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A Novel Method for Homogeneous Region Based Image Segmentation Technique for Remotely Sensed Images

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Abstract: Image segmentation is an important step in image processing. It is a process to divide the original image into sub-images. Segmentation is an emerging process in the field of image processing and computer vision. It involves partitioning an image into a set of disjoint segments to represent image structures. This can be achieved using enhanced region based segmentation on a remotely sensed data. Segmentation algorithms based on regions are more immune to noise. Region based methods partition an image into regions that are similar to a set of predefined criteria. In this paper, region based segmentation is proposed based on enhanced splitting and merging process. The algorithm is experimented for coastal, remote sensing and conventional images. The result shows that, the proposed algorithm is able to segment the images and is evaluated using the parameters homogeneity, contrast, mean, pixel value analysis and correlation.

Keywords: Computer-vision, Coastal images, Image segmentation, Remote sensing, Region based, Satellite image.

I. INTRODUCTION

Image processing is a vital domain in the field of computer vision. Image segmentation is a fundamental process in many image, video, and computer vision applications. Partitioning a digital image into multiple sets or pixel is called image segmentation. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze [1]. Image segmentation is typically used to locate objects and boundaries in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics.

Image segmentation has become the focus of contemporary research. It remains a challenging problem in image processing and computer vision and gives more methodology applied to different fields. Image segmentation is the first step and also one of the most difficult task of image analysis. This has objective of extracting information which is represented in the form of data from image via image segmentation, feature measurement and object representation.

Image segmentation approaches are divided into various categories based on two properties of images.

a) Detecting discontinuities:

Edge can be described by the boundary between the adjacent parts of an image. Then edge detection requires detecting the discontinuity properly. Segmentation is done by finding pixels on a region boundary.

b) Detecting similarities:

Partitioning an image into regions that are similar according to a set of predefined criteria. Various segmentation algorithms are considered under this method like thresholding, region growing and region splitting and merging. Thresholding is a very common approach used for region based segmentation. Image is represented as groups of pixels with values greater or equal to threshold values and values less to threshold values. Clustering is also an another approach for region segmentation where image is partitioned into a set of cluster or pixels.

Region based methods based on continuity divides the entire image into sub regions depending on rules like all pixels in one region must have same grey level. The goal of the segmentation is to group region according to their functional or anatomical rules. Region based technique use intensity values with a cluster of neighboring pixels. The cluster is referred to as region. Region based methods are immune to noise and simple. There are mainly two methods in region based techniques like region growing and region splitting and merging. Nowadays the image segmentation is used for the biomedical and satellite image processing. Segmentation is a method which can be related to the recognition. It may be referred as isolation of the image [17].

Early remote sensing image segmentation approaches utilize pixel-established strategies and ignore spectral and constitution expertise. As a consequence, the segmentation results are unsatisfactory and have adversarial effect on image evaluation. In recent years, object-oriented segmentation ways are applied in far off sensing image evaluation. Homogenous region facets equivalent to intensity, texture, and form can be utilized to fortify the segmentation accuracy. Despite the fact, that there have been many gigantic object-oriented segmentation algorithms. High-resolution remote sensing graphics incorporate rich spatial texture expertise in lots of scales which is a wonderful useful resource within the procedure

of remote sensing image segmentation. However, average image segmentation algorithms don't take wealthy texture know-how under consideration. Nock and Nielsen proposed a statistical process for image segmentation with the aid of merging region following a distinctive order of regions [8]. The approach uses essentially the most common numerical pixel attribute areas. [6, 7].

However, it most commonly exploits spectral know-how in pictures and ignores valuable texture elements. On the groundwork of Nock and Nielsen's work, few emerging Statistical Region Merging (SRM)-situated segmentation algorithms which might be specific for high-decision far off sensing photograph segmentation are proposed [9-11]. To take such texture points into consideration, the addition of texture know-how within the merging approach of the Statistical Region Merging (SRM) is used to improve the segmentation quality and performance. Amongst countless texture description approaches, the Local Binary Pattern (LBP) operative is selected in concern of its mixture of statistic-established and constitution-centered ways. It has been proved to be theoretically easy and very amazing in describing the traits of neighborhood texture areas. Some upgrades on LBP operators have been proposed such as multiscale LBP, rotation invariant LBP, rotation invariant uniform LBP (RIU-LBP) in the field of image segmentation.

In this paper, a high-resolution remote sensing image segmentation algorithm located on the improved region based image splitting and merging process is proposed. The proposed algorithm could make full use of the spectral information and the feel understanding within the excessive-resolution remote sensing image. Additionally, the proper criterion can be adaptively chosen within the neighborhood merging step consistent with the traits of regions, which is able to further support the segmentation performance. To evaluate the results of the algorithm, Synthetic Aperture Radar (SAR) data and Optical remote sensing data have used. SAR incorporates satellite-transmitted and received radar image of the Earth's surface. SAR information, dissected utilizing Interferometric SAR (InSAR) methods, can be utilized to model millimeter-to-centimeter scale distortion of the Earth's surface [8].

The organization of this paper is as follows. Section II contains the description of the literature survey. The proposed methodology is presented in section III and next part, section IV describes the experimental results and evaluation. Section V describes performance analysis. Finally conclusion is presented in section VI.

II. Related Work

This section describes about the state of art of the work. As it is discussed in introduction section that segmentation is the main process for image processing tasks. Qingsong Zhu, Zhan Song etal, in their work presented the approach for the videos. Background subtraction method is proposed for the segmentation.

The segmentation can be used for the many application in real life that is automatic road sign detection which has been presented in [3]. Joint Change Detection method is proposed for this approach. The main key part of segmentation is to find the relation between the original image and segmented part of the image. Homogeneous areas of a picture are districts containing basic qualities and are gathered as single section. One of the chart parceling systems in picture division, standardized cuts, has been perceived creating dependable division result [5]. This study gives some exploration discoveries for viable picture division utilizing diagram apportioning system with reckoning expense decreased. In view of its expense lavish and it gets to be unfavorable in performing picture division on high determination picture particularly in online picture recovery frameworks. In this way, a graph based picture division technique done in multistage methodology is presented by Mei Yeen Choong, Wei Yeang Kow, Yit Kwong Chin, Lorita Angeline and Kenneth Tze Kin Teo. In unsupervised procedures, the programmed era of number of groups and its habitats for a tremendous database is not exploited to their maximum capacity. Subsequently, a progressive grouping calculation that uses part and blending methods is proposed [6]. An execution examination of the proposed various leveled bunching calculations (MSC, NPSO and GSO) is displayed utilizing two run of the mill multi-ghostly satellite pictures - Landsat 7 and QuickBird. From the outcomes, it is reasoned that the proposed GSO based various leveled grouping calculation is more exact and vigorous. Jilan Feng, Zongjie Cao et al [8] in his paper, proposed a variational multiphase division system for Synthetic Aperture Radar (SAR) pictures in view of the factual model and dynamic shape techniques. The proposed strategy is motivated by the multiregional level set segment approaches. Initial, a vitality useful which consolidates the locale data and edge data is characterized. The provincial term is taking into account the $G0$ factual model. The adaptability of $G0$ dispersion makes the proposed way to deal with portion SAR pictures of different sorts.

J.Schiewe summarizes the state of the art of respective segmentation methods by describing various concepts, applications and problems of high resolution remotely sensed data. Ashraf A. Aly etal proposed a review of digital image segmentation techniques. They have also discussed the main tendency of each algorithm with their applications, advantages and disadvantages. This study is useful for determining the appropriate use of the image segmentation methods and for improving accuracy and performance [14-15].

Salem Aksoy and H.Gokham Akcay have presented an approach for classification of remotely sensed imaginary using multiple resolution and spatial techniques. Wavelet decomposition was used to model image content in different levels.Sujata Saini and Komal Arora in there survey an overview of different image segmentation technique are studied. They showed that image segmentation is the crucial part of the image processing model. Segmentation technique are broadly categorized on the basis of detection of discontinuity and similarity of the image[16-17].

Balazs Dezso etal, demonstrated that graph theory is a powerful tool to describe image processing algorithm

in their work, four graph based image segmentation algorithm are compared and evaluated, namely best merged algorithm of Beaulieu, Goldberg and Tilton, tree merge segmentation of Felzenswalb, minimum mean cut segmentation of Wang and Sisking, and finally normalized cut algorithm of Shi and Malik. Aim of this paper is to compare the efficiency and the effectiveness of graph based image segmentation algorithm in satellite image classification[18].

Dr. S.V.Kasmir Raja etal, analyzed functional performance of region based image segmentation method. They considered two general purpose methods of water shed and mean-shift methods. This paper consists of comparing performance of two region based segmentation methods on the basis of important characteristics such as correctness and stability. H.P.Narkhede proposed a review of image segmentation by using different techniques. This study reviews the research on various research methodologies applied for image segmentation. The current methodology of image segmentation is also studied using different algorithm. V.Dey etal, in their paper, different image segmentation technique applied on optical remote sensing images are reviewed. Homogeneity measures described in this paper are spectral, spatial, texture, shape, size, contextual, temporal and prior knowledge [19-21].

III. PROPOSED METHODOLOGY

Image segmentation, the progressive system line in the conventional strategy has loads of excess connections. A new method based on quantified merging cost is introduced for region merging image segmentation. A region denoted by *R* of an image is defined as a connected homogenous subset of the image with respect to some criterion such as gray level or texture. Regions in an image are a group of connected pixels with similar properties. In the region approach, each pixel is assigned to a particular object or region.

Region splitting is a prime-down technique. It starts with a whole image and divides it up such that the segregated sections are more homogenous than the whole. As a result, a merging phase after the splitting is constantly fascinating, which is termed as the split up-and-merge algorithm. Any neighborhood can also be break up into sub regions, and the proper regions may also be merged into a neighborhood. Rather than settling on seed facets, one can divide an image into a suite of arbitrary unconnected areas and then merge the areas [2]-[3] in an attempt, to satisfy the conditions of affordable photograph segmentation. Region splitting and merging is carried out on quad tree decomposition as shown in Fig 1. Essential thought of area part is to break the picture into disjoint areas. A check is made if the entire pixels contained in the area fulfill some closeness limitation. If true, then the area relates to a district in the picture, otherwise split the area into four equivalent sub regions and consider each of the sub ranges as the region in turn. The splitting of the image is performed using a tree structure by utilizing modified quad tree. Each non terminal node in a tree has almost four descendants, all though it may less due to merging. This procedure proceeds until no further splitting happens which contains only one pixel in size. The last division contains numerous neighboring areas that have indistinguishable or comparative property.Predicate is the measurement of dissimilarity between two regions. For merging, predicate includes measurement of dissimilarity to determine the candidate region for merging, to check if the regions are homogenous. In this manner, merging procedure is utilized after very split which looks at contiguous region and merges them. Calculations of this nature are called split and merge algorithm.

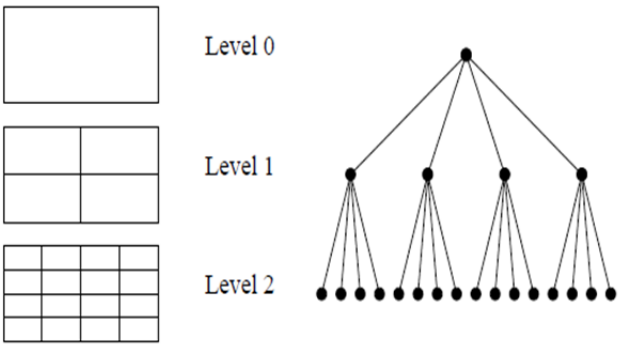

Fig 1: Quad Tree Decomposition

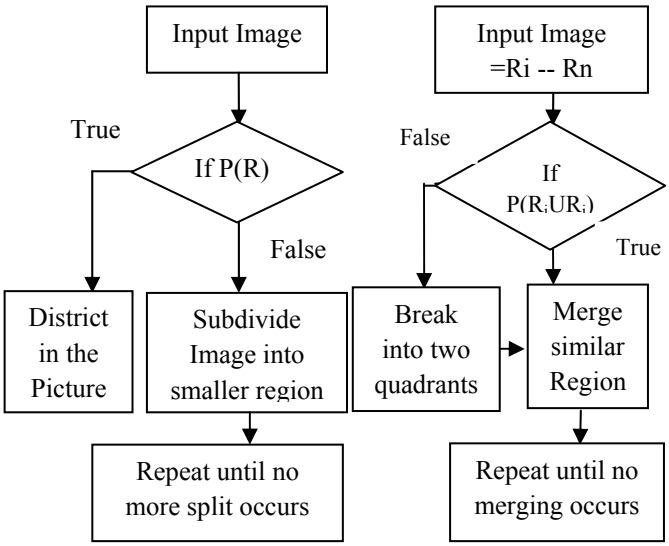

Fig 2a: Region Split

Fig 2b: Region Merge

The proposed methodology starts by considering image as region R. If a region R is inhomogeneous (P(R) = False), then R is split into four sub-regions where P is the predicate. This is continued until no more splitting is possible which contains only one pixel. If two adjacent regions Ri, Rj are homogeneous (P(RiURj)=True), then they are merged. The algorithm stops when no further splitting or merging is possible. Finally allocate clusters to the closest mean. The flowchart is shown in Fig 2a and 2b with the algorithm below.

Algorithm for Region Split and Merge

Step 1: Input Image = R

Step 2: If P(R) is false, then split image into smaller regions, where P is the predicate and R is the region.

Step 3: Else R is a district in the picture.

Step 4: Repeat the step 2 until no more split occurs.

Step 5: Image = R_i to R_n

Step 6: If $P(R_iUR_j)$ = True, then merge similar regions

Step 7: Else break into two quadrants.

Step 8: Repeat the step 6 until no more merge occurs.

Step 9: For n = 1 to N, allocate clusters to the closest mean.

IV. Experimental Results And Evaluation

The proposed method is tested by conducting three experiments with different images. Performance is measured using pixel value analysis, mean, contrast, correlation and homogeneity.

Experiment 1: Coastal images.

These images extracts information about water cover and land use scenarios. Coastal images can provide data for assessment and analysis of shoreline changes, salinity, hydrology, natural hazards, coastal erosion, change detection and potential threats to coastal area.The image shown in Fig 3(a) is the optical image captured by LISS-III sensor of Resourcesat-2 satellite. The Linear Imaging Self Scanning Sensor (LISS-III) is a multi-spectral camera operating in four spectral bands, three in the visible and near infrared and one in the short wave infra red(SWIR) region. LISS-III provides data with a spatial resolution of 23.5 m. Resourcesat-2 has three cameras mounted on a single platform with high resolution sensors LISS-IV, medium resolution LISS-III and a coarse resolution Advanced Wide Field Sensor(AWiFS).

In this section qualitative analysis of the proposed algorithm is demonstrated. In order to achieve this goal, the experiment is carried to study the performance of the proposed method. For our experimental results the first input image is shown in Fig 3(a) which is optical satellite image. This image represents the coastal area of Karnataka. Initially original image is subjected to process of segmentation. Fig 3(b) represents the segmented output image. To show the comparison between original image and segmented image pixel value analysis has been done. For this analysis the middle row of both the input and output images is considered. According to the pixel value analysis the original image pixels and segmented image pixels values should be similar which is obtained shown in Fig 3(c). The second evaluation parameter is mean. Mean is the average pixel values for input image and segmented image. In mean value analysis, the mean values of input image and segmented image are close to each other as in Fig 3(d). So, proposed algorithm works well.

The third parameter for evaluation is contrast It is the representation of the difference in luminance or color that makes an object (or its representation in an image or display) distinguishable. The contrast should not degrade after segmentation. So, there is no much degradation in contrast after segmentation according to Fig 3(e) after applying proposed algorithm. By analyzing the result it is understood that, it is able to maintain the contrast of the segmented image. Fourth parameter is correlation, it is a relationship between input image and output image. Fig 3(f) is the correlation between input image and output image which is more. Correlation should be more to get the better quality of the segmented image. Fig 3(g) is the homogeneity presentation of both images. This is the crucial parameter for quality assessment. If the homogeneity is more for both the images, then the quality of the segmentation is better. Hence the proposed algorithm works well in the process of segmentation.

Fig 3(a): Original Input image

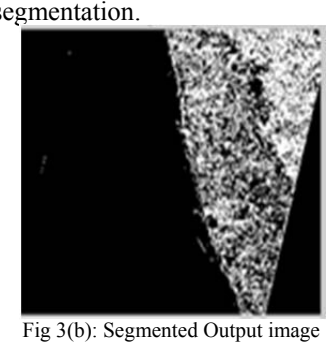

Fig 3(b): Segmented Output image

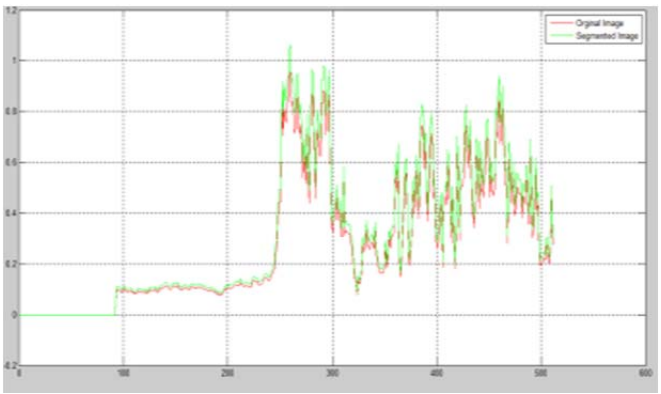

Fig 3(c): Comparative pixel analysis of original image and segmented image

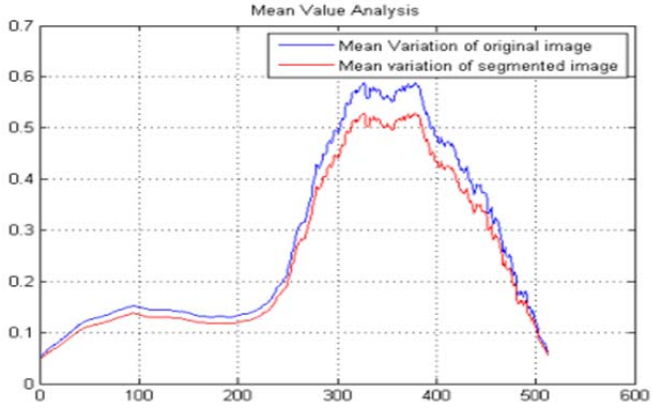

Fig 3(d): Mean variation analysis of original image and segmented image

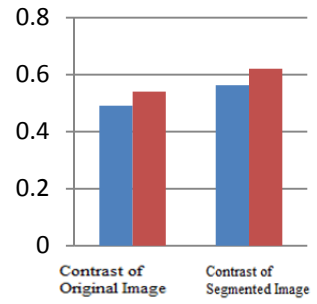

Fig 3(e): Comparative contrast analysis of original image and segmented image.

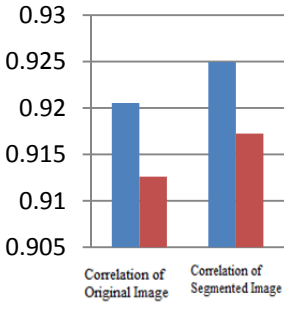

Fig 3(f):Correlation analysis of original image and segmented image

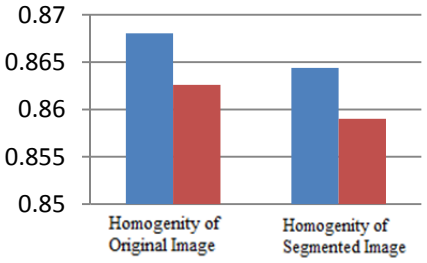

Fig 3(g):Homogeneity analysis of original image and segmented image

EXPERIMENT 2: REMOTE SENSING IMAGE

In this experiment, remotely sensed image is considered for analysis. In remote sensing, object usually mean area of identical land cover or land use, including smaller landscape features and artificial facilities. This experiment is conducted with the same process as that of experiment-1 with SAR image shown in Fig. 4(a).

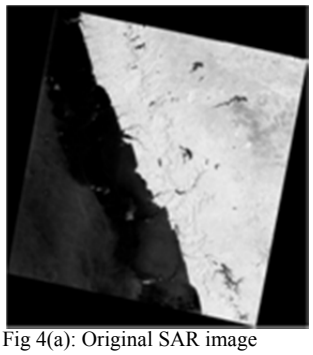

Fig 4(a): Original SAR image

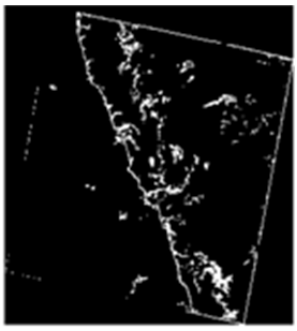

Fig 4(b): Segmented SAR image

The image is captured by Radar Satellite (RISAT) which is a state of the art Microwave Remote Sensing Satellite carrying a Synthetic Aperture Radar (SAR) payload operating in C-band (5.35 GHz), which enables imaging of the surface features during both day and night under all weather conditions. These unique characteristics of C-band (5.35GHz) Synthetic Aperture Radar enable applications in agriculture and management of natural disasters like flood and cyclone. Input image is subjected to a process of segmentation. Input image and segmented image is shown in Fig 4(a) and Fig 4(b).

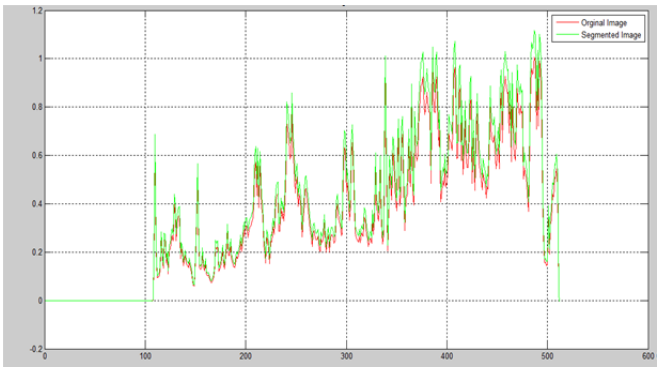

Fig 4(c): Comparative pixel analysis of original image and segmented image

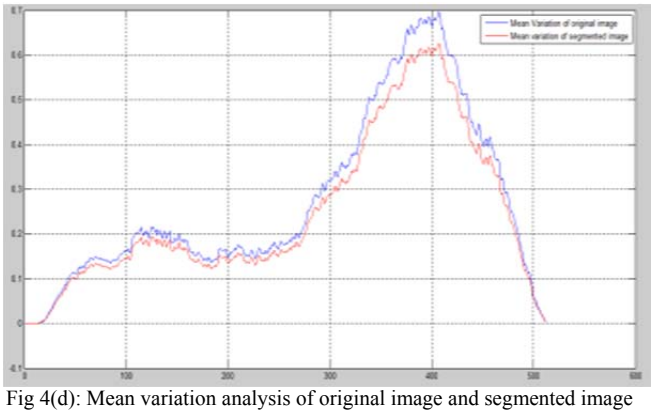

Fig 4(d): Mean variation analysis of original image and segmented image

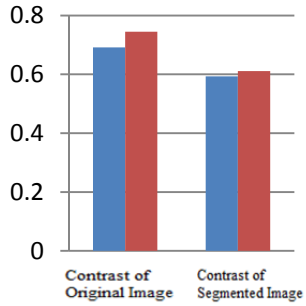

Fig 4(e): Comparative contrast analysis of original image and segmented image

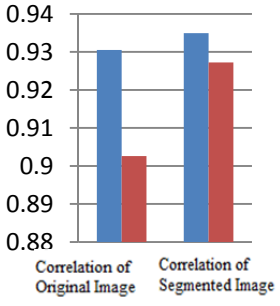

Fig 4(f): Correlation analysis of original image and segmented image

The statistical parameters are analyzed. It is known that correlation and homogeneity should be high when compared between input image and segmented image. Hence correlation and homogeneity is more which is depicted in Fig 4(f) and Fig 4(g) by applying proposed method.

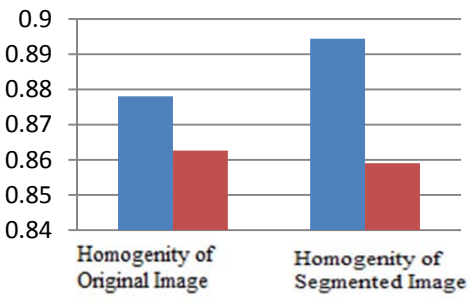

Fig 4(g): Homogeneity analysis of original image and segmented image

The graphical analysis of pixel shows that pixel values of original image and segmented image are almost similar which is shown in Fig 4(c). Fig 4(e) is the contrast representation. By analyzing the result, the segmented image is able to maintain the contrast. In mean variation analysis, the values are nearer as shown in Fig 4(f). So it is observed that the proposed method gives better results.

EXPERIMENT 3: CONVENTIONAL IMAGE.

In image processing research, it is important to have standard test image, so one can compare the result. Fruits image is a test image that has been used for decades.

To test the performance of proposed method, conventional image data is used. This experiment is conducted with the same process as that of experiment 1 and 2. Original image is subjected to segmentation. The result is shown in Fig 5(a) and 5(b). To show the comparison between original image and segmented image, pixel value analysis has been performed. The graphical analysis of pixel demonstrates that the pixel values are almost similar. Hence the proposed algorithm works better for pixel value analysis as in Fig 5(c).

Fig 5(a): Original Input image

Fig 5(b): Segmented Output image

In mean value analysis the mean values of original image and segmented image are close to each other as shown in Fig 5(d). The contrast is maintained even after segmentation which is shown in Fig 5(e). The correlation and the homogeneity are high when compared between original and the segmented image. Hence the quality of segmentation is better when analyzed for various parameters. So, the proposed algorithm performs better by considering this parametric evaluation.

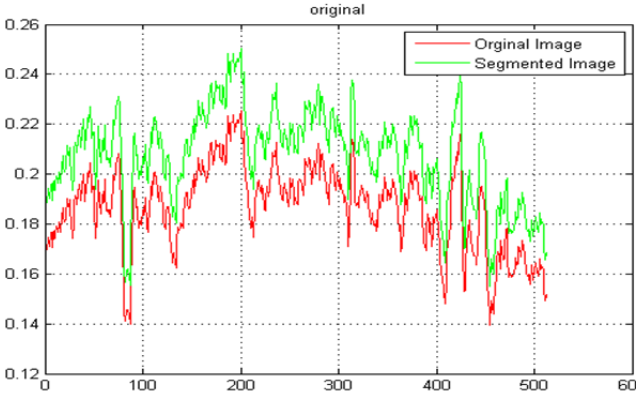

Fig 5(c): Comparative pixel analysis of original image and segmented image

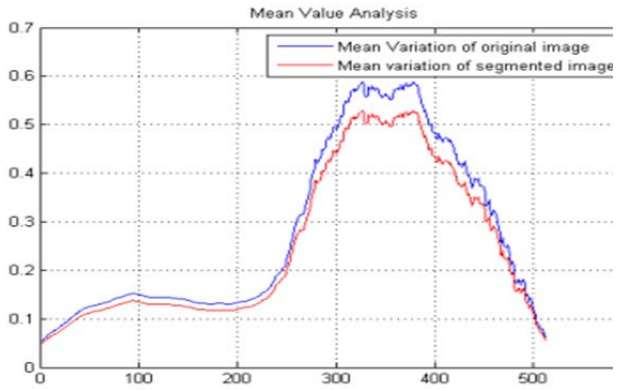

Fig 5(d): Mean variation analysis of original image and segmented image

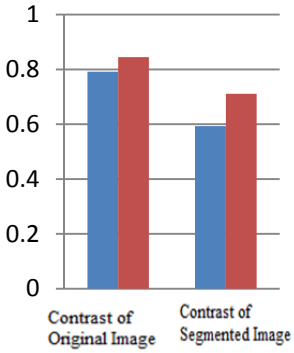

Fig 5(e): Comparative contrast analysis of original image and segmented image

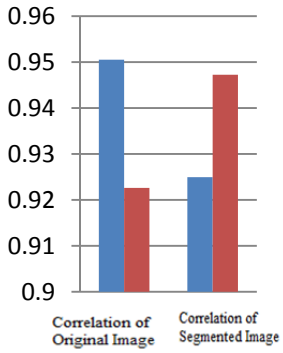

Fig 5(f): Correlation analysis of original image and segmented image

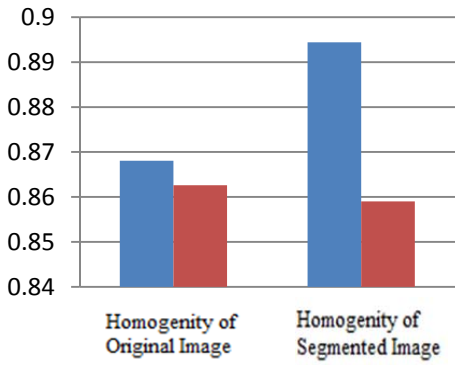

Fig 5(g): Homogeneity analysis of original image and segmented image

V. PERFORMANCE ANALYSIS

To test the performance of the proposed method, the segmentation approach is considered for the satellite image after adding speckle, salt and pepper and Gaussian noise. The original image after adding three noises is shown in Fig 6(a). The image is subjected to segmentation with the result shown in Fig 6(b). To compare between original image and segmented image, pixel value analysis and mean value analysis is shown in Fig 6(c) and Fig 6(d). This demonstrates that pixel values and mean values of original image and segmented image are close to other. Hence even after addition of noises , the proposed algorithm performs well. The contrast analysis and correlation analysis is shown in Fig 6(e) and Fig 6(f). The

contrast of segmented image is not degraded even after segmentation. The correlation is high which maintains the better quality of segmented image. Fig 6(h) is the homogeneity presentation of both the images. In this work the comparative result obtained are better with, correlation (90%), homogeneity (more than 85%) and similar contrast values which prove that proposed method performs well for satellite image segmentation.

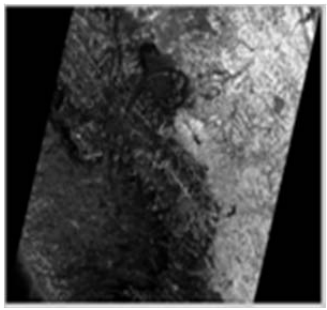

Fig 6(a): Original Input satellite image

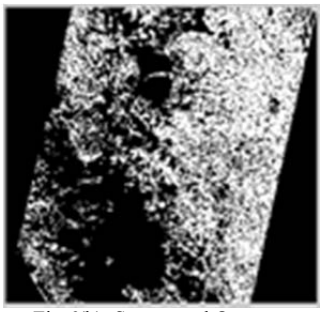

Fig 6(b): Segmented Output satellite image

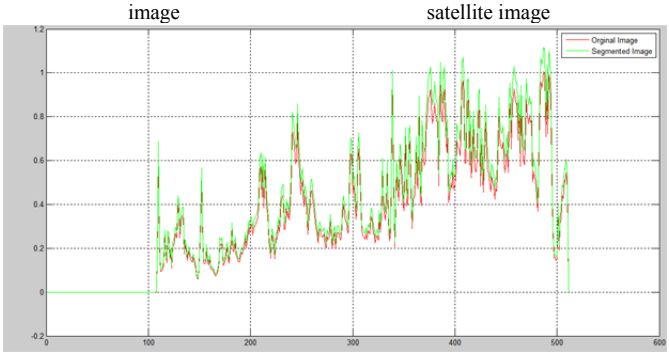

Fig 6(c): Comparative pixel analysis of original image and segmented image

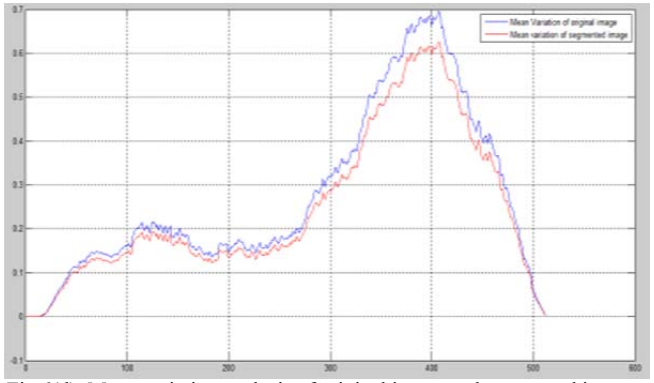

Fig 6(d): Mean variation analysis of original image and segmented image

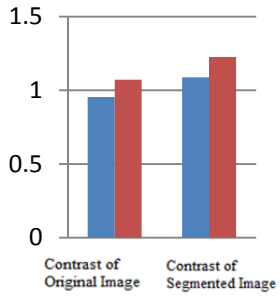

Fig 6(e): Comparative contrast analysis of original image and segmented image

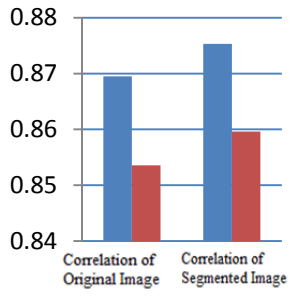

Fig 6(f): Correlation analysis of original image and segmented image

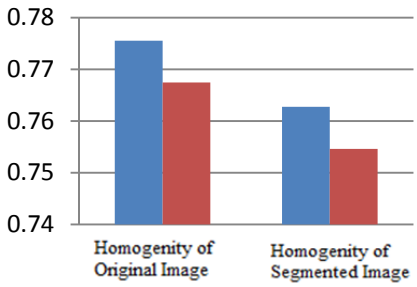

Fig 6(h): Homogeneity analysis of original image and segmented image

V. Conclusion

In this paper, a novel approach for image segmentation is presented. According to the experimental results, the proposed method is better by applying enhanced region based segmentation algorithm. The proposed method is tested on different images. The results show that proposed method is good for segmentation. Region based segmentation method are more immune to noise. The proposed method is analyzed by adding various noises also. The performance is evaluated on the basis of pixel value analysis, mean, contrast, correlation and homogeneity. Hence the improved region split and merge region based segmentation would be effective for segmentation.

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