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MARKER CONTROLLED WATERSHED SEGMENTATION USING BIT-PLANE SLICING

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Abstract - Image segmentation is the basis for computer vision and object recognition. Watershed transform is one of the common methods used for region based segmentation. The previous watershed methods results in over segmentation. In this paper we present a novel method for efficient image segmentation by using bit-plane slicing and marker-controlled watershed. Bit-Plane slicing method produces the sliced image by taking the most significant bit of the image as the input to the bit-plane slicing algorithm. The output of the Bit-Plane slicing algorithm is used to produce the gradient image .The watershed segmentation algorithm is applied to the average of the marker image and the gradient image so as to get efficient segmentation result. Experimental results, shows that the proposed method reduces the memory consumption and computation**.**

***Keywords** - component; Image Segmentation, Marker- controlled Watershed Transform, Bit-Plane Slicing, Multi-scale gradient.*

I. INTRODUCTION

Image segmentation involves partitioning an image into groups of pixels which are homogenous with respect to some criterion. The segmentation is based on measurements taken from the image and might be gray level, color, texture, depth or motion. The purpose of image segmentation is to partition an image into meaningful regions with respect to particular application. Image segmentation is an initial and vital step for overall image understanding. The classical image segmentation is bounded by various aspects like Shadow problem in object variability and noise leading to over segmentation. To overcome these problems, examining the image at multi-resolution level is being considered.

Segmentation algorithms are generally based on one of the two basis properties on intensity values: They are discontinuity and similarity. Discontinuity: To partition an image based on sharp changes in intensity (such as edges). Similarity: To partition an image into regions that is similar according to a set of predefined criteria. Other conventional segmentation are spit-and-merge and morphological method. Among them morphological segmentation is commonly used because they deal with geometric features, such as size, shape, contrast or connectivity. Thus morphological transformations can be considered as object-oriented, and therefore segmentation oriented [7]. Until now, a variety of techniques and algorithms have been proposed for image segmentation. The three main categories of image segmentation are: edge detection, clustering and region extraction [1],[2],[8]. Clustering consists of classifying a homogenous cluster and naming each cluster as different region. Drawback of this method is that, the number of cluster is not known. Edge detection identifies the points in a digital image at which the image brightness changes sharply or more formally, has discontinuities. Discontinuities of edge detection correspond to depth, surface orientation; etc. The purpose of detecting sharp changes in image brightness is to capture important events and changes in the properties of the world. Finally, region extraction groups pixels into a set of regions based on similarity [2].Most segmentation techniques are based on region extraction [2],[3],[4]. Image enhancement is the method to enhance the low contrast image. Disadvantages of this method is that all the total pixels in the image are brightened and so that this method may not be suitable for some applications. Bit- plane slicing (BPS) method is used to solve this problem. Bit-plane slicing is a technique in which the image is sliced at different planes. It bit level ranges from 0(LSB) to 7 (MSB). The input to this method is an 8-bit per pixel [5].We proposed an efficient image segmentation method is based on BPS and Marker controlled watershed segmentation (MCWS) algorithm. In this approach the over segmentation is avoided by marker-controlled watershed (MCW). The computation and along with memory is reduced using BPS.

II. RELATED WORKS

Watershed transformation is a morphological based tool for image segmentation. In grey scale mathematical morphology the watershed transformation for image segmentation is originally proposed by Digabel and Lantuejoul [6],[7]. The watershed transform can be classified as region based segmentation approach. The watershed algorithm is known to be a very fast algorithm for segmenting the images. Regions of the image characterized by small variations in grey levels have small gradient values, so watershed segmentation is applied on the gradient of the image rather than the actual image. The major problem with the watershed segmentation is that it produces over segmentation due to the large number of minima. The drawbacks of normal watershed transform are sensitivity to strong noise and high computation. To overcome these problems, a strategy was proposed by Meyer and Beucher (1990). The strategy is called marker-controlled segmentation [2].The goal of the marker controlled segmentation is to detect the presence of the homogenous regions from the image by a set of morphological operations. Markers are connected components belonging to an image [9] ,[10]. The marker image used for watershed segmentation (WS) is a binary image consisting of either single marker points or larger marker regions, where each connected marker is placed inside an object of interest. Each marker has one-to-one relationship to specific watershed regions. After segmentation the boundaries of the watershed regions are arranged on the desired ridges, thus separating each object from its neighbors. The multi-resolution image is generated by the two-scale Daubechies 4-tap wavelet transform and the markers for the WS algorithm were extracted from a low-resolution image. The flat regions larger than 85 pixels were extracted as markers [2]. Multi-resolution framework watershed segmentation is mainly used to reduce the noise related problems and computation [2].

III. PROPOSED METHODOLOGY

The proposed method is concerned with satellite images. The methods used in this system are BPS and MCWS. BPS slices the image into eight planes and the most significant bit plane is used in this system. The image is segmented by using MCWS, which reduces over segmentation .The proposed algorithm is given below:

- Apply bit-plane slicing to input image.
- Use marker- controlled watershed transform to the sliced image.
- Compute morphological gradient for the sliced image.

$$G(f) = (f \oplus B) - (f \ominus B) \quad (1)$$

Where *G (f)* = Morphological gradient,
f = given image
B = Structuring element.

- Compute multi-scale morphological gradient.

$$MG(f) = 1/n \sum_{i=1}^{n} (G(f) \ominus B) \quad (2)$$

- Compute final gradient image is obtained by reconstructing the multi-scale gradient image, with its dilated image as a reference image.

$$FG(f) = \Phi_{rec}((MG(f) \oplus B)\ MG(f)) \quad (3)$$

- Extract Markers using top-hat transform and bottom-hat transform.
- The segmented image is obtained by applying the morphological watershed to the average of the marker image and the final gradient image.

IV. STUDY AREA

The study areas used Mumbai city and Rome city images from quick bird satellite images which has the resolution of 215x215 and 216x215 respectively.

Fig. 1 : Mumbai City Image

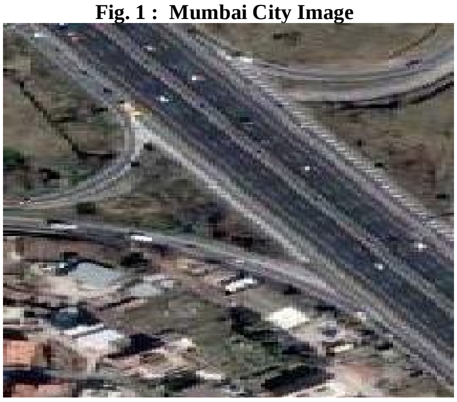

Fig. 2 : Rome City Image

A. Figures and Tables

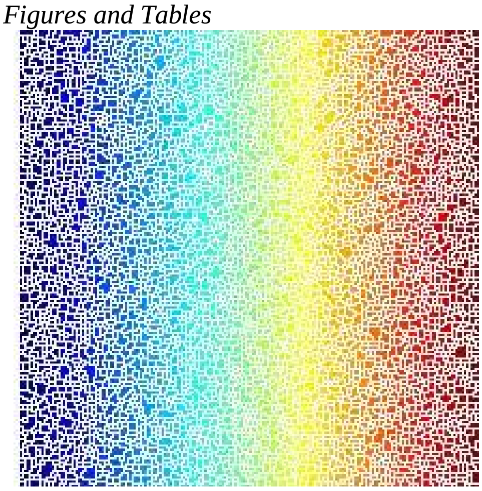

Fig. 3 : Watershed algorithm applied for Mumbai city image.

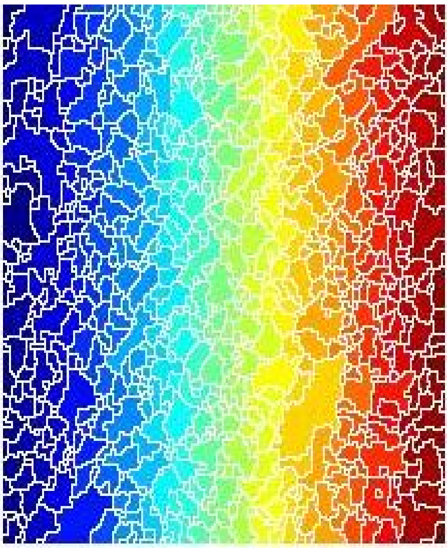

Fig. 4 : Morphological Watershed algorithm applied for Mumbai city image.

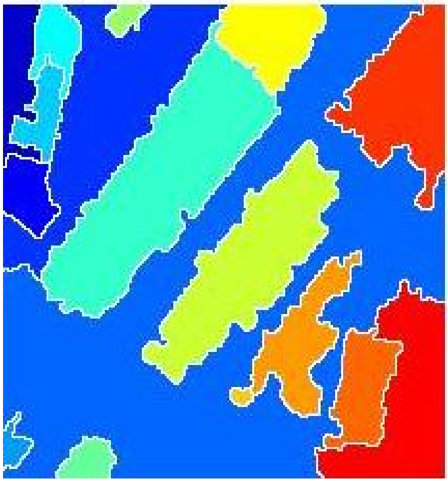

Fig. 5 : Marker-controlled Watershed algorithm applied for Mumbai city image.

Fig. 6 : Multi-resolution Marker-controlled Watershed algorithm applied for Mumbai city image.

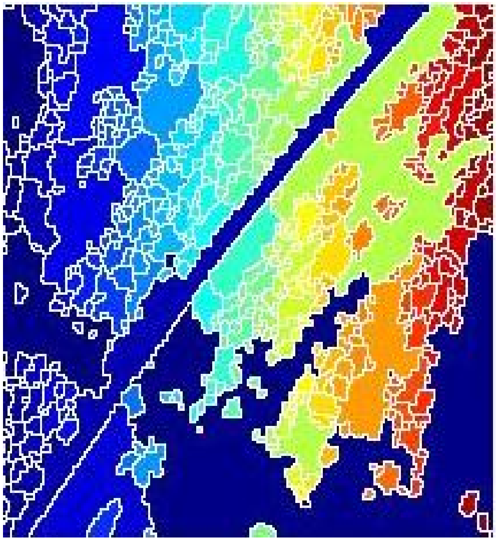

Fig. 7 : Bit-Plane slicing and Marker-controlled Watershed algorithm applied for Mumbai city image.

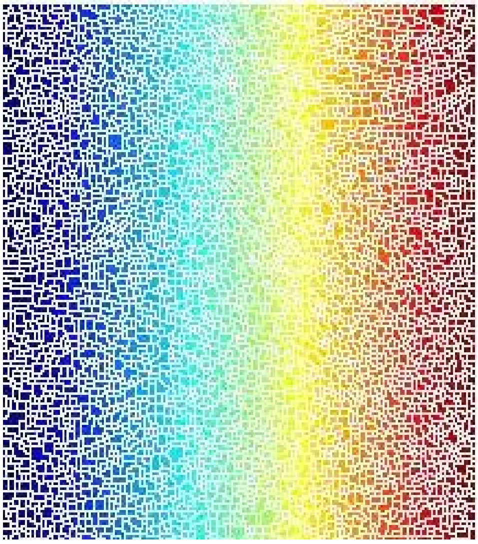

Fig. 8 : Watershed algorithm applied for Rome city image.

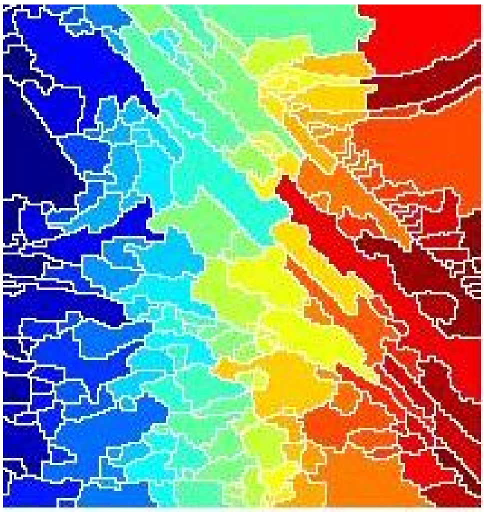

Fig. 9 : Morphological Watershed algorithm applied for Rome city image.

Fig. 10 : Marker-controlled Watershed algorithm applied for Rome city image.

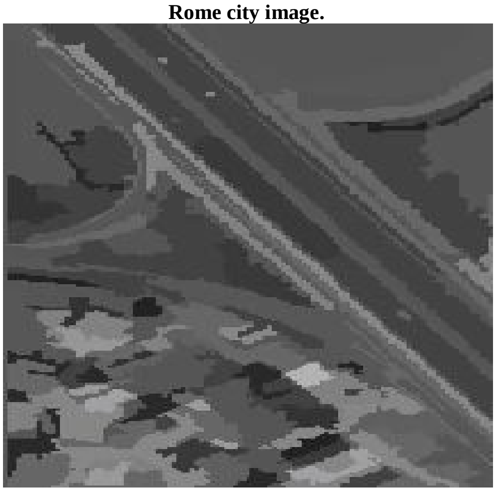

Fig. 11 : Multi-resolution Marker-controlled Watershed algorithm applied for Rome city image.

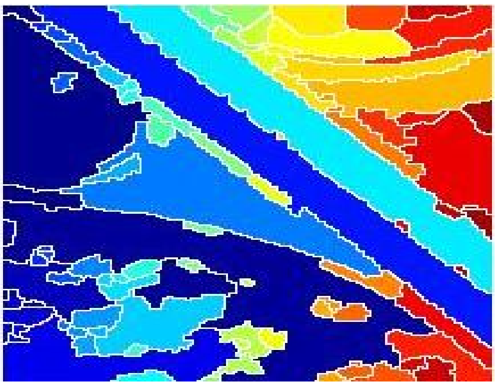

Fig.12 : Bit-Plane slicing and Marker-controlled Watershed algorithm applied for Rome city image.

The figure3 to figure 6 shows the previous watershed method results of Mumbai city image. The figure7 shows the proposed method result for Mumbai city image. The figure8 to figure 11shows the previous watershed method results of Rome city image. The figure12 shows the proposed method result for Rome city image. Comparing with the previous watershed methods, the proposed method gives the good segmentation result.

Evaluation of segmentation results	Number of Segments	Elapsed Time (second)	PSNR	Goodness Value
Watershed (WS)	4041	0.857296	41.2287	6.1938
Morphological Watershed (MWS)	478	2.025499	41.2964	7.4010
Marker-controlled Watershed(MCWS)	15	3.023527	40.7937	4.0761
Multi-resolution marker controlled watershed (MMCWS)	265	14.634666	30.7023	7.9766
Bitplane Slicing (BPS)with Marker-controlled Watershed(MCWS)	208	7.975092	41.6423	1.4766

Table 1: Mumbai City Image Evaluation Results

Evaluation of segmentation results	Number of Segments	Elapsed Time (seconds)	PSNR	Good ness Value
Watershed (WS)	4394	0.576636	41.2287	6.6117
Morphological Watershed (MWS)	942	1.264298	41.2964	7.4010
Marker-controlled Watershed(MCWS)	8	2.800380	40.7937	4.0761
Multi-resolution marker controlled watershed(MMCWS)	832	12.925644	36.6794	1.5775
Bitplane Slicing (BPS)with Marker-controlled Watershed(MCWS)	896	7.253986	41. 7937	1.2176

Table 2: Rome City Image Evaluation Results

Evaluation of segmentation results is done on number of segmented regions, PSNR and Goodness function. PSNR is calculated by the following function:

$$PSNR = 10 * \log10 (256^2 / MSE) \quad (4)$$

Where MSE is the Mean Squared Error.

The higher the value of PSNR is better. The Goodness function is calculated by

$$F(I) = \sqrt{M} \times \sum^{n}_{i=1} (e_i)^2 / \sqrt{A} \qquad (5)$$

Where I is the image to be segmented, M is the number of regions in the segmented image, A is the area or i^{th} region number of pixels and e_i is the sum of the Euclidean distance of the color Vectors between the original image and the segmented image of each pixel in the region. The smaller the value of F gives the good segmentation.

V. CONCLUSION

The proposed system uses bit-plane slicing thus reduces the memory when compared to other segmentation approaches. It takes less execution time when compared with the MMCW and gives the good segmentation result compared with the WS, MWS, MCWS, and MMCWS algorithms .The same work can be extended for real time video processing with minimum execution time by using Multi-threading in a multi-core machine.

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