Survey on Satellite Images Segmentation

دراسة على تجزئة صور الأقمار الصناعية

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Abstracts

Image segmentation plays a vital role in various image processing techniques where a lot of application in medical image, satellite images required precise segmentation as an efficient front end to advanced algorithms Lin image processing. Satellite image segmentation indicates to the process of partitioning the images into various regions sharing with identical properties. This work aims to familiarize the reader with the most popular approaches in satellite images segmentation.

Keyword: Image Segmentation, Satellite Images, Clustering, Edge Detection, Region based, Thresholding.

الملخص

يلعب تجزئة الصور دورًا حيويًا في تقنيات معالجة الصور المختلفة حيث تتطلب الكثير من التطبيقات في مجال الصور الطبية وصور الاقمار الصناعية تجزئًا دقيقًا كخطوة اولية فعالة للخوارزميات المتقدمة في معالجة الصور .تجزئة صورة الأقمار الصناعية تهدف إلى تقسيم الصور إلى مناطق مختلفة تتشارك بخصائص متطابقة .يهدف هذا العمل إلى تعريف القارئ بالأساليب الأكثر شعبية في تجزئة صور الاقمار الصناعي.

1- Introduction

Image Segmentation is one of the emerging trends in the scope of image processing. It has a large application in number of field such as medical images, satellite images, security monitoring, photography, etc. Image segmentation is a pivotal tool in image processing aims to partitioning the images into multiple segment which represent the regions that are more meaningful for studying and analyzing. Also, image segmentation is usually to define the objects entire the images and their boundaries such as lines, curves and so on. Normally, all pixels related to a region are identical to some features such as intensity, texture or color [1; 2]. Generally, segmentation approaches have been established to segment the input images depending on two basic properties, discontinuity and similarity. In the first one (discontinuity), the partitioning of the images is carried out depending on rapid change in intensity or grey level of the image, so the segmentation process is based on isolated points, lines and edges. While

the second one (similarity), the similar pixels are grouped to segment the images into regions, this one includes thresholding, region splitting and merging and region growing [3].

Satellite images indicate to the earth observation images which collected by imaging satellites Remote sensed images naturally consist of regions varying sizes and shapes which depicted land cover [4]. Unlike other images, the satellite imagery is characterized by complex and varient content and structure also the difficulty in the acquisition of such image with less noise and resolution leads to a preprocessing time and difficulty of the segmentation process [5].

This research work in literature review on satellite image segmentation techniques. It depict details on diverse satellite images segmentation methods.

2- Segmentation Techniques

In this section most three techniques which used to segment the satellite images are introduced, these techniques are edge,-Based, clustering and growing segmentation approaches.

2-1 Edge- Based Segmentation:

Edge is a vital geometrical feature of images which represent sudden changes in intensity. The edge detection can be defined as the operation to identify and locate the intense discontinuities in images. This discontinuities are prompt changes in pixel density that separate the boundaries of objects in remote sensing image. In satellite image segmentation, edge detection can be used to separate regions or as preprocessing stage for feature extraction. [4]

With satellite images edges can be used in numerous processing such as segmentation to isolate regions in entire images. Currently, various researches have been conducted to detect edges in satellite images which can be divided into three classes. First, traditional edge detection operators include Sobel, Canny, LOG operators and others. Second, edge detection that based on specific mathematics theories. In this category different approaches based on wavelet transform, morphology and NN (neural network), and other mathematical approaches were utilized to detect the edges of images acquired from different satellite. Finally and in order to benefit from the advantage of various approaches and algorithms, multiple algorithms were integrated and performed such as traditional edge detection operator was combining with an algorithm (Hough Transform, pulse coupled neural networks (PCNN) … etc) to carry out edges in remote sensing images [4].

2-2 Clustering

Clustering is the task of grouping samples where these samples have similar properties and/or features within each group, and these groups should have highly dissimilar properties and/or features and named clusters. Clustering can be considered as a data mining technique used in anomaly detection, medical imaging, statistical data analysis, pattern recognition, image segmentation etc [7]. Practically there are many clustering algorithms, the more popular algorithms in the literature is the K-means clustering. In this technique a positive integer number (k) which represent number of clusters that derived based on some similarity feature of pixels (such as pixels intensity) and the distance of pixel from centroid pixel in the cluster. Because of simplicity and low computational cost of k-mean algorithm many of authors compare their proposed works results by the k-means [8].

2-3 Region- Based Segmentation

One of image segmentation techniques is the region based segmentation where the images are segmented into diverse regions. The gray values of the image pixels have been used in the segmentation process. There are two main techniques in this approach:

Region growing technique: In this technique a predefined criteria which represent the pixels properties such as color, texture, gray scale etc are used to groups these pixels into larger regions. The pixels gathering begins with a combination of seed points where the regions grow depending on similarity between the seed pixel and neighboring pixels [9].

The second technique is split-and-merge algorithm which is accomplished by performing two main steps. The first one is achieved by subdividing the target image into a set of smaller regions (arbitrary, disjoint regions) depending on a dissimilarity criterion. A quad tree partition and a binary space partition can be adopted in this step to divide the image into number of small areas or regions. Secondly, a similarity criterion is applied between the neighbor areas gained in the previous step in order to merge the similar regions or areas. The similarity and dissimilarity criteria can be based on an intensity range, gradient, contrast, region statistics, or texture [10].

3- Literature Review

This section introduces number of literary works that related to satellite images with the three segment approaches that presented in the previous section.

In [11] work, five traditional edge detection techniques (Sobel, Roberts, Prewit, LOG and Canny) were used to detect edges in remote sensing images, the results of detectors are compared with cellular automaton technique and the results indicate good performance of the proposed method.

In [12] work the edge information was used to multiscale segmentation of seaboard multispectral remote sensing images. The work was implemented in three steps. Firstly, the edge detection is applied using Canny detector, then features of first step result are employed in a segmentation process and finally the edge information are combined with the segmentation scale. The results presents good work on tested coastal satellite multispectral imagery.

[13] introduced region based segmentation approach where the Region based technique applied on tested image after a preprocessing that reduce speckle in tested satellite image. The results identify the edges of tested images by the region image sets.

In [14] work the threshold technique with edge detection have been used to extract the coastline in aerial images. The aim of this work is to segment the input images into two regions, land and sea. The input images enhanced by reducing the noise distortion, then the threshold technique has been implemented to segment the image into land and sea regions, finally the edge detection with active contours has been performed after the morphology operation to extract coastline.

In clustering technique. The color feature with unsupervised FCM Algorithm was used by [15] to segment high resolution multispectral satellite images by performing two steps. First, the entire satellite images are enhanced using color transformation. Second, the FCM algorithm was used to grouped the enhance images regions into clusters. The implementation of the introduced work was assessed in qualitative and quantitative ways which presented a good performance of the proposed work.

In [16] presents a comparison study between K-means clustering segmentation and thresholding technique. Segmentation parameters (mean square error MSR, peak signal-to-noise ratio PSNR) were used to gauge the degree of distortion in segment image.

In [5] work both fuzzy$c$-means (FCM) and$K$-means clustering algorithms were used to generate clusters in homogeneous remote sensing images. After that Zernike moments are utilized to detect the edges on clustered image. Both quantitative and qualitative metrics were used to verify the efficiency of the work on two set of experimental data. The results demonstrate the effectiveness of the presented work.

[17] Adopting two algorithms which applied on wide database satellite images. The Back Propagation Algorithm of ANN was applied to calculate the density count which stored in database for further application and the K-means was used as segmentation method.

In [18] five samples of different satellite images have been used with fuzzy cluster region means (FCM) segmentation technique. A top-hat and boots-hat morphological method have been used before applying FCM to improve the quality of segment images.

The paper presented by [19] aims to presents a segmentation algorithm performed on multispectral remote sensing images with high resolution in order to recognize regions with numerous cover types. A Gabor filter banks was combined with variable mean shift clustering algorithm to achieve feature fusion. The QuickBird image was used in performing the segmentation approach with ideal land cover types, then the results compared with fixed bandwidth Mean Shift segmentation algorithm. The results indicate good performance of the introduced approach in distinguishing different land cover types which has the identical spectral surface.

Authors in [20] presents a work where both clustering and histogram thresholding technique were combined in order to achieve automatic Landsat TM- satellite images segmentation. In this work the histogram of hue color palette was generated where the objects on the image have been identified as peaks of the histogram, then the K-mean clustering algorithem was performed to generate the segmented result.

In [21] work, a High Resolution Multispectral satellite image segmentation was introduced based on color feature with unsupervised FCM Algorithm. The work was implemented by performing two steps, first the color transformation was used to enhance the color separation of the entire image, then in the second step the FCM clustering algorithm was utilized to grouped the regions of the processed images.

In [22] paper both region growing and region merging were used to apply the segmentation in very high resolution images which represent the urban..A seeded region-growing procedure was applied using seed point which generated from gradient image, then the similarity between a seed pixel and its surrounding pixels (neighboring) was used to obtain the first segmentation result. Finally the region merging process was used to get the ultimate segmentation image.

[23] presented a study to segment different satellite images in three steps. Firstly using local thresholding to achieve an initial segmentation of the natural scenes, then from the threshloded images the spectral, spatial and textural features are generated. Finally, the features extracted in step2 are used as attributes in conceptual clustering to cluster the images regions into N classes automatically.

In [24] paper the histogram was used to recognize the region of interest (ROI) in high-resolution satellite images by identifying the behavior of the histogram mapping to recognize three different region in the satellite image. Morphological operation was used in this work to manage the RIO in this work.

Edge based segmentation technique provide accurate edges while in growing region approach present related area but with less exact edges. Therefore [25] suggest to combine edge detection with region growing to gain areas with quite clear edges. The cooperative fusion technique have been used to correct the edge in image resulting from region segmentation approach using the edges resulting from Laplacian edge operator also at the same time it is possible to close the edges in Laplacian results with information provided from region growing result.

4- Conclusions

Image segmentation is the process of separating a digital image into numerous set of pixels called segments to locate objects and modify the representation of an image into more significant for further studying and analysis. In this work main image segmentation algorithms related to remote sensing image have been introduced. As a result, there is no single method that can be adopted for all types of image and at the same time, not all methods can be suitable for a particular type of image where the process of segmentation is affected by a number of factors related to satellite image such as image homogeneity, texture, spatial characteristics of the image and others.

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References

[1] N.P. Deepika, K. Vishnu, "Different techniques for satellite image segmentation", In 2015 Online International Conference on Green Engineering and Technologies (IC-GET) (pp. 1-6). IEEE.

[2] H. Kaur, "Review of remote sensing image segmentation techniques", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), 2015, Issue 4, Vol. 4, pp. 1667-1674.

[3] V. Gurusamy, S. Kannan, G. Nalini, REVIEW ON IMAGE SEGMENTATION TECHNIQUES.

[4] M. Ali, D. Clausi, "Using the Canny edge detector for feature extraction and enhancement of remote sensing images" In IGARSS 2001. Scanning the Present and Resolving the Future. Proceedings. IEEE 2001 International Geoscience and Remote Sensing Symposium Vol. 5, pp. 2298-2300, IEEE.

[5] M. M. Awad, K. Chehdi, "Satellite image segmentation using hybrid variable genetic algorithm", International Journal of Imaging Systems and Technology, 2009, Issue 3, Vol.19, pp. 199-207.

[6] D. Chakraborty, G. K. Sen, S. Hazra, "High-resolution satellite image segmentation using Hölder exponents", Journal of Earth System Science, 2009, Issue 5, Vol. 118.

[7] R.Dass, S. Devi, "Image segmentation techniques" 2012

[8] A. Kaur, "A review paper on image segmentation and its various techniques in image processing", International Journal of Science And Research, 2012.

[9] H. Kaur, "Review of remote sensing image segmentation techniques", International Journal of Advanced Research in Computer Engineering & Technology, 2015 Issue 4, Vol 4, pp.1667-1674.

[10] M. G. Patil, M. V. Galande, M. V. Kekan, M. K. Dange, "Sentiment analysis using support vector machine", International Journal of Innovative Research in Computer and Communication Engineering, 2014, Issue(1), Vol. 2, pp.2607-2612.
[11] J. Chen, J. Li, D. Pan, Q. Zhu, Z. Mao, "Edge-guided multiscale segmentation of satellite multispectral imagery", IEEE transactions on geoscience and remote sensing, 2012, Issue 11, Vol. 50, pp. 4513-4520.
[12] G. G. Krishnan, A. Tholkappia, "Region based segmentation algorithm for remote sensing image based on Heterogeneity of objects", Middle-East Journal of Scientific Research, 2015, Issue 7, Vol. 23, pp. 1375-1378.
[14] V. Paravolidakis, K. Moirogiorgou, L. Ragia, M. Zervakis, C. Synolakis, "Coastline extraction from aerial images based on edge detection", ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences,2016, Vol. 3, 153.
[15] S. S. Baboo, S. Thirunavukkarasu, "Image segmentation using high resolution multispectral satellite imagery implemented by fcm clustering techniques", International Journal of Computer Science Issues (IJCSI), 2014, Issue 3, Vol. 11, pp. 154.
[16] P. Panwar, G. Gopal, R. Kumar, "Image Segmentation using K-means clustering and Thresholding. Image", 2016, Issue 5, Vol. 3, pp. 1787-1793.
[17] L. Huang, X. Yu, X. Zuo, "Edge detection in UAV remote sensing images using the method integrating Zernike moments with clustering algorithms", International Journal of Aerospace Engineering, 2017.
[18] P. Sathya, L. Malathi, "Classification and segmentation in satellite imagery using back propagation algorithm of ann and k-means algorithm", International Journal of Machine Learning and Computing, 2011, Issue 4, Vol. 1, pp. 422.
[19] T. A. Munandar, A. Suhendar, A. G. Abdullah, D. Rohendi, " Contrast enhancement for satellite image segmentation with fuzzy cluster means using morphological filtering", IOP Conference Series: Materials Science and Engineering, 2016, Issue 1, Vol. 128.

[20] X. Xie, M. Liu, L. Wang, Q. Qin, "A remote sensing image segmentation method based on spectral and texture information fusion" In 2009 Sixth International Conference on Information Technology: New Generations (pp. 22-27). IEEE
[21] A. Guarnieri, A. Vettore, " Automated techniques for satellite image segmentation", INTERNATIONAL ARCHIVES OF PHOTOGRAMMETRY REMOTE SENSING AND SPATIAL INFORMATION SCIENCES,2002, Issue 4, Vol. 34, pp. 406-410.
[22] J. Liu, P. Li, X. Wang, "A new segmentation method for very high resolution imagery using spectral and morphological information", ISPRS journal of photogrammetry and remote sensing,2015, 101, pp.145-162.
[23] L. K. Soh, C. Tsatsoulis, "Segmentation of satellite imagery of natural scenes using data mining", IEEE Transactions on Geoscience and Remote Sensing, 1999, Issue 2, Vol. 37, pp. 1086-1099.
[24] K. Warinthorn, R. L. Adrian, "REGION OF INTEREST DETECTION BASED ON HISTOGRAM SEGMENTATION FOR SATELLITE IMAGE", International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences, 2016, 41.
[25] A. Rekik, M. Zribi, A. B. Hamida, M. Benjelloun, "Review of satellite image segmentation for an optimal fusion system based on the edge and region approaches",

International Journal of Computer Science and Network Security, 2007, Issue 10, Vol. 7, pp.242-250.