IOSR Journal of VLSI and Signal Processing (IOSR-JVSP)
Volume 2, Issue 2 (Mar. – Apr. 2013), PP 10-14
e-ISSN: 2319 – 4200, p-ISSN No. : 2319 – 4197
www.iosrjournals.org

Feature Extraction on Images through a Mathematical Morphological Operation Using Watershed

G.S.Raman[1] R.T.Subhalakshmi[2]
[1]*Associate Professor, Department of Information Technology, KLN College of Information Technology, Sivagangai, India*
[2]*PG Student, Department of Information Technology, KLN College of Information Technology, Sivagangai, India*

Abstract: *Image processing plays a major role in various applications. These images may be affected from noises that lead to disorder in embedding the messages. Inorder to overcome this problem various pre-processing techniques are involved. The main objective of this paper is to segment the image through watershed segmentation of image and can embed the secret messages. Extraction of segmentation is also done by adding the more morphological operations such as erosion, dilation, eroding, smoothing with an existing detectors such as sobel operators. This paper involves in evaluating the quality of an image with various techniques such as PSNR (Peak-Signal-to-Noise Ratio). Experimental results show that our proposed technique achieve good visual quality image with excellent PSNR values. This value provides high level security and more robust when compared to other combination of transformation technique.*
Keywords: *Stego image, Morphological operators, Edge segmentation, PSNR*

I. INTRODUCTION

Image processing is any form of a signal processing for which the input is an image, such as multimedia data. The output of an image processing may be either an image or a set of characteristics or parameters related to an image. An image may be considered to contain sub-images sometimes referred to as regions-of-interest (ROI) or simply regions [1]. This perception reflects the fact that images repeatedly contain collections of objects each of which can be the basis for a region.

In a complicated image processing system it should be possible to apply specific image processing operations to selected regions [3]. Thus one part of a region might be processed to smother motion blur while another part might be processed to progress color interpretation. The most requirements for image processing of images is that the images be available in digitized variety, that is, arrays of finite length of the twofold words [2]. For digitization, the given image is sampled on a discrete framework and each illustration or pixel is quantized using a finite quantity of bits.

Segmentation is defined as decomposing an image into its constituent parts [5] extracting the location and the outline of the objects of interests or partitioning an image into several constituents is also called as segmentation [6]. Image segmentation is based on mainly three principle concepts. Detection of discontinuities, thresholding and region processing are the principle concepts.

II. SEGMENTATION

Watershed segmentation with the morphological operations is embedded with the above principle approaches. It provides a simple framework for incorporating knowledge based on constraints then it includes the segmentation boundaries [4]. It often produces more stable segmentation including continuous segmentation boundaries in the watershed segmentation.

Topographical interpretation consists of three points in this segmentation. They are given below

a. Points must be in regional minimum.
b. Catchment basin or watershed
c. Divide lines or watershed lines

The technique used for image segmentation is watershed segmentation. The term watershed refers to ridge that divides areas drained by different systems as shown in figure1.

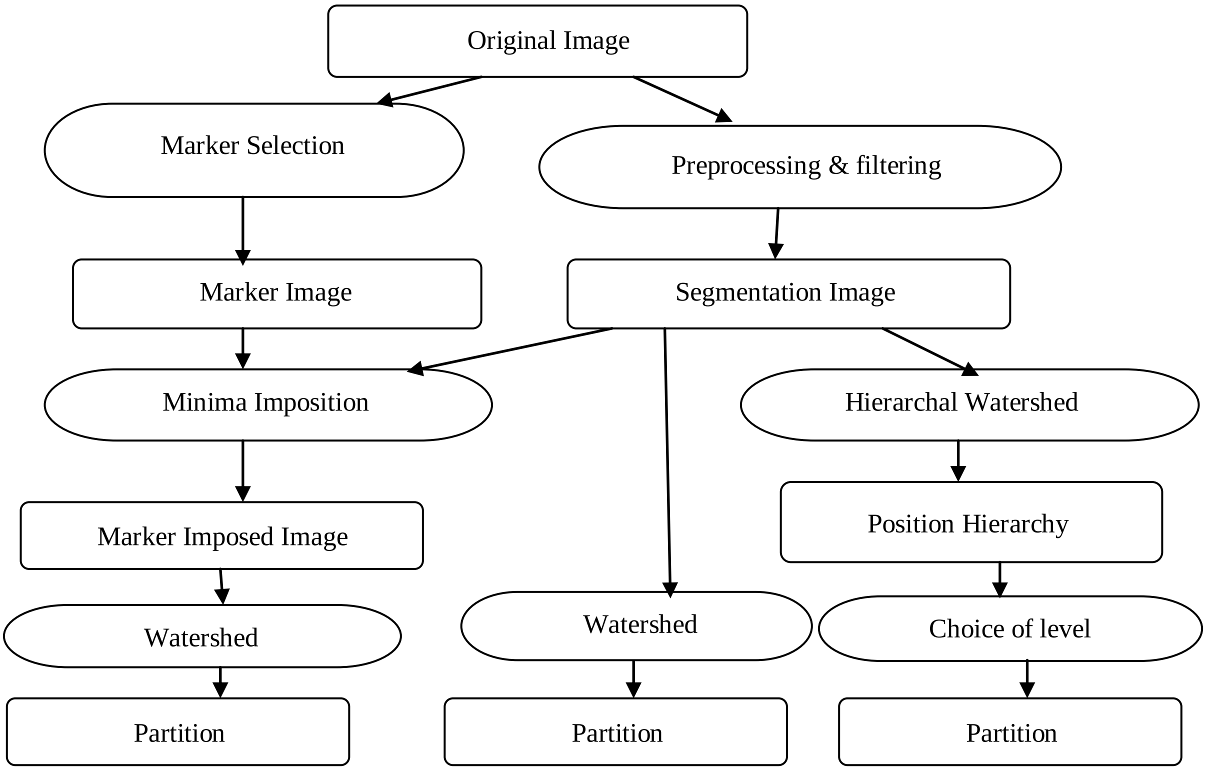


Fig 1.Three approaches in watershed segmentation

Watershed segmentation name comes from the manner in which the algorithm segment regions into catchment basins. The term watershed refers to a ridge that divides areas drained by different river systems. The term catchment basins are the geographical area draining into a reservoir. The key behind this segmentation algorithm is changing our image into other image whose catchment basins are the objects to identify.

III. Watershed Segmentation Algorithm

Step 1. Let M_1, M_2, M_3….M_n be the sets of coordinates of points in the regional minima of the image g(x,y)

Step 2. $A(M_i)$ be the coordinates of points of the catchment basin associated with regional minima M_i

Step 3. $T[n] = \{ (s,t) \mid g(s,t) < n \}$

- a. T[n] = Set of points in g(x,y) which are lying below the plane g(x,y) = n
- b. n = Stage of flooding, varies from min+1 to max+1
- c. min = minimum gray level value
- d. max = maximum gray level value

Step 4. Let $A_n(M_1)$ be the set of points in the catchment basin associated with M_1 that are flooded at stage n.

- a. $A_n(M_1) = A(M_1) \cap T[n]$
  - i. $A_n(M_i) = 1$ at location (x,y) if (x,y) Є $C(M_i)$
  - ii. AND (x,y) Є T[n], otherwise it is 0.

Step 5. C[n] be the union of flooded catchment basin portions at the stage n

- a. $A[n] = \bigcup_{i=1}^{R} A_n(M_1)$
- b. $A[\max+1] = \bigcup_{i=1}^{R} A(M_i)$

Step 6. Algorithm keeps on increasing the level of flooding, and during the process $A_n(Mi)$ and T[n] either increase or remain constant.

Step 7. Algorithm initializes A[min +1] = T[min+1], and then proceeds recursively assuming that at step n C[n-1] has been constructed.

Step 8. Let S be set of connected components in T[n].

Step 9. For each connected component q Є S[n], there are three possibilities:

a. $q \cap A[n-1]$ is empty.

b. $q \cap A[n-1]$ Contains one connected component of C[n-1].

c. $q \cap A[n-1]$ contains more than one connected component of A[n-1]

i. Condition (a) occurs when a new minima is encountered, in this case q is added to set A [n-1] to form A[n].

ii. Condition (b) occurs when q lies within catchment basins of some regional minima, in the second case.

iii. Condition(c) occurs when ridge between two catchment basins is hit and further flooding will cause the waters from two basins will merge, so it must be built within q.

IV. Steps for Watershed Segmentation

The various steps involved in the watershed segmentation are

a. Use the gradient magnitude as the segmentation function with morphological operation.
b. Mark the foreground objects
c. Compute the background markers.
d. Compute the watershed transform of the segmentation function.
e. Visualize the result.

4.1 Color Progressions

An image gradient is a directional change in the intensity or color in an image. Gradient is used for a gradual blend of color which can be considered as an even gradation from low to high values, as used from white to black in the image to the right. Color progression also used for robust feature and texture matching with different lighting properties that can cause to have drastically different pixel values.

Each pixel of a gradient image measures the change in intensity of that same point in the original image in the given direction are represented in figure2. Regions of the image are characterized by miniature variations in gray levels have small gradient standards, so watershed segmentation is useful on the gradient of the image rather than the actual image. In this way, the regional minima of catchment basins correlate nicely with the small value of the gradients corresponding to the objects of interest.

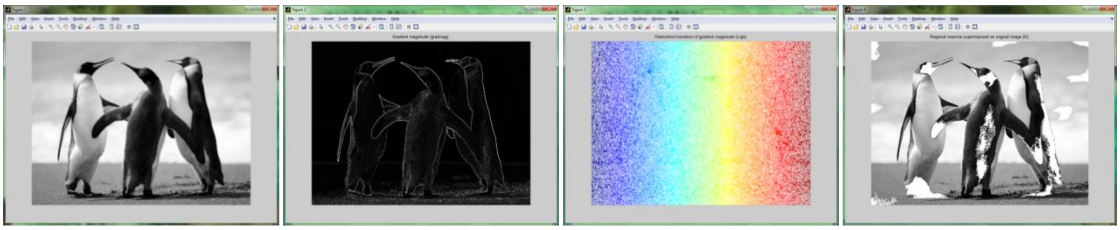


Fig 2 a) Original image b) Gradient magnitude c) Watershed Transform of gradient magnitude d) Regional maxima superimposed on original image

4.2 Uses of Markers

When the watershed segmentation algorithm is applied on application it can be lead to over-segmentation of an image due to noise and other local irregularities of the gradient. This can render the result to be virtually useless. Solution is to limit the number of allowable regions by incorporating a preprocessing stage designed to bring additional knowledge into the segmentation procedure. A concept of markers is used as a solution; a marker is connected component belonging to an image are mentioned in figure 3. Selection of markers consists of two principle steps, one is preprocessing and other is definition of a set of criteria.

Two kinds of markers:

i. External markers: This can associate with the background.
ii. Internal markers: This can associate with the objects of interest.

Effective measures are used to minimize the effect of small spatial details to filter the image with a smoothing filter. We can define the internal markers as the region surrounded by the higher altitude points, every region should be a connected component and every point in the region should have same gray level value. External markers can be some regions of particular background color.

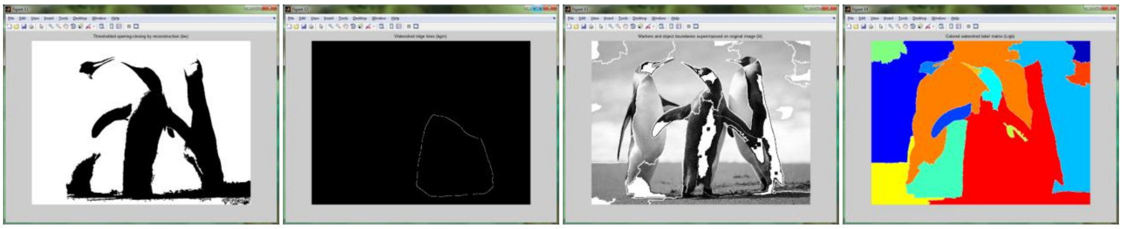


Fig 3. a) Threshold opening-closing by reconstruction b) Watershed ridge lines c) Markers and object boundaries superimposed on original image d) Colored watershed label matrix

4.3Visualize the Result

The regional minimum is punched and floods the entire topography at uniform rate from below. It built to prevent the rising water from distinct catchment basins from merging. Eventually only the tops of the images are visible above the lines. These images divide the lines of the watersheds.

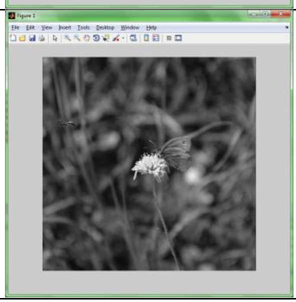
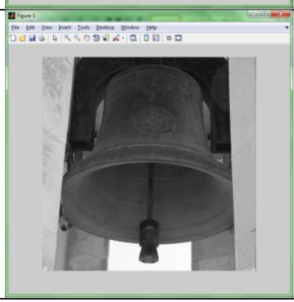
III. Measures of Image Quality

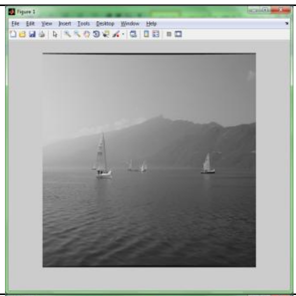
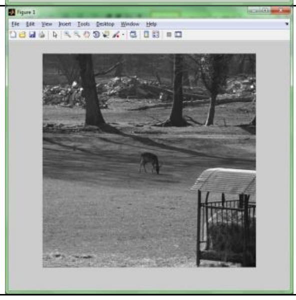
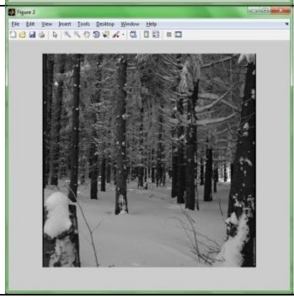
Two measures are used they are MSE and PSNR. Peak Signal-to-Noise Ratio is often called as PSNR. It is an engineering term for the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the dependability of its representation. PSNR is the most commonly used to measure the image quality. Mean Square Error is often called as MSE. MSE is used to quantify the difference between values implied by an estimator and the true values of that quantification are being estimated.

The MSE between two images such as $g(x,y)$ and $\bar{g}(x,y)$ is mentioned in equation (1)

$$e_{MSE} = {}^{1}\!/_{MN} \sum_{n=1}^{M}\sum_{m=1}^{N}\left[\bar{g}(n,m) - g(n,m)\right] \cdots (1)$$

TABLE I
EXPERIMENTAL RESULTS FOR SAMPLE DATABASE EXTRACTED FROM BOSS

Image1	**Image2**	**MSE**	**PSNR(db)**
		135.8449	26.8004
		90.8757	28.5463
		91.8956	28.4979

		225.9396	24.5909
		122.0038	27.2671

PSNR avoids the problem which occurs in MSE by scaling according to the image range is mentioned in equation (2)

$$PSNR = -10\log_{10} e_{MSE} / S^2 \cdots (2)$$

Here, S is the maximum pixel values. PSNR is measured in decibels (DB).The PSNR is a good measure for comparing restoration results for the same image.

V. CONCLUSION

Effective segmentation schemes in attacking all uncompressed raw images are proposed here. This Scheme is based on Watershed segmentation. It is used to segment an image into rigid lines which has been adopted in this process. The experimental results have demonstrated that the proposed scheme out performs the segmentation for all uncompressed raw images or different uncompressed image format. This system is also used to identify the segments that make the further process with the PSNR and MSE are shown above in TABLE I. It is very important and useful to analyze all the techniques for future purposes and inventions of new techniques in each field.

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