**RADAR Classification efficiently utilizing conventional and Edge Detection Technique**

**Abstract –** An edge detection and linking method is developed for the classification of the man-made linear geographic features like canals, roads and the railway connectivities. Presently in the land cover classification methods used it is difficult to extract these type of linear features using the classifier algorithm generally used. By using the edge detection and linking algorithm parallely we can effectively consider these linear features as one separate class and then combine our result with the previous classification result of the Land cover classifier and we can obtain the fully classified Land features. During any natural hazard condition these are the features effected mostly and hence the model can be used to obtain the information about any of the changes.

**Keywords –** edge detection, edge linking, linear geographic features

1. **INTRODUCTION**

Land cover contains all the aspects on the earth’s surface. It can be both the natural phenomenon and the effect of human intervention on the earth’s surface[1]. We classify all these features for many applications using the various classification approaches. Land cover classification[2] have many advantages. It has become one the most important aspect for the Nations plans to overcome the problems of the natural hazards, uncontrolled development and loss of the prime agriculture land. It is also needed for the flood control, water supply management and water resource management.

Traditionally used classifiers like mean to minimum distance or the advanced classifiers like artificial neural network (ANN)[3] [4]we can easily detect all the natural phenomenon land cover but it is difficult to extract the man-made linear geographic features and hence cannot classify all the land cover features separately and completely using these classifiers. In this paper we have used edge detection and linking method for the detection of the geographical linear features. Edge detection[5] [6]is a technique used in the image processing for finding boundaries of objects within the image. Edges in the image have discontinues in the brightness. Edge detection provides wide range of applications for image segmentation and extraction of data as computer vision, image processing and machine vision. There are many approaches for the detection of the edges but mainly classified into two important categories, zero crossing and the search based[6] [7]. In search based approach we first go for the strength of the edge by calculating first order derivative expression i.e. gradient magnitude, then searching for the local directional maxima for the gradient magnitude. In zero crossing method we search for the zero crossings in the second order derivative expression computed for the image in order to find the edges. The edge detection filters that are used differ mainly in the smoothening filter applied and the way that is used to compute the strength of the edge. Searched based method are also known as gradient methods Roberts, Perwitts and sobel method falls in this category. Zero crossing method also called Laplacian method and example of this method is Marrs-Hildreth method.

In this work for the detection of the edges we have used the canny filter. Canny filter is proposed by John Canny[8]. He used mathematical problem of describing an optimal smoothening filter given criteria for detection, localization and minimizing multiple responses to a single edge. Canny filter mainly have three basic criterion. Firstly a Gaussian filter is used for the smoothening of the image[9]. Then the maximum and the minimum value of the first derivate correspond to each other i.e. both the strong edge (points with sudden change of gray-scale) and the weak edge (point with small change in gray-scale) correspond to second derivative zero crossing point. Canny algorithm’s advantage lies in it’s ability to detect the weak edges effectively as it is not susceptible to the noise interference.

Once we detected the edges now our objective is to separate and link the edges which gives us the meaningful information to us in our case the edge which shows the man-made linear geographic features. Hough transform[10] [11] is the feature extraction technique which is mainly used in image processing, computer and machine vision. This technique is used to obtain the features of the particular shape in the image[12]. An idea used behind the Hough transform is simple: the particular shapes in image are determined by using the parameter space as it is clear that if there is some particular shape in the image, then if we map all its point into the parametric space we must have cluster around the parametric values which corresponds to that shape. Main advantage of hough transform lies in the fact that it is relatively unaffected to image noise and is tolerant of the gaps of the feature boundary.

1. **METHODOLOGY**

In this paper we first used a traditional classifying method namely mean to minimum distance classifier to classify the PALSAR image. The flow and procedure used is given by the fig.1.

**Mean to minimum distance classifier**

In this classifier we first compute the Euclidean distance between the pixel values and the mean value of the particular class and then allocate the pixel to the class which have the shortest Euclidean distance. The elegance of mean to minimum distance classifier lies in the fact that it is simple and fast.



Fig.1. Flow chart of methodology

Minimum distance classifier can be computed from equation (1),

(1)

Where: = Distance between class a and pixel b.

= Mean spectral value for class a, band i

= Spectral value for pixel b, band i

n = Number of spectral bands

The statistical mean of a set of variables is expressed as in equation (2),

(2)

Where: µ = mean

*N* = the number of sample in the region

i =number of rows and *j* is number of column.

After considering one of the traditional classifier in the next step we used one of the advanced classifier namely the artificial neural network (ANN) to classify the same image.

**Artificial Neural Network (ANN)**

An Artificial Neural Network (ANN) is an information processing system based on our biological nervous system. ANN are generally present as system of interconnected neurons which exchange messages between each other. ANN learn by examples, we have to train it beforehand. It is configured for specific problems such as classification or pattern recognition. ANN involves adjustments to the connections that are present between the neurons. The result is obtained by introducing an invariant into the network by changing the interconnection between the layers of the network or by means of some pre-processing of some input data.

Back propagation is the most common learning algorithm which is a iterative gradient descent algorithm to minimize error function in the equation (3)-

E = 2 (3)

Where, j = 1 to L

dj = desired output of neuron j in output layer

oj = current output of neuron j in output layer

L = number of neuron in output layer.

In the last case we have used the edge detection and linking algorithm with the mean to minimum distance classifier we can use it with ANN too. We have used the edge detection and linking algorithm to detect the linear geographic feature in this particular case the canal.

**Image classifier with Edge detection and linking algorithm**

In this step we firstly use one of the previous classifier result excluding canal class from it and then superimpose this result with the result obtained after applying the edge detection and linking algorithm on the PALSAR image one of the feature we experienced when we applied the edge detection method on the PALSAR image is that the edges are best extracted in the VV polarised image. The flow of control in the following step is given in fig. 2. We have used Bresenham’s line algorithm to connect the end points of the line obtained by the Hough transform for obtaining the canal feature in the image. Bresenham’s line algorithm [\*] determines the point in the n-dimensional raster that are to be selected to form the close approximation to a straight line between two points. As from the Hough transform we can detect the line but cannot change the actual pixel value corresponding to canal feature in the class and therefore we used Bresenham’s algorithm to change the actual pixel value so that we can show the canal feature in the image for the land cover classification. Other useful information required in this step is explained in the introduction part.



Fig.2. Flow chart of methodology

1. **RESULT AND DISCUSSION**

In this paper we have considered four classes namely urban, vegetation, river and canal and firstly we calculated the mean for each class and then calculated Euclidean distance between mean value of each class and pixel value. We have considered the combination of all 3 polarisations (-HH, -HV and -VV) for applying the mean to minimum distance classifier. The image used in the present work is 850 × 850 pixels PALSAR image. The mean values for the each class for each polarisation are collected in the table 1.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Polarisation** | **Mean values calculated for each class** | | | |
| **Urban** | **Vegetation** | **River** | **Canal** |
| **-HV** | -18.53 | -25.59 | -31.52 | -29.58 |
| **-HH** | -9.69 | -15.48 | -19.42 | -20.92 |
| **-VV** | -12.39 | -15.79 | -18.58 | -22.05 |

Table 1: Mean values for individual classes for each polarisation

After applying mean to minimum distance classifier on the combination of the images of different polarisation we get the classified image as shown in fig 3 and after obtaining the classified image the result of accuracy assessment is presented in the table 2. It can be seen from the fig 3 that some part of the canal is somewhat distinguishable from the other features but as we are using the mean values therefore a large part of the canal overlaps with the other classes and hence the goal to extract the canal feature in the land cover classification cannot be achieved effectively by the traditional method of land cover classification which can also be observed by the accuracy result too. From table 2 we can see that we obtain very poor user accuracy (28.57%) and producer accuracy (19.35%) for canal class which reduces the overall classification accuracy (54.6392%) of the image under consideration.

C:\Users\Shivam\Desktop\New folder\canaloverclassi232.tif

Fig.3. Mean to minimum distance classified

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Classes** | **Producer’s Accuracy (%)** | **User’s Accuracy (%)** | **Producer’s Accuracy (Pixel)** | **User’s Accuracy (Pixel)** |
| Urban | 87.76 | 63.24 | 43/49 | 43/68 |
| Canal | 19.35 | 28.57 | 6/31 | 6/21 |
| River | 40.54 | 51.72 | 15/37 | 15/29 |
| Vegetation | 54.55 | 55.26 | 42/77 | 42/76 |

Table 2: Accuracy assessment of fig.3

As per our methodology next result is to be discussed about the advanced method for classifying image i.e. ANN method the classified image we got after applying ANN is given by the fig. 3 and the accuracy assessment result is shown in the table 3. We can see it clearly from the classified image that canal feature is somewhat distinguishable from other features but as in case of traditional classifier it is not completely extracted and the overlapping of the canal class with the other classes is still high which is supported by the low user accuracy (42.86%) and the low producer accuracy (29.03%) and hence, resulted in the low overall accuracy of 48.50%.It is clear the accuracy for the canal class is increased from the previous classification but still can be improved much more.

C:\Users\Shivam\Desktop\New folder\9may\anncanal.tif

Fig.4. ANN classified image

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Classes** | **Producer’s Accuracy (%)** | **User’s Accuracy (%)** | **Producer’s Accuracy (Pixel)** | **User’s Accuracy (Pixel)** |
| Urban | 68.97 | 57.14 | 20/29 | 20/35 |
| Canal | 29.03 | 42.86 | 9/31 | 9/21 |
| River | 43.33 | 30.95 | 13/30 | 13/42 |
| Vegetation | 50.65 | 56.52 | 39/77 | 39/69 |

Table 3: Accuracy assessment of fig.4

Finally the work we want emphasise in this paper is the method we can superimpose with the any of the above to methods to distinguish the linear features like canal effectively. In present work we have superimposed edge detection and linking method with the mean to minimum distance classifier (it will work equally good with the ANN classifier too). So applying the proposed method we obtained the classified image in the fig. 4 and the accuracy assessment result in the table 4. It is clear that the canal is clearly extracted from the all other land cover aspects and the overlapping with the other classes is reduced much more effectively than the previous two methods alone supported by the increased user accuracy (81.48%) and producer accuracy (70.97%) and hence increased overall accuracy of 65.77%.

C:\Users\Shivam\Desktop\canalclassioverall254.jpeg

Fig.5. traditional + edge detection and linking classified image

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Classes** | **Producer’s Accuracy (%)** | **User’s Accuracy (%)** | **Producer’s Accuracy (Pixel)** | **User’s Accuracy (Pixel)** |
| Urban | 91.84 | 68.18 | 45/49 | 45/66 |
| Canal | 70.97 | 81.48 | 22/31 | 22/27 |
| River | 40.00 | 34.29 | 12/30 | 12/35 |
| Vegetation | 57.14 | 74.58 | 44/77 | 44/59 |

Table 5: Accuracy assessment of fig.5

**VALIDATION OF THE PROPOSED ALGORITHM**

In the above discussion we have described the comparison between the traditional method, advanced method and the method proposed by us in this paper for image classification on the test image. Now to validate our proposed algorithm we have taken a different PALSAR image of 850 × 850 pixels and applied the same proposed algorithm used for the test image to the new image and the classified image for this new image is given by fig.6.

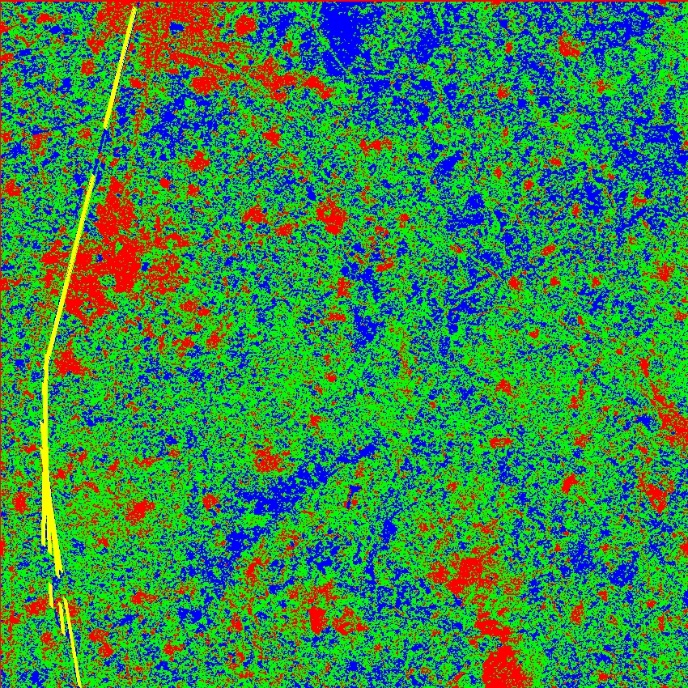


Fig.6. traditional + edge detection and linking classified image (new)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Classes** | **Producer’s Accuracy (%)** | **User’s Accuracy (%)** | **Producer’s Accuracy (Pixel)** | **User’s Accuracy (Pixel)** |
| Urban | 96.00 | 85.71 | 24/25 | 24/28 |
| Canal | 59.26 | 55.17 | 16/27 | 16/29 |
| River | 52.17 | 63.16 | 12/23 | 12/19 |
| Vegetation | 83.33 | 88.24 | 15/18 | 15/17 |

Table 6: Accuracy assessment of fig.6

It is clear from the above classified image that the canal feature is clearly distinguishable in the new image also that is taken for the validation of algorithm. The accuracy assessment of this new classified image given by table 6 also supports our above statement. High user accuracy (83.33%) and high producer accuracy (88.24%) is obtained for the canal feature of the new classified image having overall accuracy of 72.04% which shows that the canal feature is easily distinguishable from the other features. This shows that by using the above proposed method for the classification of the PALSAR image we can distinguish the linear man-made features in image from the other features effectively.

1. **CONCLUSION**

We have implemented the extraction of the linear feature in present case the canal in the land cover classification by using three procedures. It is clear from the above results that the all three procedures provide some amount of extraction but third method i.e. combination of the traditional or advanced land cover classification method with the edge detection and linking method gives the best result in linear feature extraction. The key feature of the proposed method is that it reduces the overlapping of the different classes up to great extent and hence gives the complete extraction of linear feature which is the key application mentioned by us in the introduction part i.e. during natural hazard condition we will get the clear picture of the real time scenario. The future work can be done by using improved techniques for placing the linear features on the image.

1. **References**

[1] A. Sceoran, “Land Cover/Use Classification Using Optical and Quad Polarization Radar Imagery,” *Bachelor of science Thesis, Shippensburg University of Pennsylvania*, 2005.

[2] P. Mishra, D. Singh, and Y. Yamaguchi, “Land cover classification of PALSAR images by knowledge based decision tree classifier and supervised classifiers based on SAR oservables,” *Progress in Electromagnetic Res. B*, vol. 30, pp. 47–70, 2011.

[3] G. Dong & M. Xie, “Color Clustering & Learning for Image Segmentation Based on Neural Networks”, IEEE, Vol. 16, No. 4, Pp.925- 936.

[4] Hepner, G. F., “Artificial neural network classification using a minimal training set. Comparison to conventional supervised classification”, Photogrammetric Engineering and Remote Sensing, 56(4), 469-473.

[5] D. Ziou and S. Tabbone "Edge detection techniques: An overview", International Journal of Pattern Recognition and Image Analysis, 8(4):537–559, 1998

[6] Gonzalez G. Hemantha Kumar Tian Jipeng ―Different Edge Detection Algorithms Comparison and Analysis on Handwritten Chinese Character Recognition‖, *International Journal of Computer Applications* (0975 – 8887) Volume 47– No.17, June 2012.

[7] G.T. Shrivakshan, Dr.C. Chandrasekar, “A Comparison of various Edge Detection Techniques used in Image Processing”, IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 5, No 1, September 2012

[8] Canny John, “A Computational Approach to Edge Detection”, IEEE Transactions on Pattern Analysis and Machine Intelligence, PAMI-8(6), 679-6987

 [9] Fisher, Perkins, Walker & Wolfart (2003), ["Spatial Filters - Laplacian of Gaussian"](http://homepages.inf.ed.ac.uk/rbf/HIPR2/log.htm), Retrieved 2010-09-13

[10] Duda, R. O. and P. E. Hart, "Use of the Hough Transformation to Detect Lines and Curves in Pictures", *Comm. ACM, Vol. 15*, pp. 11–15

# [11] Rafael C. Gonzalez, Richard Eugene Woods, and Steven L. Eddins, “Digital Image Processing Using MATLAB”, 2nd ed.

# [12] Hough, P.V.C. *Method and means for recognizing complex patterns,* U.S. Patent 3,069,654, Dec. 18, 1962

.