

Object Based Fusion of Multitemporal Multiangle Satellite Images

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Abstract - Satellite imagery includes photographs of the earth taken through an artificial satellite revolving around the earth. A rich information content, previously hidden or not clearly distinguishable in low resolution images such as urban structures can be disclosed. Nowadays, most image fusion system are based on pixel-level methods which has skewbald in object boundary and shade region. This technique is based on "object" other than "pixel", which is accord with human's logical thinking, and is easy to fuse geo-information. However, only proper approaches are able to retrieve automatically this new detailed information. The objective of this technique is to develop robust method for segmentation of multitemporal satellite image. For better edge detection and segmentation, acquired satellite images are preprocessed for enhancement, noise removal and registration. The edge-aware region growing and merging (EARGM) algorithm is developed for segmentation of satellite images. The resulting fused image of the combination of two satellite images will be more informative which is obtained by object fusion rule.

Key Words: Low Resolution, Image fusion, Pixel-level, Skewbald, Multiangle, Multitemporal, Segmentation, EARGM, Fusion-rule.

1. INTRODUCTION

Image fusion is an important tool in remote sensing. As many earth observation satellites provide both multitemporal and multiangle images, many fusion methods have been proposed to fuse these satellite images simultaneously. There is a significant growth of urban areas on going around the globe. This has an impact both on the environment we live in and the societies living in these areas. A base for many studies exploring these kind of impacts are land cover maps. Those can very efficiently be derived from satellite imagery. The classical approach is usually based on optical imagery. In good weather conditions this is also a reasonable choice. Very often however this for optical data crucial criterion is not met, raising the need for alternatives. With the evolved generation of high resolution image which is operational available one such alternative is within reach.

1.1 Existing System

In existed system pixel based fusion is performed. Since the segmentation algorithm requires a certain level of homogeneity in the images processed, it was necessary to perform speckle filtering to get an overall smoother image the system made very good experience with multi-temporal speckle filtering, but this was not an option since this work is based on two images solely. Nevertheless, they have some disadvantages:

(1) They do not consider the spectral, spatial, and radiometric characteristic of various objects of remote sensing imagery synthetically, so the pixel-level fusion methods have no relativity.

(2) They usually fused all the pixels with the same criterion, and only fused between pixel and pixel.

(3) They need higher matching accuracy, when matching accuracy is lower, it is easy to appear skewbald in object boundary and shade region.

(4) It is hard to add "object" concept and find hidden meanings of remote sensing imagery.

1.2 Proposed System

In proposed system object based fusion is performed rather than pixel based which is much more efficient and accurate. The system develops an image segmentation method based on edge detection and region growing and merging algorithm for segmentation of the satellite images. The analysis can be divided into three phases, i.e., image preprocessing, edge detection and image segmentation, and classification. With the development of geographic object-based image analysis, the technique is applied to image fusion of remote sensing imagery, which is object-based image fusion (OBIF) technique. It adopts image segmentation technique to segment original imagery into feature objects with different size. Then the feature objects are fused with fusion method and self-adjustable fusion rule. There are three key techniques of the object-based image fusion including image segmentation, fusion method, and fusion rule.

According to the above analysis, the object-based image fusion methods have some advantages as follows:

(1) The process unit is “object” other than “pixel”, which is accord with human’s logical thinking, and is easy to fuse geo-information.

(2) It could control the contribution of different components in the fused product and choose the appropriate fusion rule.

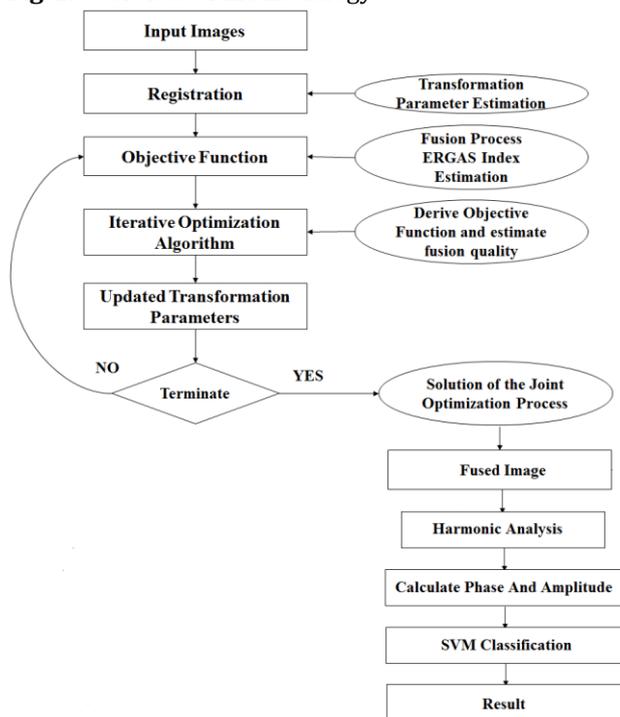
(3) It could eliminate the skewbald which appears in pixel-level fusion, and it is less affected by image matching.

(4) The self-adjustable fusion rule ensures higher fusion accuracy.

2. METHODOLOGY

The overall flow of methodology is shown below in fig 1. This technique uses egde detection and region growing and merging algorithm.

Fig-1: overview of methodology



2.1 Input Images

The technique begins with input images. The input images are the satellite images. These images are freely available from the educational sites for research purposes. They are multiangle multitemporal satellite images of low resolution of a particular geographical region. These images are fused and converted to make them more informative.

2.2 Registration

The act or process of entering information about something in a book or system is called registration. It is necessary to accurately coregister all these images together. First, both the images were orthorectified. Image pre-processing is the term for operations on images at the lowest level of abstraction. The aim of pre-processing is an improvement of the image data that suppresses undesired distortions or enhances some image features relevant for further processing and analysis task. Steps include in registration are image cropping and filtering ,intensity adjustment and histogram equalization,brightness thresholding,clearing areas of a binary image and detecting edges.

2.3 Fusion Process

The fusion of images has been proven advantageous by making use of the complementary nature of the data acquired by different sensors. Both images have their own merits and limitations, thus the fusion of images can overcome the deficiencies associated with a single sensor. This represents over 5% improvement over eCognition results from the same data set. The results further confirm the benefits of synergy of satellite images. The most interesting finding is the closeness in the overall accuracy and kappa between fusion of fused images. The results indicate that the multitemporal image acquired in multiangle and dual-look directions are advantageous for urban land-cover mapping. The additional image with similar incidence angles do not add significant value to the classification.

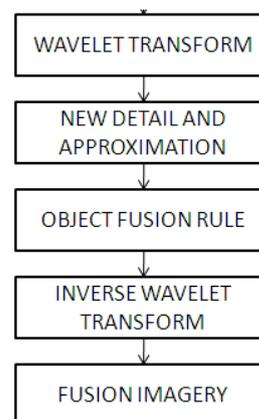


Fig-2: Fusion process

The steps involved in fusion process are wavelet transform, new detail approximation, object fusion rule, inverse wavelet transform and resulting fused imagery.

2.4 Feature Extraction

Feature extraction is a special form of dimensionality reduction. The main goal of feature extraction is to obtain the most relevant information from the original data and represent that information in a lower dimensionality space. Feature extraction starts from an initial set of measured data and builds derived values (features) intended to be informative and non-redundant, facilitating the subsequent learning and generalization steps, and in some cases leading to better human interpretations. Feature extraction is related to dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be redundant, then it can be transformed into a reduced set of features. This process is called feature extraction. The extracted features are expected to contain the relevant information from the input data, so that the desired task can be performed by using this reduced representation instead of the complete initial data.

2.5 Classification

The classification is performed using support vector machines(SVM). SVM is selected for post segmentation classification and is implemented using the JAVA version of LibSVM in this technique. SVM searches for the optimal hyperplane to separate the training vectors of two classes into two subspaces through mapping the input vectors into high-dimension space. There-fore, SVM is originally a binary classifier. There are two types of approaches for multiclass SVM. One is by constructing and combining several binary classifiers, while the other is by directly considering all data in one optimization formulation. The formulation to solve multiclass SVM problems in one step has variables proportional to the number of classes. Therefore, for multiclass SVM methods, either several binary classifiers have to be constructed or a larger optimization problem is needed. Hence, in general, it is computationally more expensive to solve a multiclass problem than a binary problem with the same number of data. For classifying N classes, $N(N - 1) / 2$ binary SVM classifiers are created according to the total $N(N - 1) / 2$ different class pairs. Each classifier is trained for a unique class pair by the training data of the two classes. In the classification process, a "Max Wins" voting strategy is applied for the final decision. In this strategy, each classifier will vote the class which is identified by this classifier for an input data set. The class that has the most votes from all the classifiers will be labeled as the class for this input data set.

2.6 Performance Analysis

The comparison of overall classification accuracies and kappa coefficients is presented. Among all results, significant differences were found using McNemar's test, specifically between the overall accuracy and kappa for classification using our segmentation and that of eCognition. Three representative areas were selected to compare various

segmentation and classification results. In terms of quality of the segmentations, several observations can be made when looking at the classification results presented. eCognition produced higher accuracies for several vegetation classes such as forest, grass/pasture, and golf course.

3. IMPLEMENTATION

This technique can be implemented in MATLAB. It has number of features such as Image Processing Toolbox provides a comprehensive set of reference-standard algorithms and graphical tools for image processing, analysis, visualization, and algorithm development. You can perform image enhancement, image deblurring, feature detection, noise reduction, image segmentation, spatial transformations, and image registration. Separate modules can be created in MATLAB for main function, registration, fusion process, performance analysis. These modules can be invoked together step by step by object based invocation. Graphical user interface can be made for each module and uploading of sample input images. Graphical user interface (GUI) should consist of step by step procedure from selecting images to fusion process to performance analysis.



Fig -3: sample image 1 and sample image 2 as input image for fusion

The above sample input image can be taken as input images for fusion process.

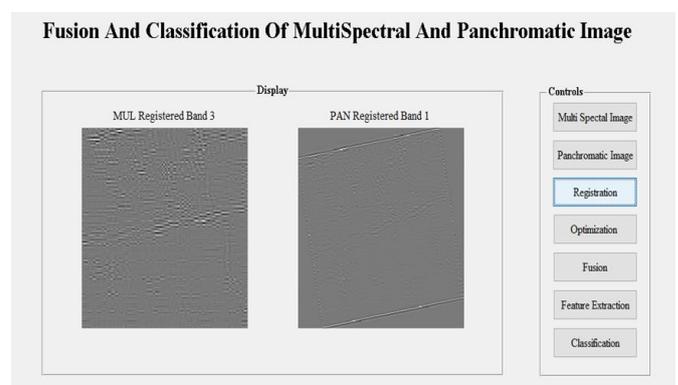


Fig -4: registration result

The above image shows the GUI for registration result for both input images.

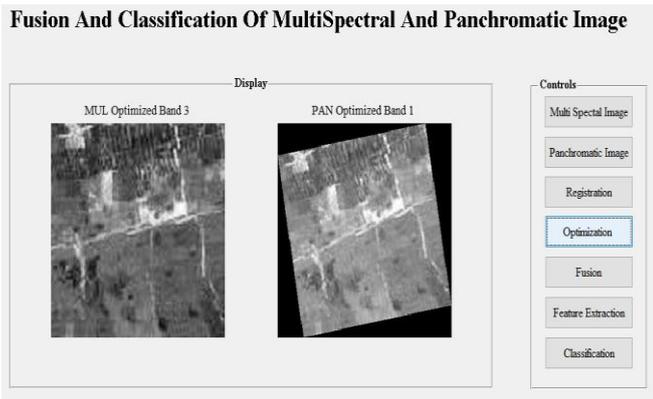


Fig -5: optimization result

The above image shows the GUI for optimization result for both input images.

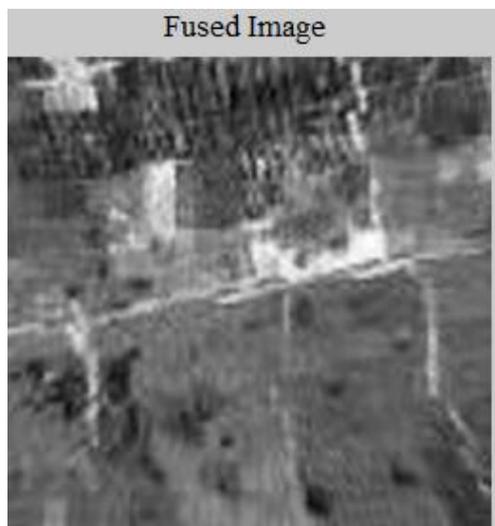


Fig -6: Fused image

The above image shows the fused image of the input images.

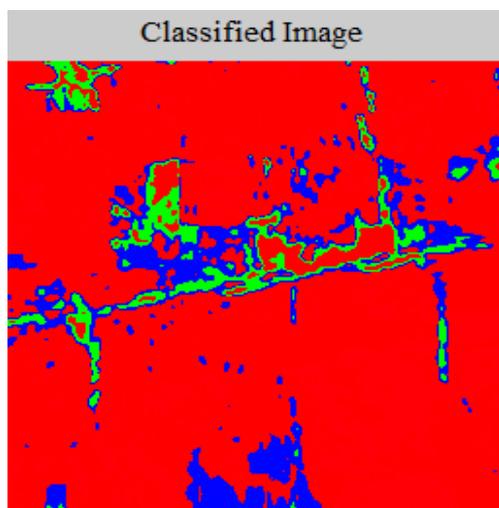


Fig -7: classified image

The above image shows the classified result of the fused image.

4. CONCLUSIONS

In this research, the system has to develop an image segmentation method based on edge detection and region growing and merging algorithm for segmentation of multitemporal multiangle satellite images. The analysis can be divided into three phases, i.e., image preprocessing, edge detection and image segmentation, and classification. On the basis of analyzing image segmentation, wavelet transformation, and fusion rule, two object-based image fusion methods based on wavelet are researched. The wavelet transform is a popular fusion technique at present with the decomposition level and the fusion strategy which could be adjusted to preserve the image spectral and spatial information. The segmentation method is used to get segmented label image to guide the OBIF technique. The self-adjustable fusion rule with object energy could control the contribution of different components. The fusion results showed that the object-based image fusion method performs better both in improving the spatial information and in preserving the spectral information than the pixel-based image fusion method. But the process time is longer because of the segmentation. Nevertheless, there are many forewords that require future investigation, including the analysis of the segmentation method, the effect of fusion rule to image fusion.

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