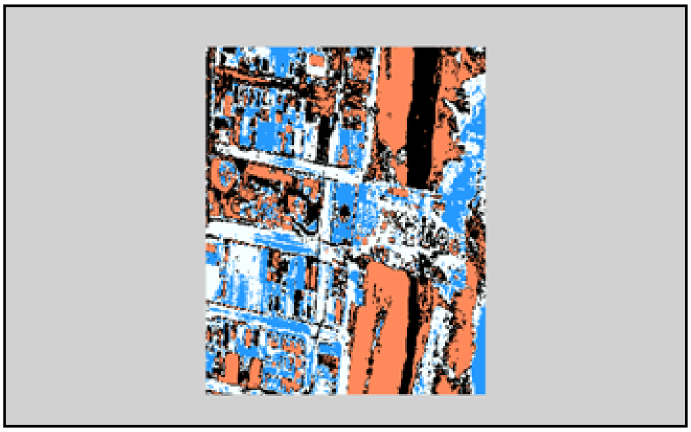

Fig. 3: P-Fusion Image

C. Object Based Semantic Approach

After segmentation of an image, image objects are divided into reliable and unreliable ones. The reliable objects are classified using the weighted probabilistic outputs of pixels that constitute the object, while the unreliable ones are identified based on a series of semantic rules.

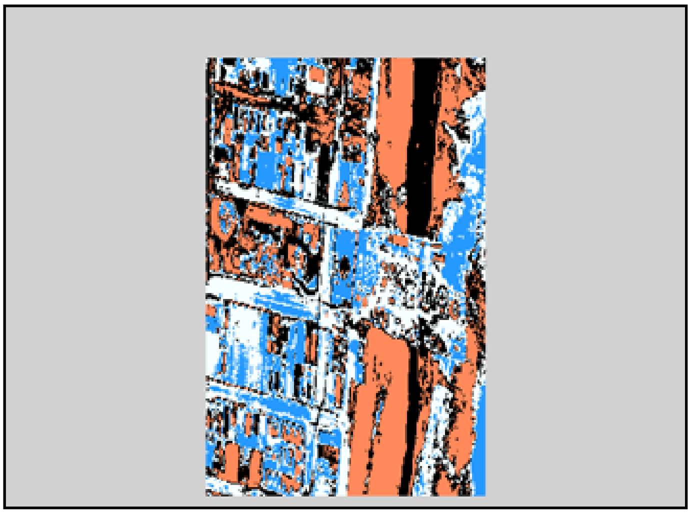

Fig 4: OBSA Image

VIII. Performance Evaluation

This graph shows the accuracy of the algorithms named as C-Voting, P-Fusion and OBSA that are used in the proposed system. In the proposed system the OBSA accuracy is said to be have higher accuracy than other algorithm that used in the proposed system.

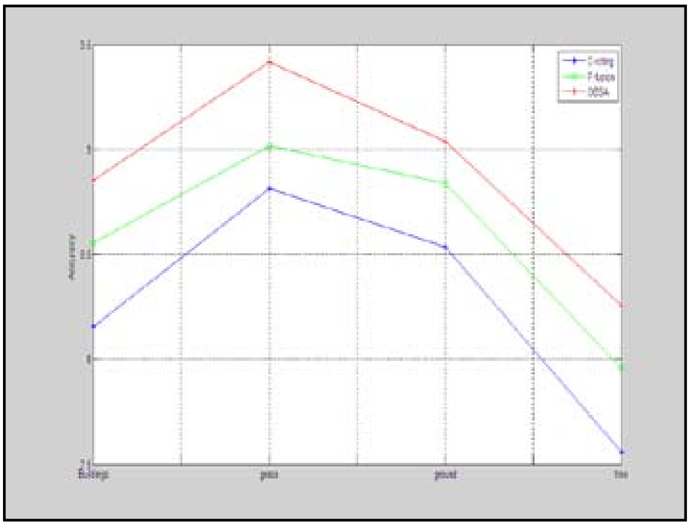

Fig. 5: Accuracy comparison between Algorithm Used in Proposed system

This graph shows the comparison between the proposed and existing systems. In this proposed system accuracy is said to be higher than the existing system.

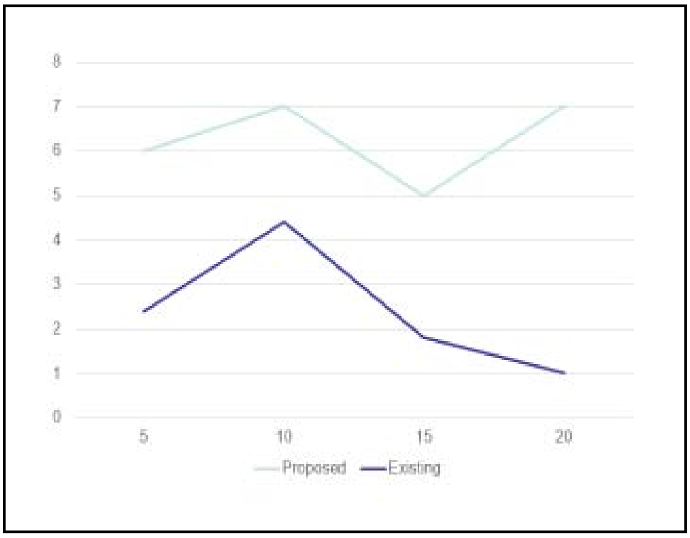

Fig. 6: Comparison Between Proposed and Existing Systems

Table shows the accuracy value of the three algorithms that used in both proposed and existing systems.

Table 1 : Comparison Between Accuracy of Proposed and Existing Systems

System	C-Voting Accuracy	P-Fusion Accuracy	OBSA Accuracy
Proposed	6.8	7.2	8.9
Existing	3.1	3.9	4.1

IX. Conclusion

The objective of this project is to systematically study SVM based multifeature ensemble methods for the classification of high-resolution remotely sensed imagery. The study is inspired by the fact that in recent years, researchers have developed a series of spatial and structural features, but it is difficult to find one feature that is appropriate for different image scenes. In this context, this study proposes three strategies: C-voting, P-fusion, and OBSA, implemented at both the pixel and object levels, for a combination of spectral, spatial, and semantic features. The algorithms were evaluated on three multispectral high resolution data sets, and their performances were compared with the Existing algorithms in experiments.

X. Future Work

In future research, we plan to introduce transductive SVM approach to improve the accuracy of the multifeature ensemble model for the classification of high-resolution remotely sensed imagery.

XI. Acknowledgement

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Author's Profile and Image

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