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Compression Technique for Land Data Recording

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Abstract— Land Data Recording is the technique of recording images of vast land areas for many applications like military survey, mapping difficult terrains etc. Recording of large amount of images contribute to insufficient storage space and transmission time while sending over the network. There are many compression techniques that overcome the problem of storage space and transmission time. The focus of this paper is to review various compression & segmentation techniques used for land data recording & propose a Fractal Lossy Compression Technique for compressing land images.

Keywords— Digital Image Processing, Land data recording, Image compression, Image segmentation, Fractal compression.

I. INTRODUCTION

Over the past few years, the interest towards storing the images of the earth has been increasing drastically. Land data recording is the technique of recording images of land for mapping engineering applications or scientific techniques. Land data recording may be done for variety of reasons such as military planning and geological exploration for survey programs and detailed information about terrain for the planning and construction of any building. Recording of large amount of images contribute to insufficient storage space and transmission time while sending over the network. Image Compression is the solution associated with transmission time and storage of large amount of images. Compression technique is required to land data recording as there is increase in online navigation services and online land measurement by the government throughout the world. There are variety of approaches to record the images of terrains depend on the scale and size of the area under study: Remote sensing, Aerial and satellite imagery and Radar and sonar There is a need of high resolution satellite based maps of forests for maintaining forest intact [1]. Microsatellites are mostly used for observing land surface because of simplicity and cost effectiveness. They capture and store the images of earth's surface but due to contact with tracking station, present a problem during image acquisition. To solve this problem the only solution is to compress the images [2].

With the increasing amount of storing and sending images of land, there is also increase in requirement of storage space and transmission bandwidth that becomes difficult to store large amount of images thus, compression algorithm requires that can efficiently utilize the memory and transmission bandwidth resources. Proposed work involves taking images of different terrains and segmenting them based on uniform patterns accordingly. Then compressing the image using the image compression algorithm making it light enough to download and upload very easily.

Image segmentation is the process of partitioning a digital image into multiple segments that have a strong correlation with objects or areas in the image [6]. Image segmentation is used to find objects and boundaries in images. Segmentation can be done based on two approaches: First approach is based on detecting discontinuities that means to partition an image based on abrupt changes in intensity e.g. Edge detection. Second approach is based on detecting similarities that means to partition an image into regions that are similar according to some predefined criteria e.g. Region growing, Region splitting and Region merging. Each approach has its own advantages and disadvantages. Edge based segmentation algorithms are usually less complex and in these algorithms edges are important features in an image to separate regions. Region based segmentation cover more pixels than edge based and thus more information is available in order to characterize region. Region growing techniques are better in noisy images where edges are difficult to detect. Region growing methods can correctly separate the regions that have same properties. To improve the accuracy of land cover mapping, image segmentation proves to be useful [6].

Image compression is the technique of reducing the image size without degrading the quality of image. Image compression plays an important role in saving storage space and time while sending images over the network. Image compression techniques are broadly classified into two categories i.e Lossless and Lossy compression techniques based on whether the exact replica of the original image can be reconstructed from the compressed image or not. In case of Lossless compression techniques, original image can be perfectly recovered from the compressed image whereas in case of lossy schemes, reconstructed image is not identical to original image but reasonably close to it [3]. Lossy compression algorithms sacrifice part of image in order to achieve high compression ratio [7]. Lossy techniques provide much higher compression ratio than lossless techniques [3].

In land data recording, images are used for applications like survey, mapping an area for construction purposes if after compression some information is lost in reconstructed image it will not affect the application results as for these

applications there is no need to store each and every minute detail of an image. Thus Lossy compression techniques are better in this case as they can achieve more compressed version of images thus need of storage space and transmission time is reduced.

In this paper, Fractal lossy compression is proposed for compressing land data images. This technique was initially proposed by Michael F. Barnsley in 1988 and Arnaud E. Jacquin improved fractal compression in 1992 [4]. Fractal image compression is a compression technique that depends on similarities of an image structure. Traditional image coding techniques encode images by pixel based methods but fractal compression is based on image structure [4]. Fractal compression is best in case of images in which parts of an image often resemble other parts of the same image. Fractal algorithm converts these parts into mathematical data called fractal codes that are used to reconstruct the compressed image. Fractal image compression has many applications in fields [4] such as image encryption, image retrieval [12], image denoising [10] and facial recognition.

The rest of this paper is structured as follows. Literature Survey is performed in Section II. In Section III, Need and Significance based on literature review has been explained. Proposed Methodology is described in Section IV. Finally, the conclusions are drawn in Section V.

II. RELATED WORK

Ponomarenko N. et al [5] proposed two automatic approaches to lossy compression of hyperspectral AVIRIS images. One approach is to filter images on-board and transfer compressed images and second approach involves image filtering to decompressed data on land. Modified 3D DCT based coder is used for compression. Authors mentioned that lossless compression is often unable to produce desirable compression ratio thus lossy compression techniques have been under intensive interest. Lossy compression is not preferred only to provide higher compression ratio than lossless compression as the hyperspectral data are noisy while compressing it there is no reason to preserve noise which can be possible by using lossy compression technique. Experimental results shows compression ratios for first approach have higher values than for second approach.

Nelson J. et al [11] presented a paper in which Landsat Data Continuity Mission record images of earth's land surface. Observation is done through spacecraft bus that is integrated with two Imaging instruments i.e. Operational Land Imager and Thermal Infrared Sensor. Paper describes the approach for managing high volumes of images at Landsat Ground Network and end to end Data flow of mission. This paper discusses the lossless compression technique i.e. Rice algorithm to readily compress the images of land. Landsat Continuity Mission also performs tasks such as file retransmissions, managing features of solid state Recorder.

Stefanski J. et al. presented a paper [6] that tells previously parameters for image segmentation were manually defined thus user- dependent and costly. This paper proposed semi-automatic optimization of Multitemporal data by using Random Forest and Region based segmentation technique i.e Superpixel Contour algorithm is used. To test the proposed concept authors use Multitemporal Rapid eye and SPOT5 images. Then Multiresolution segmentation algorithm is used for comparison and Experimental results show that both segmentation algorithms perform similar in terms of accuracy and visual interpretation. Furthermore authors mentioned that the proposed strategy is operational, easy to handle and provides similar accuracy as achieved by manual –based image segmentation but proposed method does not necessarily produce the best visual segmentation result, however it produces optimal segmentation results regarding classification accuracy.

Walker, W.S. et al presented a paper [1] to evaluate the suitability of sensor for large –area mapping of tropical forest cover. Proposed method provides data more accessible to the applications user community than data from any radar sensor before it. Authors have mentioned that although imaging radar is robust but cannot be seen as a replacement for traditional optical data sources. Through Comparative analysis of PALSAR and Landsat based classification results confirm PALSAR is an accurate source for forest cover maps. Random Forest algorithm is used for classification.

Zabala A., et al. presented a paper [7] that compare the effects of JPEG and JPEG 2000 lossy compression on Remote sensing image classification for mapping crops and forest areas. Variables such as topoclimatic and NDVI are used for improving the accuracy of the classifications of land cover. Paper considers the fact that the same compression ratio may produce an image of different quality. Experimental results show that according to classifications JPEG 2000 is better for forest but not for crop areas and in accordance to visual effects, JPEG 2000 is more effective for both land covers than JPEG.

Shimabukuro E.Y., et al presented a paper [8] in which Multitemporal land images are taken to map burned areas and deforestation occurred in recent years. Region growing Segmentation technique is used to segment land images based on similarity and area threshold then Region Classifier algorithm based on Clustering technique is used to classify segments. Results show the values by which deforestation areas are increased. Paper concluded that this type of research is useful for regional and environmental studies that will help in controlling burning and deforestation in the future.

Wang J., et al [4] proposed a novel Fractal Image Compression scheme based on the fact that similarity between two blocks is equal to the Absolute vale of Pearson's correlation coefficient between them. Absolute value of Pearson's correlation coefficient based Block Classification method is used and this coefficient value helps to speed up encoding process. In this paper, Square block type of image partitioning is used for range blocks in Fractal image compression. Experimental results show that the proposed scheme can speed up the encoding process while preserve the quality of reconstructed image.

Wohlberg B. et al presented a paper [9] on the survey of practical and theoretical advances in Jaquin's original fractal coding scheme that was published in 1990. This review considers 8 bits per pixel grayscale images. Then paper describes the different types of image partitioning used for range blocks, types of block transforms, Domain pool

selection, encoding and search strategies, transform representations and decoding in fractal scheme. Paper also shows the comparison between various types of image partitioning used for range blocks

Gleich D., et al [3] proposed a Progressive Space Frequency Quantization Data Compression technique based on wavelet image coding (PSFQ). The performances of Zero tree based lossy compression methods including EZW, SPIHT, SFQ and PSFQ that performs spatial quantization are compared with classical wavelet based methods that performs uniform scalar quantization and Results shows that Zero tree based methods outperforms the classical wavelet based methods in rate –distortion sense. Authors have also mentioned that SFQ and PSFQ wavelet based coding techniques are very complex.

Ghazel M., et al. presented a paper [10] on the application of Fractal based coding. In this paper, fractal based method is used to enhance and restore a noisy image and comparisons are performed between fractal based scheme and Lee filter and results show that fractal based scheme achieves better results in terms of PSNR at high variance value. Uniform and Quadtree type of image partitioning is used. Paper shows the fractal representations of the test images at various resolution values and confirms that at high resolution values, fractal representation is visually similar to the original image.

III. NEED AND SIGNIFICANCE

Although in literature, many techniques have been proposed for compressing and segmenting land images but existing techniques have following drawbacks.

- Lossless compression techniques does not achieve desirable compression ratios, the best achieved value reaches about 3.5 [5].
- Lossless compression techniques does not lose information .Hyperspectral Data is noisy and there is no reason to preserve noise while compression [5].
- Combination of Superpixel Contour Segmentation Algorithm and Random Forest Classifier is used for land images does not necessarily produce best visual segmentation results regarding classification accuracy [6].
- Wavelet based techniques like Space Frequency Quantization and Progressive Space Frequency Quantization Compression techniques are very complex [3].
- Although KLT (Karhunen- Loeve Transform) is optimal transform coding technique but its complex and signal adaptive nature, limits its practical applications. Improved KLT is 30% more complex than 3D wavelets [16].
- Edge based segmentation methods like Snakes approach are more sensitive to noise as compared to Region based segmentation [19].

IV. PROPOSED METHODOLOGY

To improve the drawbacks of existing techniques, this paper proposed a simple lossy compression technique i.e Fractal Compression technique with the following steps:

1. Training Set Design:
   Initially Sample images are collected and noise is removed by using adaptive filter.
2. Land Data Recording & Analyzing using Image Segmentation:
   Region based segmentation is performed to extract the uniform patterns in an image.
3. Data Size Reduction using Compression:
   Apply Fractal image coding algorithm for image compression.
4. Comparison of results/performance with some existing technique.

V. CONCLUSIONS

A survey is performed on various Image segmentation and compression techniques used for land images. Based on the review of literature, we conclude that existing techniques have various drawbacks. Fractal image coding is widely used in many fields such as Image denoising, Image encryption and Image Retrieval. Thus, this Paper proposes a Fractal Lossy Compression Technique for Land Data Recording as it will give better results in case of compressing land images.

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