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Image Segmentation Techniques for Remote Sensing Satellite Images

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Abstract:

The use of satellite imagery has become an integral aspect in the planning of multiple domains that include disaster management and analysis of natural calamity images, snow cover mapping, smart city development, etc. Extraction of urban information like linear features(roads), structured features(buildings, dams, man-made structures), boundaries of water bodies) from satellite images has now become an important area in remote sensing studies.

The whole part of a digital image is not useful for a particular purpose hence the image needs to be segmented. Various methods for image segmentation have been proposed but the choice of a particular method depends upon our requirement. Hence it is necessary to have a basic insight of different methods used for remote sensing satellite images. This paper gives a brief explanation of various segmentation methods and the use of these methods on different data sets.

Keywords: Image Segmentation, Remote Sensing Images, Satellite Images, Filters, Edge Detection.

1. Introduction:

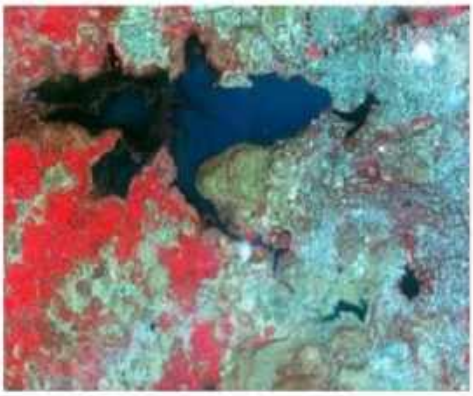
Image segmentation is used to partition a digital image into multiple segments. An image can be represented in a more meaningful way using image segmentation so that it can be easily analyzed. By segments, we mean pixels i.e., similar pixels in a region are grouped to form segments. Various criteria to find the similarity among pixels can be color, intensity, or texture. The Segmentation process is used to find the target region in a particular image. Various techniques of segmentation have been proposed but the selection of technique varies from application to application.

Remote Sensing is the process of detecting and monitoring the physical characteristics of earth surfaces and phenomenon with the use of sensors that is not in physical contact to the surface and phenomena of interest. GIS database can be generated and updated using remotely sensed data in many applications. A large amount of information is contained in remote sensing satellite images and is generally corrupted with many factors like noise. The textural features of remotely sensed images are generally studied by morphological transformations.

A digital image can be defined as a set of pixels. Satellite images are the images of the earth and other planets captured by different Satellites from outer space. Satellite images are generally masked with cloud shadow, hence they are difficult to detect[Fawwaz,2018].

Satellite imagery is used for many applications such as Earth observation, space astronomy, science research, etc. The spatial resolution of the Satellite describes the level of detail. Satellite images like digital photographs are also made up of little dots called pixels. The width of each pixel is the satellite's spatial resolution. Fig.1 shows the LISS III (Linear Imaging Self Scanning Sensor) JPEG image for the Belgaum region and the spatial resolution of 23.5 m. This image has two regions: Vegetation is denoted by red and yellow while brown color denotes an uncultivated region. Figure 1 (b) is the IKONOS satellite pan image showing building features and Figure (c) shows the water body of the Bhopal city.

Figure 1: (a) LISS III Image [Ashketkar,2013]



(b) IKONOS PAN image **(c) LISS IV Bhopal Water Body**

Image processing is used to perform some operation over a digital image using computer algorithms to get a magnified image or to retrieve some valuable information. The extraction of useful information by image processing must be done so that other features of the image are not affected. Some portion of an image contains information that is not useful for a particular application then to process the whole image is not necessary [Krishnan, 2017]. Hence, the image is divided into multiple segments. Image segmentation puts those pixels in the same group that share similar features[Yin,2018]. For better understanding of the objects in an image, the objects are separated by masks of pixels using image segmentation [Sharma, 2019].

Image segmentation is used in almost every field of science- Satellite imagery, computer vision, machine vision, biometrics, military, feature extraction, recognition of objects from the given image [Saini,2014]. Image segmentation can be categorized into semantic segmentation, where objects are classified as a single substance and instance segmentation, where each object is identified individually [Sharma, 2019]. The rest of the paper is organized as follows: SectionII focuses on different methods for image segmentation. Section III contains a literature survey and section IV includes a conclusion.

2. Image Segmentation methods:

Based on two properties of an image , we can divide the image segmentation techniques into two types: [Dass, 2012]

(a) *Detecting Discontinuity*: An image can be partitioned by finding gradual changes in intensity. This includes the algorithm like *Edge Detection* [Saini, 2014].

(b)Detecting Similarity: An image can be partitioned into similar regions. This includes algorithms like thresholding, Region growing, merging, and splitting [Naraghi, 2011; Saini,2014].

Each image has its own type. It is not easy to find a segmentation technique that can be applied to a specific image [Saini, 2014]. Since the same technique applied to two different images can't always give good results. Hence, image segmentation techniques can be divided into six types as shown in Figure 2.

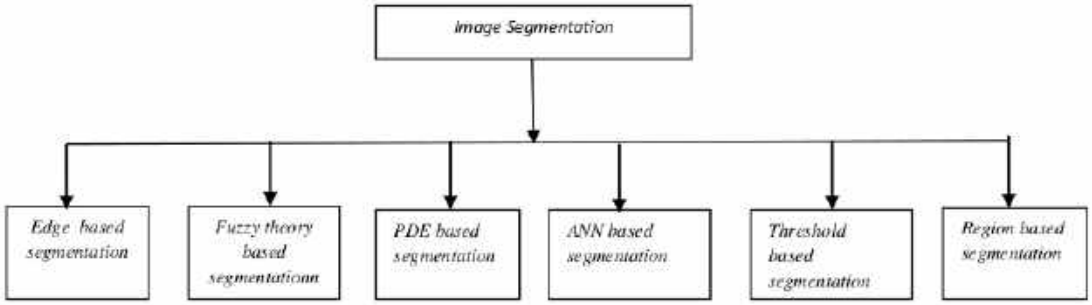


Figure 2: Various image segmentation techniques [Khan, 2013]

An edge can be thought of as a boundary that separates different sections of an image [Maini, 2009; Katiyar, 2014; Jayakumar, 2014; Dharampal, 2015]. *Edge detection* is to identify intense intermittence in an image [Maini, 2009; Katiyar, 2014; Jayakumar, 2014].Detection and Extraction of features is achieved through Edge Detection [Naraghi, 2011;Dharampal,2015]. Generally, three basic types of features are extracted: Areal features, Linear features, and point-like features [Xi, 2012]. *Edge detection* of the noisy image is difficult because both contain high-frequency contents [Maini, 2009]. Hence edge detection algorithms include filtration, enhancement, detection, and localization [Jayakumar, 2014; Krishnan, 2017; N., 2009].

The data space can be partitioned accurately using membership functions , hence *Fuzzy systems* are easily understandable. A gray-level image can be converted into a fuzzy image using fuzzification function [Khan, 2013]. In image processing, Fuzzy k-means and Fuzzy C-means (FCM) are widely used methods. Fuzzy clustering methods divide the input pixel into groups or

clusters according to some homogeneity criteria like distance, intensity, and connectivity[Dass, 2012].

An image can also be segmented using a partial differential equation. The segmentation problem is transformed into the *PDE framework* using active contour model or snake. Snakes is a framework that is applied over an image for delineating an object outline. The drawback of this method is that it requires user interaction. Three most commonly used PDE based methods are: Snakes, Level set, and Mumford Shah model [Dass, 2012; Khan, 2013].

Segmentation using Artificial Neural Network is a fast method thus it is useful for real-time applications[Dass, 2012]. Firstly, an image is mapped into a neural network where each neuron corresponds to a pixel. Then using some sample sets, the neural network is trained and thus the connections between the pixels or neurons can be determined. This way new images are segmented using this newly trained network[Dass, 2012; Khan, 2013; MengieZhang, 1997].

Thresholding is a simple but powerful technique that is used to convert a gray-level image into binary image. It's primary use is to separate the object from the background. The pixels(x,y) of an image is marked as black or white depending upon the pixel value falls above or below the chosen threshold value such that if , f(x,y)>= T ; pixel may be marked as black else it is marked as white. Black colored pixel can be considered as object and white colored pixels as background [Sharma, 2019; Khan 2013; Dass, 2012].

An image can be partitioned into similar regions according to some predefined criteria such as color, intensity, or objects usnig *Region-based segmentation methods*[4]. These methods are relatively simple as compared to edge detection methods but are computationally expensive. Segmentation methods based on the region are of three different types: *region growing, region splitting, and region merging* [Saini, 2014]. *Region growing* methods combines sub-regions into larger regions. *Region splitting* methods subdivide the regions that don't satisfy homogeneity criteria. *Region merging* methods compare the neighboring regions and merge them if they meet the criteria chosen[Kaur, 2015; Khan, 2013]. The region-based methods are used in medical images to find tumors, veins, etc. to find targets in satellite images/areal images, etc.

3. Literature Review:

Segmentation is typically associated with the pattern recognition problem. This is the first step in the pattern recognition process and is also called as Object isolation. It is a challenging task for poor or low contrast images that may result in diffusing tissue boundaries. [Kaur & Kaur, 2013]. It requires prior knowledge. Although various edge detection methods have already been proposed in the literature, use of a particular method depends upon the image type and the problem domain.

Ye, H. et al.[2018], have proposed a new method for edge detection of *Remote sensing image* using *fast Guided* filters for image smoothening, then an *improved Sobel operator* of 3X3 mask and 8 direction template is used to find gradients and directions of the gradients. High and low thresholds are selected using a new two-dimensional Ostu method as the traditional method is susceptible to noise and object size. The experiment is carried out on the image of the University of Chinese Academy of Science that is .PNG image with pixel size of 1280X659. The s/w is implemented using MATLAB 2016. Although the proposed algorithm gives more edge details, clear and continuous contours while the algorithm suffers from two limitations –high time complexity, inefficient for high-intensity noise.

Fawwaz, I. et al.[2018], compares the performance of Gaussian Filter and Bilateral Filter. The filters are applied to various satellite images using Canny, Robert, and Frie Chen. The benefit of a Bilateral filter over the Gaussian filter is the use of two kernel filters –Spatial kernel and Range kernel. The distance between the pixels of an image is "Spatial kernel". The similarity of intensity between the two pixels in an image is "Range kernel". Two comparison parameters MSE and PSNR values are used. It was found that the image quality degrades for higher MSE value, while the higher the PSNR value gives better image. The authors have used the satellite images of Sea and Lakes and applied Canny, Robert, and Frei Chen methods for different MSE and PSNR values on these images using Bilateral filters and Gaussian filters. Experiments showed that Bilateral filters with the Canny operator for the lowest MSE value and highest PSNR values give the best result.

Zaaj I et al.[2018], have proposed a hybrid approach for the extraction of building in Satellite image THR using feature detection. The Canny method is used to find borders of an object. If the

image is noisy then the detection of contours is very difficult. Hence, Harris operator along with Canny is used to create a new method for Building Extraction. Building extraction from Satellite image THR requires the detection of edges and corners. The canny method sometimes can't detect all edge points. Harris operator is used for the detection of corners. Harris operator is used as a threshold determinant. The new combined method is used on different images with three different thresholds. The chosen thresholds are combined with the output of Harris. Results were found more effective for the higher threshold value.

Kumar N.S. et al.[2017], have used a three-stage process for the extraction of road networks from high-resolution *multispectral satellite imagery*. Multispectral images are images with three or more spectral bands. The extraction of road features is necessary for urban planning, traffic management, maps updation, etc. The proposed method uses three steps for the extraction of road features. Edges are detected by using different edge detection operators (Canny, Sobel, Prewitt). Noise present in the resultant image is detected by using Morphological operation. Median filters are used to reduce the noise present in an image.

Guiming, S. et al.[2016], have introduced an *improved Canny method* that overcomes disadvantages of the conventional Canny method. Figure.3 depicts the process:

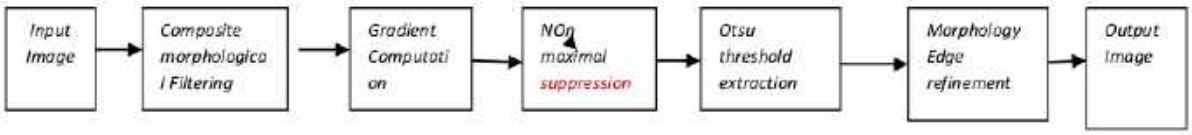
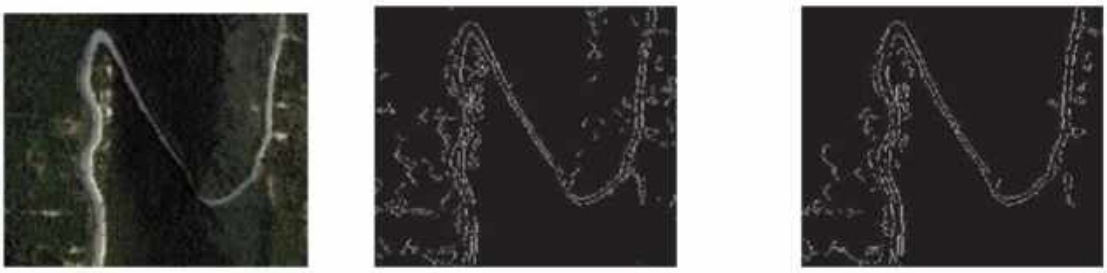


Figure 3: Improved Canny Algorithm [Guiming, 2016]

The conventional method uses Gaussian Filters which sometimes detects the noise as an edge. High and low thresholds are selected manually hence it provides an incomplete edge. Improved Canny algorithm uses Morphological Filters for smoothening the image and provides accurate image contours. Using the Ostu method the two thresholds are chosen automatically which provides a clear and continuous edge. Both methods were applied on three different images to detect the edges of Lena and two Remote sensing images of road and ship. Figure 4 shows the result of the two methods for road edge detection. It is concluded that the improved Canny algorithm provides more accurate results than the conventional method.



(a) Original image (b) Traditional canny operator (c)Improved canny operator

Figure 4: Comparison of road image experimental result [Guiming, 2016]

Lavanya K. B. et al.[2014], has implemented the Sobel method on Simulink blockset and tested on three different images. Sobel technique is mainly used for implementation in hardware and real-time edge detection. The advantage of the Sobel method is less complexity and easy computation. The result of the Sobel operator is not accurate as it uses only two masks. Accurate results with Sobel operators can be obtained by using a larger set of masks.

K. Wang et al.[2014], has proposed a new technique for detecting edges of *high spatial resolution Remote Sensing Images*. The magnitude spectrum is obtained by image's Fourier transform, the analysis of spectrum is done by using radius and angle samples to identify edges. Two log Gabor Filters are multiplied with frequency spectrum and IFFT is applied on the result to detect the edges. Quickbird image of Nanjing Region, China is used for an experiment which gives good result.

Vijayarani S.et al.[2013], has described two different methods for edge detection of facial images: the *Canny Edge Detector* and the *Sobel Edge Detector*. The advantage of edge detection is to remove the unnecessary data to be stored. Authors have used the techniques to detect edges of various images and compared the techniques with reference to accuracy and speed. After comparison, it is found that the Canny algorithm takes 34.7sec, while Sobel takes 34.9 sec to detect the edge. Canny's accuracy is 87.5% while Sobel 's accuracy 75%. It was observed that the Canny method performs well when compared to Sobel method for edge detection.

Kaur G.S. et al.[2013], discussed recently proposed methods for automatic image segmentation. Applications of automatic image segmentation are in machine vision tasks such as *object recognition, image compression, image editing, image searching,* etc. Methods studied for

automatic image segmentation are Dynamic Region merging in which homogenous regions are merged iteratively according to some defined predicate.

Xi, J. et al.[2012], used Canny Operator and Hough transform for detecting edges of Remote Sensing Images. A lot of information is contained within *Remote sensing images* that is corrupted with noise hence traditional methods are not successful for edge recognition of *Remote sensing images* because traditional methods sometimes detect the noise as an edge and can also miss the real edges. Experiments show that the combined approach detects more accurate Edges of Remote sensing images.

Kaur, B.et al.[2011], used Mathematical Morphology for edge detection of 'Saturn' Image. Results are compared with Sobel Edge Detection, Canny Edge Detection, LOG, Prewitt edge detection. It has been observed that edge detection using mathematical morphology gives a better result than the traditional method. The proposed algorithm applied varying sized structure elements with different direction templates using morphological operators. The difference of eroded and dilated images in various directions helps to detect the edges.

Senthilkumaran, N. et al.[2009], explaind various methods of edge detection for image segmentation such as Robert, Prewitt, and Sobel. It also explains some soft computing approaches. The methods were applied to a real-life image of a university and it shows the output of the different methods.

Yi, L. et al.[2004], have introduced a new method for edge detection of the *multi-source remote sensing image* using *fuzzy logic*. Edge detection of Remote sensing images by conventional methods require complex calculations. In the proposed method, a new membership function is designed, modified the methods of fuzzy enhancement, and using edge evaluation criteria handles the iterative procedure automatically. Images of Landsat-7, Ikonos, Quickbird, and SPOT-5 are used for the experiment. It is concluded that the new technique is more appropriate for real-time applications and edge detection of multisource and multi-temporal satellite images.

Zhang M.[1997], uses Neural Network for segmenting an image. Image features are used as input vectors. In this technique, object features that are to be segmented are identified by manual analysis of object samples, then programs are created. There are various types of Neural Networks: ART(Adaptive Resonance Theory) network, SIM(Self- organizing maps), and recurrent network. A sample neural network for segmenting an image is shown in Figure 5. Each pixel in an image corresponds to neurons. The training sample sets are used to train the neural

network to determine the connection and weight between nodes. Using this newly trained neural network, new images are segmented.

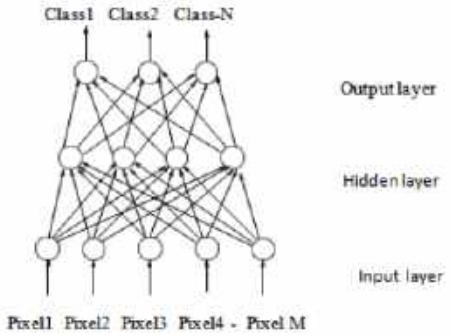


Figure 5: A sample neural network [Zhang M.,1997]

Maini et al[2009]; Jayakumar R. et al[2014]; Dharampal et al[2015]; Bala Krishnan K. et al[2017]; author grouped the *edge detection* into two classifications: *Gradient-based and Laplacian based*. The first one methods detect the edges by finding the maximum and minimum values in the first-order derivatives of the image. Second method detect edges by finding zero crossings in the second-order derivative of an image. These methods are often applied to the images that have been smoothed using Gaussian smoothing filters. *The gradient-based methods* mainly include a *Canny operator, Sobel operator, Prewitt operator, Robert's Cross operator*. Among these methods, Canny is a more efficient algorithm for object extraction since it returns fewer false edges hence it is also called **'Optimal Edge Detector'**[17,18]. The *Sobel* method generally uses a pair of 3x3 convolution mask one is simply the other rotated by 90^0 as shown in Figure 6.

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

Figure 6: Masks Used by Sobel Operator [Jayakumar, 2014]

Sobel operator returns edges at the points where the image's gradient is maximum. The derivative of Gaussian filters is used to calculate the gradient and detected Edges are refined using non-maximal suppression and hysteresis.

Partial derivative in X and Y direction is given by:-

Gx=(P1+CP8+P9)-(P1+CP2+P3) ……(eq.1)

Gy=(P3+CP6+P9)-(P1+CP4+P7)……..(eq.2)

The magnitude's gradient is given by:

$G[f(x,y)]= \sqrt{Gx^2 + Gy^2}$ ……(eq.3)

The angle of orientation of the edge relative to the pixel grid which boost up the spatial gradient is given by:

Theta= arctan(Gy/Gx) …… (eq.4)

Similar to Sobel operator, the Prewitt operator is used to detect horizontal and vertical edges in an image. Robert's cross operator calculates a 2-D spatial gradient of an image. The operator consist of a pair of 2X2 convolution kernels, one is simply the other rotated by 90^0 .These kernels are designed to respond maximally to edges running at 45^0 to the pixel grid, one kernel for each of the two perpendicular orientations. Bala Krishnan K. et al; Maini et al; also analyzed the performance of these edge detection methods using different parameters such as PR, PSNR ,MSE and found that Canny method is computationally costly but gives more accurate result compared to other methods under almost all conditions.

Table 1: Compilation of edge detection techniques used for image segmentation

S.No.	Author Name	Method Used	Methodology	Pros and Cons
1.	Ibtissam Z.,Brahim C. ,El Khalil (2018)	Canny edge detection and Harris operator	Edges are detected by the canny algorithm and Harris operator is used to find the corners to improve building extraction.	Harris operator is reliable for corner detection. Corner information is lost when the threshold is large

2.	Fawwaz I., Zarlis M. & Rahmat R. F. (2018)	Bilateral filters and canny edge detection	Bilateral filters used spatial kernel and range kernel for image's smoothening and noise reduction and the edges are detected by the canny operator	Bilateral filters gives a more smooth image than Gaussian filters.
3	Ye H., Ding M. & Yan S. (2018)	Edge detection using Fast guided filters	First, the image is smoothened using fast guided filters. Then gradient and magnitude are calculated using a 3x3 and 8 direction template isotropic Sobel method. Finally canny operator identify edges of *high-resolution remote sensing images.*	Fast and accurate. High time complexity. Not suitable for high noise intensity
4	Kumar N. S., Sukanya B., Mohan B., & Prathibha, G (2017)	Canny,Sobel,Prewitt And Median filtering	Canny,Sobel and prewitt are used to detect edges of the road and the noise present in the image is removed using the median filter.	It is a fast method. Median filters are often used to remove impulse noise.
5	Guiming S. & Jidong S. (2016)	Improved Canny operator using Morphological operator	Composite morphological smoothening is used in place of Gaussian filtering. Then Ostu method is used for automatic threshold selection, Finally morphological structure elements are used to get more refined edges of *remote sensing images.*	The traditional *canny operator* needs more calculations, returns false edges. The improved method reduces the effect of noise and returns more accurate edges.
6	Lavanya K B ,K V	Sobel edge detection	Edges of three input	Easy computation and less

	Ramana Reddy & Yllampalli (2014)		images are found using Sobel on MATLAB /SIMULINK	complex. Less accurate when uses only two masks for the horizontal and vertical direction
7.	Wang K., Yu T., Meng Q. Y., Wang G. K., Li S. P., & Liu S. H. (2014)	Edge detection using two –dimensional *log Gabor* filter	Edge features of *high-resolution remote sensing images* are detected by *log Gabor* filters in the frequency domain.	Good performance.
8.	Vijayarani S., & Vinupriya M. (2013)	Canny edge detection and Sobel edge detection	Two methods are compared in terms of accuracy and speed	Canny is more accurate and fast as compared to Sobel
9.	Kaur B., & Garg A. (2011)	Mathematical morphological operator	Edges of *Remote sensing* image are detected by applying structure elements in various directions using morphological operators such as dilation, erosion, and the result is compared with Sobel, Prewitt, and canny.	It is very simple and efficient for Hardware implementation. Noise can be suppressed and image can be enhanced.
10.	Yi L., & Xue-quan C. (2004)	Edge detection using Fuzzy sets	A new membership function is designed and an edge evaluation criterion is used to automatically control the iterative procedure of image enhancement.	Very useful in the processing of multisource remote sensing satellite images. Also suitable for low contrast images.
11.	Zhang M. (1997)	Multilayer Feed Forward Neural network	Raw pixel data of small objects and backgrounds are used as input to a neural network.	It can detect the small and regular objects. Difficult to detect the complex objects.

4. Conclusion:

In this research paper various techniques of segmentation for remote sensing satellite images are described. Although various methods of image segmentation have been proposed but there is not any optimal algorithm that can be applied to any kind of image. The selection of a particular techniques depends upon the application. We find that canny method gives better result compared to the other methods of edge detection but sometimes canny gives us false detection of corner, hence Harris operator can be used for efficient corner detection . Also it has been observed that for image smoothening bilateral filters or morphological filters perform better than Gaussian filters. The choice of parameter for segmenting an image also plays an important role in feature detection. The choice of band for extracting certain features is also important. For linear feature extraction such as roads, buildings, boundaries, etc. the IR band was found suitable. Modified version of some of the gradient based approaches of edge detection have also been used in some research papers such as improved canny operator and improved sobel operator. Much work have been done using independent methods hybrid approaches can also be used for better results.

5. References:

1) Chethan K.S., Sinchana G.S.,Dr. Nataraj K.R.,Dr. Choodarathnakara A.L., Analysis of image quality using sobel filter, International Conference on Inventive Systems and Control IEEE Explore Part Number CFP19J06-ART,pp.526-531, 2019.
2) Sharma P., Computer Vision Tutorial: A Step-by-Step Introduction to Image Segmentation Techniques., https://www.analyticsvidhya.com/blog/2019/04/introduction-image-segmentation-techniques, 2019.
3) Fawwaz, I., Zarlis, M. & Rahmat R. F, The edge detection enhancement on satellite image using bilateral filter. IOP Conference Series: Materials Science and Engineering,vol.308,no.1,p. 012052, 2018.
4) Yin, S., Zhang, Y., & Karim, S. Large scale remote sensing image segmentation based on fuzzy region competition and gaussian mixture model, IEEE Access, vol 6,pp. 26069-26080, 2018.

5) Zaaj I.,Brahim C.Khalil ,Extraction of building in satellite image THR using feature detection, International Journal of Computer Applications, vol.181, No.10,pp. 23-27, 2018.

6) Ye, H., Ding, M., & Yan, S., Improved edge detection algorithm of high-resolution remote sensing images based on fast guided filter, IEEE 4th Information Technology and Mechatronics Engineering Conference,pp. 29-33, 2018.

7) Li, L., Wang, C., Chen, J., & Ma, J.,Refinement of hyperspectral image classification with segment-tree filtering,Remote Sensing, vol.9,issue 69, 2017.

8) Krishnan K.B., Ranga S. P, & Guptha N, A survey on different edge detection techniques for image segmentation, Indian Journal of Science and Technology.vol.10,issue 4,pp 1-8, 2017.

9) Kumar, N. S., Sukanya, B., Mohan, B., & Prathibha, G, Extraction of roads from satellite images based on edge detection,International Journal of Engineering Development and Research,vol.5,issue 2,pp.187-190, 2017.

10) Varghese, N., & Babu, P. A Survey on remote sensing image segmentation, International Journal of Scientific Engineering and Applied Science, vol.2,issue 1, pp 488-491, 2016.

11) Guiming S., & Jidong, S. Remote sensing image edge-detection based on improved Canny operator, IEEE 8th International Conference on Communication Software and Networks ,pp. 652-656, 2016.

12) Kaur H, Review of remote sensing image segmentation techniques,International Journal of Advanced Research in Computer Engineering & Technology,vol. 4,issue 14,pp 1667-1674,2015.

13) Dharampal, V.M., Methods of image edge detection: A review, J Electrical & Electronic System, vol.4, issue 2, 2015.

14) Lavanya K. B., K. V. Ramana Reddy and Siva S Yellampalli, Implementation of sobel edge detection algorithms, International Journal of Management,Information Technology and Engineering ,vol.2,issue.7,pp 65-70, 2014.

15) Katiyar S. K., & Arun P. V., Comparative analysis of common edge detection techniques in context of object extraction, IEEE TGRS vol. 50,issue 11,pp. 68-79, 2014.

16) Saini, S., & Arora, K., A study analysis on the different image segmentation techniques,International Journal of Information & Computation Technology, vol.4,issue 14, pp. 1445-1452, 2014.

17) Jayakumar, R., & Suresh, B.,A review on edge detection methods and techniques, International Journal of Advanced Research in Computer and Communication Engineering ,vol.3,issue 4,pp.6369-6371, 2014.

18) Wang K., Yu T., Meng Q. Y., Wang G. K., Li S. P. & Liu S. H., Edge detection from high resolution remote sensing images using two-dimensional log gabor filter in frequency domain, IOP Conference Series: Earth and Environmental Science ,vol. 17,issue.1, pp. 012191, 2014.

19) Yuan J., Wang D., & Li R., Remote sensing image segmentation by combining spectral and texture features, IEEE Transactions on GEOSCIENCE and Remote Sensing,vol. 52,issue 1,pp. 16-24., 2014.

20) Kaur G.S., Kaur R., A Study of automatic image segmentation methods, International Journal of Advanced Research in Computer Science and Software Engineering ,vol. 3,issue. 2, 2013.

21) Vijayarani S., & Vinupriya M., Performance analysis of canny and sobel edge detection algorithms in image mining, International Journal of Innovative Research in Computer and Communication Engineering, vol.1,issue 8, pp. 1760-1767, 2013.

22) Khan W., Image segmentation techniques: A survey, Journal of Image and Graphics, vol. 1,issue 4,pp. 166-170, 2013.

23) Dass R., Priyanka & Devi S., Image segmentation techniques , International Journal of Electronics and Communication Technology, vol.3,issue 1,pp. 66-70, 2012.

24) Xi J. & Zhang J. Z.,Edge detection from remote sensing images based on canny operator and hough transform. Advances in Computer Science and Engineering Springer, Berlin, Heidelberg, pp. 807-814, 2012.

25) Naraghi M. G., Koohi M. & Shakery.A, Edge detection in multispectral images based on structural elements,The International Journal of Multimedia & its Applications,vol.3,issue 1,pp. 90-99, 2011.

26) Kaur B., & Garg A, Mathematical morphological edge detection for remote sensing images, IEEE 3rd International Conference on Electronics Computer Technology ,vol. 5, pp. 324-327, 2011.

27) Senthilkumaran, N., & Rajesh, R. Edge Detection Techniques for Image segmentation: A Survey of Soft Computing Approaches, International Journal of Recent Trends in Engineering ,vol. 1.issue 2,pp. 844-846, 2009.

28) Maini R. & Agarwal H.,Study and comparison of various image edge detection techniques, International Journal of Image Processing (IJIP),vol. 3,issue 1,pp.1-11, 2009.

29) Yi L. & Xue-quan C., An edge detection algorithm of remote sensing images based on fuzzy sets, International Conference on Communications, Circuits and Systems (IEEE Cat. No. 04EX914),vol. 2, pp. 984-988, 2004.

30) Schiewe J., Segmentation of high-resolution remotely sensed data-concepts, applications and problems, International Archives of Photogrammetry Remote Sensing and Spatial Information Sciences, vol.34, issue 4, pp. 380-385., 2002.

31) Zhang M., A pixel-based approach to recognizing small objects in large pictures using neural networks, In Proceedings of the Annual RMIT Computer Science Postgraduate Students Conference, Department of computer science, RMIT. TR ,pp. 97-51, 1997.

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