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A Survey on Airbase Detection and Airship Recognition in High Spatial Remote Sensing Images

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***Abstract*: Automatic target localization in satellite images still remains as a challenging problem in the field of computer vision. The issues involved in locating targets in satellite images are viewpoint, intensity and scale variations. Automatic target localization is done using various algorithms. In this paper ten airship recognition algorithms were discussed.**

***Keywords*: Airport detection, feature extraction, image processing, saliency analysis, support vector machine (SVM).**

1. Introduction

With the increasing ability to acquire remote sensing images using various satellites and sensors, the detection of valuable targets from remote sensing images has become one of the most fundamental and challenging research tasks in recent years. It is impossible for human image analysts to search targets through heavy manual examination because of the overwhelming number of remote sensing images available daily. Hence, there is a need for automated algorithms to interpret remote sensing data. Especially in real-time image processing, reducing the amount of data needed for further processing is of great value, if we can preprocess the original image and identify certain regions that may contain the targets, or the regions of interest (ROIs). The accurate and efficient detection of regions of interest (ROIs) in those high-spatial-resolution remote sensing images has become an important issue in remote sensing. Many approaches cast target detection as a classification problem. A set of features that can characterize the targets is extracted first, and then classification is performed using the extracted features and predefined classifiers. The establishment of the classifiers can be based on template matching or direct application of a variety of sophisticated machine learning methods such as Support Vector Machines (SVM), Kernel-Based Density Estimation, Gaussian Mixture Models, Hough Forests, Latent Dirichlet Allocation models, and Support Tensor Machines. An airport, as a key transportation target, has also attracted much attention. Airports located in dense urban and suburban areas are often difficult to distinguish from the background, composed of roads and buildings. An airport scene is typically characterized by runways of particular length and width. Such properties distinguish airports from their surrounding environment.

2. Literature survey

A. Airport detection in large aerial optical imagery

Dehong Liu, Lihan He and Lawrence Carin et. al. (2004) [2] introduced Airport detection in large aerial optical imagery . A method to detect airports in large aerial optical imagery is considered. Combining texture segmentation and shape detection, this method shows advantages in analyzing large aerial imagery. First, large aerial images are segmented and interpreted according to textural features using a fast kernel matching pursuits (KMP) algorithm. As a result, attention is then paid on small regions of interest, extracted from the large images. Second, for each region of interest, a corresponding binary image is generated via the Canny edge operator, yielding a modified Hough transform image with which we search for elongated rectangles with desired dimensions (characteristic of runways). Those detected rectangles are declared as runways and the corresponding region of interest as an airport. Application in a dozen aerial images from southern California demonstrates the effectiveness of the algorithm. It achieves good generalization at low computational costs. Requires much time and computer memory.

B. Line detection in images through regularized hough transform

Nitin Aggarwal ,William Clem Karl et.al(2006) [6] proposed line detection in images through regularized hough transform.The problem of determining the location and orientation of straight lines in images is of great importance in the fields of computer vision and image processing. Traditionally the Hough transform, (a special case of the Radon transform) has been widely used to solve this problem for binary images. In this paper, we pose the problem of detecting straight lines in gray-scale images as an inverse problem. Our formulation is based on use of the inverse Radon operator, which relates the parameters determining the location and orientation of the lines in the image to the noisy input image. The advantage of this formulation is that we can then approach the problem of line detection within a regularization framework and enhance the performance of the Hough-based line detector through the incorporation of prior information in the form of regularization. We discuss the type of regularizers that are useful for this problem and derive efficient computational schemes to solve the resulting optimization problems enabling their use in large applications. Finally, we show how our new approach can be alternatively viewed as one of finding an optimal representation of the noisy image in terms of elements chosen from a dictionary of lines. This interpretation relates the problem of Hough-based line finding to the body of work on adaptive signal representation.

C. Airport detection from large ikonos images using clustered sift key points and region information

Chao Tao, Yihua Tan, Huajie Cai, and Jinwen Tian et.al. (2011)[1], proposed airport detection from large ikonos images using clustered sift key points and region information .This letter presents a new method for airport detection from large high-spatial-resolution IKONOS images. To this end, we describe airport by a set of scale-invariant feature transform (SIFT) key points and detect it using an improved SIFT matching strategy. After obtaining SIFT matched key points, to both discard the redundant matched points and locate the possible regions of candidates that contain the target, a novel region location algorithm is proposed, which exploits the clustering information from matched SIFT key points, as well as the region information extracted through the image segmentation. Finally, airport recognition is achieved by applying the prior knowledge to the candidate regions. Experimental results show that the proposed approach outperforms the existing algorithms in terms of detection accuracy. Reduce the comput -ational cost.Many useless edge pixels can be extracted around the airport due to the complicated background.

D. Rotation-invariant object detection of remotely sensed images based on texton forest and hough voting

Rotation-Invariant Object Detection of Remotely Sensed Images Based on Texton Forest and Hough Voting proposed by Zhen Lei, Tao Fang et.al(2012)[10]. The Hough forest method is an effective method for object detection in ground-shot images that has received increasing research attention. However, this method lacks the ability to detect objects with arbitrary orientations. This largely constrains the method from being used in detecting geospatial objects from remotely sensed (RS) images since geospatial objects can have many different orientations. In order to achieve rotation invariance and compensate the associated loss of discriminative power, this paper presents a novel color-enhanced rotation-invariant Hough forest (CRIHF) method for detecting geospatial objects in RS images. In our method, we propose to train a Pose-Estimation-based Rotation-invariant Texton Forest (PE-RTF) which first uses dominant gradient orientations to align local image patches. The orientations are then jointly used with coordinates in Hough voting to detect object position. In order to increase discriminative power, Texton Forest is used in codebook generation. Moreover, theoretically sound color-invariant gradients are employed. By rotating split functions rather than image patches in the RTF and sparsely accumulating Hough votes on grid points, computational times can be reduced by two orders of magnitude. The evaluation of the CRIHF method on a data set containing 525 airplanes and a second data set containing 68 residential buildings shows that our method is rotation invariant and robust. The detector achieves around 90% recall rate on both data sets. Experiments also show that our method is noise resistant and can achieve a decent detection performance at a high level (30%) of "salt and pepper" impulsive noise.

E. Automatic recognition of airfield runways based on radon transform and hypothesis testing in SAR images

Wei Xiong , Juanjuan Zhong, Ye Zhou et.al(2012)[8] proposed automatic recognition of airfield runways based on radon transform and hypothesis testing in SAR images. A novel approach to recognize the airport runway in SAR image based on Radon transform and hypothesis testing was proposed in this paper. Firstly, a nonlinear edge detection method with arithmetic average and geometric average (A/G) coefficient was adopted to extract the edges of airfield runway. Secondly, Radon transform was performed on the edge image. Several max values of Radon transform matrix were reserved, while the rest were set to zero. Thirdly, with inverse Radon transformation, the Radon transform matrix was transformed to a new binary image, where the main straight lines of runways were retained and other noisy lines and region of no interest were excluded. Finally, the airfield runway was identified by hypothesis testing with the knowledge of the runway's intensity property and structure features. Experimental results demonstrated the proposed method could automatically recognize the airfield runway effectively.

F. Aircraft identification by moment invariants

Yu Li, Xian Sun, Hongqi Wang, Hao Sun, and Xiangjuan Li et.al. (2012) [7] proposed aircraft identification by moment invariants .Although many systems for optical reading of printed matter have been developed and are now in wide use, comparatively little success has been achieved in the automatic interpretation of optical images of three-dimensional scenes. This paper is addressed to the latter problem and is specifically concerned with automatic recognition of aircraft types from optical images. An experimental system is described in which certain features called moment invariants are extracted from binary television images and are then used for automatic classification. This experimental system has exhibited a significantly lower error rate than human observers in a limited laboratory test involving 132 images of six aircraft types. Preliminary indications are that this performance can be extended to a wider class of objects and that identification can be accomplished in one second or less with a small computer.Background noise is presented in output image.

G. VHR object detection based on structural feature extraction and query expansion

Xiao Bai, Huigang Zhang, and Jun Zhou et.al.(2014)[9] proposed VHR object detection based on structural feature extraction and query expansion .Object detection is an important task in very high resolution remote sensing image analysis. Traditional detection approaches are often not sufficiently robust in dealing with the variations of targets and sometimes suffer from limited training samples. In this paper, we tackle these two problems by proposing a novel method for object detection based on structural feature description and query expansion. The feature description combines both local and global information of objects. After initial feature extraction from a query image and representative samples, these descriptors are updated through an augmentation process to better describe the object of interest. The object detection step is implemented using a ranking support vector machine (SVM), which converts the detection task to a ranking query task. The ranking SVM is first trained on a small subset of training data with samples automatically ranked based on similarities to the query image. Then, a novel query expansion method is introduced to update the initial object model by active learning with human inputs on ranking of image pairs. Once the query expansion process is completed, which is determined by measuring entropy changes, the model is then applied to the whole target data set in which objects in different classes shall be detected. We evaluate the proposed method on high-resolution satellite images and demonstrate its clear advantages over several other object detection method.

H. Efficient, simultaneous detection of multi-class geospatial targets based on visual saliency modeling and discriminative learning of sparse coding

Junwei Han, Peicheng Zhou et.al. (2014) [4], proposed Efficient, simultaneous detection of multi-class geospatial targets based on visual saliency modeling and discriminative learning of sparse coding. Automatic detection of geospatial targets in cluttered scenes is a profound challenge in the field of aerial and satellite image analysis. In this paper, we propose a novel practical framework enabling efficient and simultaneous detection of multi-class geospatial targets in remote sensing images (RSI) by the integration of visual saliency modeling and the discriminative learning of sparse coding. At first, a computational saliency prediction model is built via learning a direct mapping from a variety of visual features to a ground truth set of salient objects in geospatial images manually annotated by experts. The output of this model can predict a small set of target candidate areas. Afterwards, in contrast with typical models that are trained independently for each class of targets, we train a multi-class object detector that can simultaneously localize multiple targets from multiple classes by using discriminative sparse coding. The Fisher discrimination criterion is incorporated into the learning of a dictionary, which leads to a set of discriminative sparse coding coefficients having small within-class scatter and big between-class scatter. Multi-class classification can be therefore achieved by the reconstruction error and discriminative coding coefficients. Finally, the trained multi-class object detector is applied to those target candidate areas instead of the entire image in order to classify them into various categories of target, which can significantly reduce the cost of traditional exhaustive search. Comprehensive evaluations on a satellite RSI database and comparisons with a number of state-of-the-art approaches demonstrate the effectiveness and efficiency of the proposed work.

I. Global and local saliency analysis for the extraction of residential areas in high-spatial-resolution remote sensing image

Libao Zhang, Aoxue Li, Zhongjun Zhang, And Kaina Yang et. al. (2016)[5], proposed global and local saliency analysis for the extraction of residential areas in high-spatial-resolution remote sensing image. Extraction of residential areas plays an important role in remote sensing image processing. Extracted results can be applied to various scenarios, including disaster assessment, urban expansion, and environmental change research. Quality residential areas extracted from a remote sensing image must meet three requirements: well-defined boundaries, uniformly highlighted residential area, and no background redundancy in residential areas. Driven by these requirements, this study proposes a global and local saliency analysis model (GLSA) for the extraction of residential areas in high-spatial-resolution remote sensing images. In the proposed model, a global saliency map based on quaternion Fourier transform (QFT) and a global saliency map based on adaptive directional enhancement lifting wavelet transform (ADE-LWT) are generated along with a local saliency map, all of which are fused into a main saliency map based on complementarities. In order to analyze the correlation among spectrums in the remote sensing image, the phase spectrum information of QFT is used on the multispectral images for producing a global saliency map. To acquire the texture and edge features of different scales and orientations, the coefficients acquired by ADE-LWT are used to construct another global saliency map. To discard redundant backgrounds, the amplitude spectrum of the Fourier transform and the spatial relations among patches are introduced into the panchromatic image to generate the local saliency map. Experimental results indicate that the GLSA model can better define the boundaries of residential areas and achieve complete residential areas than current methods. Furthermore, the GLSA model can prevent redundant backgrounds in residential areas and thus acquire more accurate residential areas.The advantage of this method is no background redundancy.

J. Joint multi-image saliency analysis for region of interest detection in optical multispectral remote sensing images

Joint multi-image saliency analysis for region of interest detection in optical multispectral remote sensing images proposed by Jie Chen and Libao Zhang et.al(2016)[3] .The automatic detection of regions of interest (ROI) is useful for remote sensing image analysis, such as land cover classification, object recognition, image compression, and various computer vision related applications. Recently, approaches based on visual saliency have been utilized for ROI detection. However, most existing methods focus on detecting ROIs from a single image, which generally cannot precisely extract ROIs against a complicated background or exclude images with no ROIs. In this paper, we propose a joint multi-image saliency (JMS) algorithm to simultaneously extract the common ROIs in a set of optical multispectral remote sensing images with the additional ability to identify images that do not contain the common ROIs. First, bisecting K-means clustering on the entire image set allows us to extract the global correspondence among multiple images in RGB and CIELab color spaces. Second, cluster wise saliency computation aggregating global color and shape contrast efficiently assigns common ROIs with high saliency, while effectively depressing interfering background that is salient only within its own image. Finally, binary ROI masks are generated by thresholding saliency maps. In addition, we construct an edge-preserving JMS model through edge-preserving mask optimization strategy, so as to facilitate the generation of a uniformly highlighted ROI mask with sharp borders. Experimental results demonstrate the advantages of our model in detection accuracy consistency and runtime efficiency.

3. Conclusion

The finding from the review reveals that airship detection is based on edge detection and image segmentation .the former which focuses on the airfield runways, Hough transform and some other common methods to locate the airship. It is clear that results of the above methods primarily uses threshold segmentation method to extract the simple silhouette of targets: however the results were not always perfect.

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