



Analysis of Various Image Segmentation Techniques Using MATLAB

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Abstract: *Image segmentation divides the image into meaningful structures which is an essential step in image analysis, object representation, visualization, and many other image processing tasks. The purpose of image segmentation is to partition an image into meaningful regions with respect to a particular application. The segmentation is based on measurements taken from the image and might be grey level, colour, texture, depth or motion. Usually image segmentation is an initial and vital step in a series of processes aimed at overall image understanding. Applications of image segmentation include identifying objects in a scene for object-based measurements such as size and shape as well as identifying objects in a moving scene for object-based video compression (MPEG4). This paper discusses the various image segmentation techniques and analyse their outputs using MATLAB software.*

Keywords: *Image segmentation, pixels, threshold, histograms, MATLAB*

I. INTRODUCTION

Image segmentation is an important step in image processing, and it is used everywhere if we want to analyse the image. Image segmentation basically provides the meaningful objects of the image. This paper represents the various image segmentation techniques that could be used in the segmentation algorithm. Whenever we work with the image in any application, initial step is to segment the image in order to solve its complexity. The segmentation of images is the basic thing for understanding the images. It is used in the Image processing applications, Computer vision, etc. Image segmentation means assigning a label to each pixel in the image such that pixels with same labels share common visual characteristics [1]. It makes an image easier to analyze in the image processing tasks. There are many different techniques available to perform image segmentation. Our motive is to implement almost the same concept as we humans try to implement, while understanding the image which we visualize. In human vision, the complex image is immediately segmented into the simple objects on the basis of colour, texture, patterns, shapes, etc. This same thing is constructed with the help of the image segmentation techniques in the computer vision system. We could segment the digital image on the basis of these features, so that the task of understanding of image could be done in a simple and human way. On the basis of these defined features, there are several image segmentation techniques which would provide the segmented results. Image segmentation refers to the process of partitioning a digital image into multiple segments i. e. set of pixels, pixels in a region are similar according to some homogeneity criteria such as colour, intensity or texture, so as to locate and identify objects and boundaries in an image. The choice of a segmentation technique over another and the level of segmentation are decided by the particular type of image and characteristics of the problem being considered.

II. IMAGE SEGMENTATION TECHNIQUES

There are various techniques of image segmentation, we have used threshold technique, point transformation, watershed technique and wavelet transformation techniques which are explained further

A. *Threshold segmentation:*

In this background and foreground can be separated using histogram. In this we use bimodal kind of images. We divide images in two parts. We can manually find out the values which separate the intensity values of these images. This works for the images which have high contrast and clear background is there so we just want to segment thresholding method. This method is based on a clip-level (or a threshold value) to turn a gray-scale that background. The simplest method of image segmentation is called the image into a binary image [12]. The key of this method is to select the threshold value (or values when multiple-levels are selected). Several popular methods are used in industry including the maximum entropy method, Otsu's method (maximum variance), and k-means clustering. Recently, methods have been developed for thresholding computed tomography (CT) images. The key idea is that, unlike Otsu's method, the thresholds are derived from the radiographs instead of the (reconstructed) image. New methods suggested the usage of multi-dimensional fuzzy rule-based non-linear thresholds. In these works decision over each pixel's membership to a segment is based on multi-dimensional rules derived from fuzzy logic and evolutionary algorithms based on image lighting environment and application.

B. Point Transformation

Logarithm operator: reducing contrast of brighter regions.

Histogram equalization: general method of modifying intensity distribution.

1) Logarithm operator:

When changing the brightness of an image, the pixel values are mapped to a different range, with the result that the brightness is enhanced or decreased. The only parameter of this function is a factor in the range [-1, 1]. If this factor is smaller than 0, the brightness is decreased, if it is bigger than 0, the brightness is increased. This operation can't enhance the quality of an image, so normally it won't be used in a segmentation process. But it can be used to make an image 'looking' better. When changing the contrast of an image, the pixel values are mapped to a different range, with the result that the contrast is enhanced or decreased. The only parameter of this function is a factor in the range [-1, 1]. If this factor is smaller than 0, the contrast is decreased, if it is bigger than 0, the contrast is increased. This operation can't enhance the quality of an image, so normally it won't be used in a segmentation process [10]. But it can be used to better visualize image details for the eye. Logical operations are point operations which can only be executed on binary images. These operations consist of the application of logical operators on every pixel of the image. As explained above it is used to reduce contrast of brighter regions. Its syntax is given as:

$$S=C*\log (1+r) \quad (1)$$

The logarithmic operator is a simple point processor where the mapping functions is a logarithmic curve. In other words, each pixel value is replaced with its logarithm. Most implementations take either the natural logarithm or the base 10 logarithm. However, the basis does not influence the shape of the logarithmic curve, only the scale of the output values which are scaled for display on an 8-bit system [5]. Hence, the basis does not influence the degree of compression of the dynamic range. This is used in image processing as shown below in following program:



Fig.1 Input true scale image

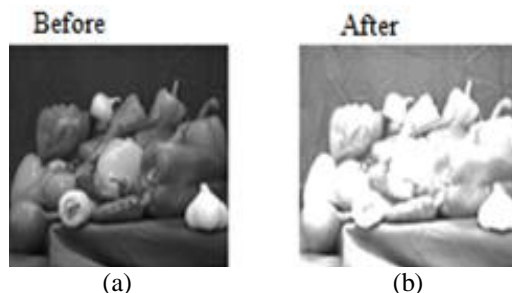


Fig.2 (a) Input greyscale image (b) Final output image

The conclusion we get from this method is that the dynamic range of an image can be compressed by replacing each pixel value with its logarithm. This has the effect that low intensity pixel values are enhanced. Applying a pixel logarithm operator to an image can be useful in applications where the dynamic range may too large to be displayed on a screen.

2) Histogram equalisation:

Given a greyscale image, its histogram consists of the histogram of its grey levels; that is, a graph indicating the number of times each grey level occurs in the image. We can infer a great deal about the appearance of an image from its histogram. In a dark image, the grey levels would be clustered at the lower end. In a uniformly bright image, the grey levels would be clustered at the upper end. In a well contrasted image, the grey levels would be well spread out over much of the range [7]. Problem is given a poorly contrasted image; we would like to enhance its contrast, by spreading out its histogram.

C. Watershed Transformation

The watershed transformation considers the gradient magnitude of an image as a topographic surface. Pixels having the highest gradient magnitude intensities (GMIs) correspond to watershed lines, which represent the region boundaries [8]. Water placed on any pixel enclosed by a common watershed line flows downhill to a common local intensity minimum (LIM). Pixels draining to a common minimum form a catch basin, which represents a segment.

- Morphological watershed provides a complementary approach to the segmentation of the objects
- It is especially useful in separating the objects touching each other
- We view the greyscale image as a topological surface where values of $f(x,y)$ represents the height

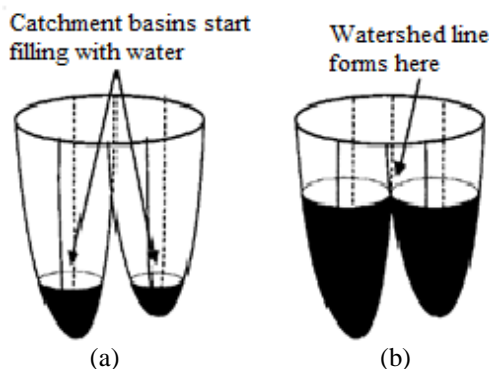


Fig.3 (a) Catchment basins filling with water (b) Catchment basins filled with water

Steps for Watershed Transformation:

- $L = \text{watershed}(f)$
Where f is the input image and L is the labelled matrix image having positive integer values at different regions and 0 at watershed ridge lines. The key behind using this algorithm is to change image into another image whose catchment basins are the objects you want to identify. This image is not very useful because there is only one catchment basin spanning the entire image. So we try computing the distance transform of the image's complement
- $B = \text{bwdist}(\sim im)$
In this image it is easier to turn the two bright areas into catchment basins
- $C = \sim B$
Now there is one catchment basin for each object, so we call the watershed algorithm
- $L = \text{watershed}(C)$
 L is called the label matrix and it contains the positive integers corresponding to the location of each catchment basin. We can use the non-zero elements of L which are located along the watershed lines, to separate the objects in the original image.

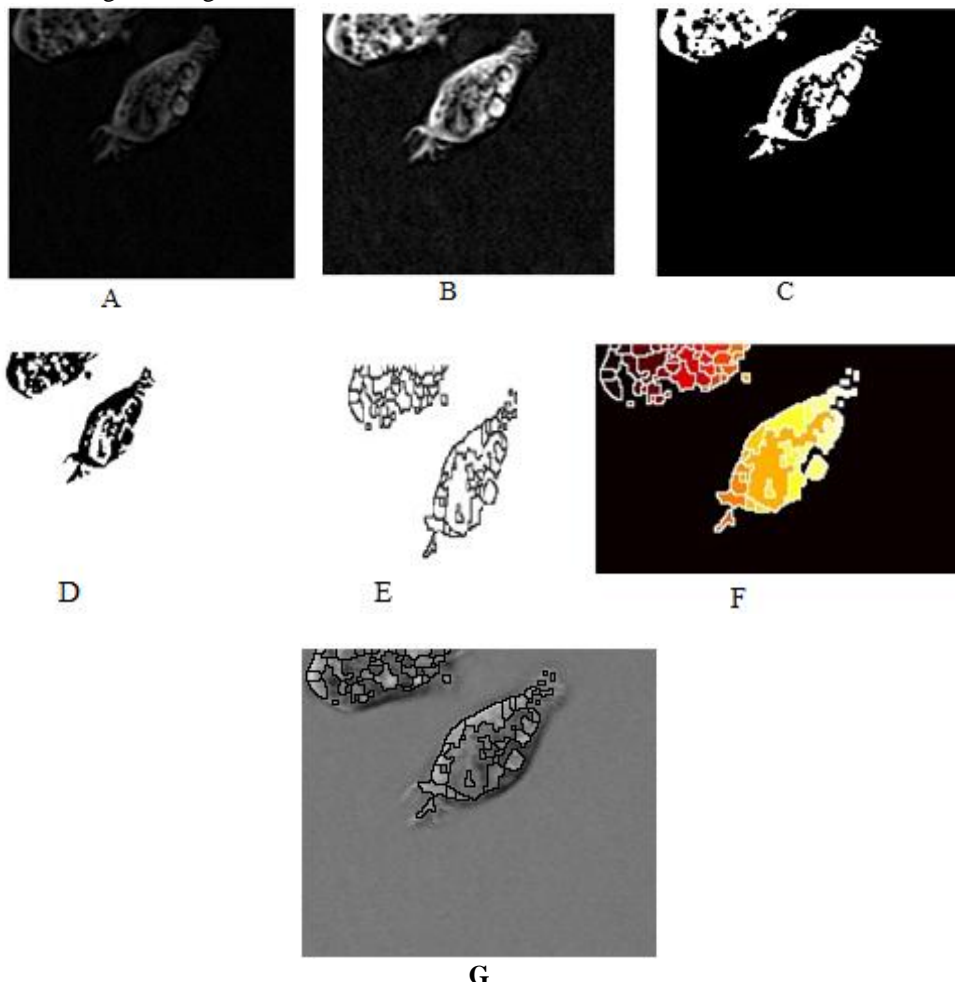


Fig.4(A) Input image, (B) Uniform background image, (C) Adjusted intensity image, (D) White background images, (E) bwdist image, (F) Watershed image, (G) Final output image

The conclusion we get from watershed transformation technique is that we can separate two merged objects and can analyze it in the best manner.

D. Wavelet Transform

Wavelets (little waves) are functions that are concentrated in time as well as in frequency around a certain point. Fourier transform has the drawback of dealing with just the frequency component in the signal. The temporal details are not available. Due to Heisenberg's uncertainty principle we know that we can have either high frequency resolution or poor frequency resolution and good temporal resolution.

This transform is most appropriate for non stationary signals. The basis function varies both in frequency range and in spatial range [9]. The wavelet transform is designed in a way that we get good frequency resolution for low frequency components and high temporal resolution for high frequency components.

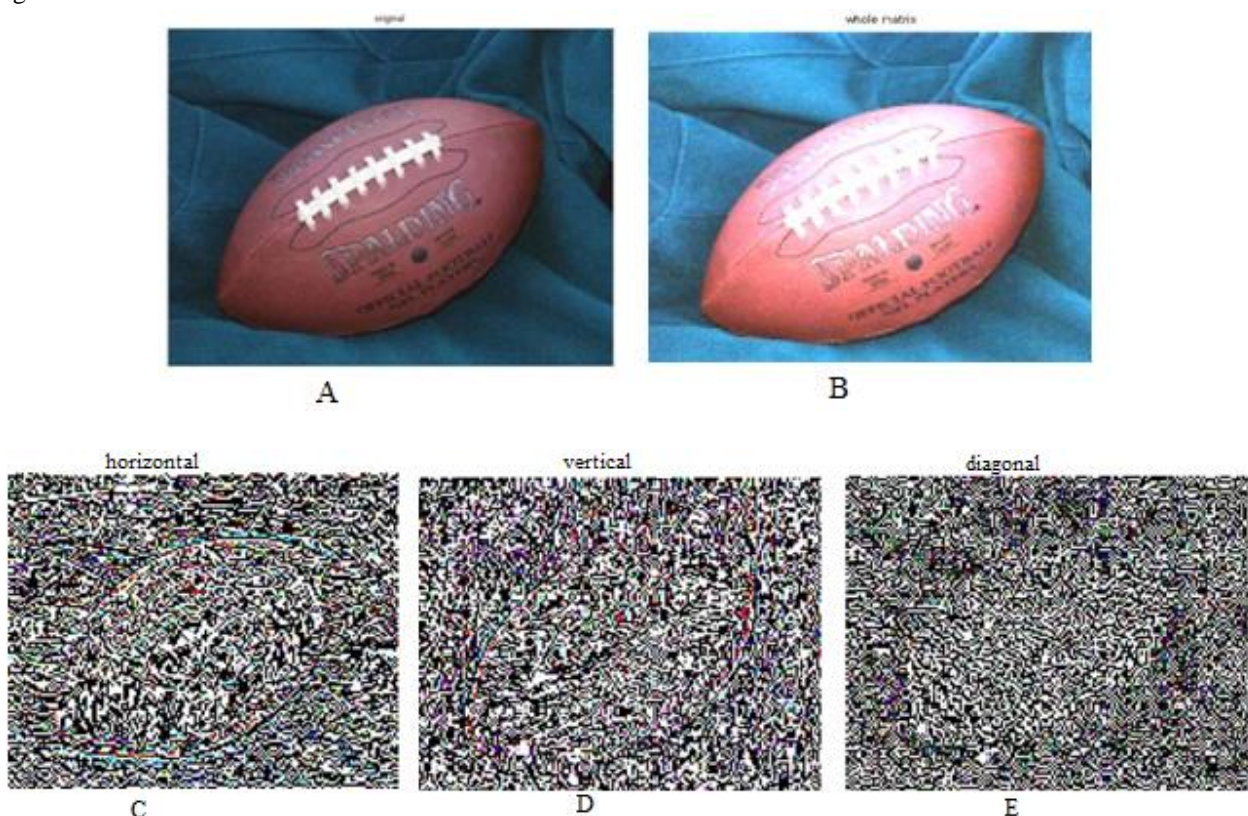
Steps for Wavelet Transformation:

- We start with a mother wavelet such as "Haar", "daubechies".
- The signal is then translated into shifted and scaled versions of this mother wavelet.
- Wavelet analysis can be used to divide information of an image into approximation and detail sub signal.
- The approximation sub signal shows general trend of pixel values and three detail sub signals on the horizontal, vertical and diagonal details.
- If these details are small they can be set to zero without significant change in the image. Hence filtering and compression can be achieved.

If a signal is put through two filters:

- 1) High pass filter
 - 2) Low pass filter
- Then the signal is decomposed into two parts-a detailed part (high frequency) and an approximation part (low frequency).
 - The sub signal produced from low filter will have a highest frequency equal to half of the original.
 - According to Nyquist sampling this change in frequency range means that only half of the original samples need to be kept in order to perfectly reconstruct the signal.

At every level 4 sub images are obtained: 1 approximation and three detail sub signals on the horizontal, vertical and diagonal details.





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Fig.5 (A) Input image of rugby ball, (B) Wholly Selected matrix, (C) Horizontally view of segmented image, (D) Vertical view of segmented image, (E) Diagonal view of segmented image, (F) Final output with 2-D view of horizontal, vertical and diagonally compressed image

The image segmentation using wavelet transform technique help us to analyse horizontal, diagonal, and vertical two dimensional views of an image. This techniques are used in medical purpose like CT scan, X-Ray etc.

III. CONCLUSION

The various image segmentation techniques are discussed and analysed in this paper. The MATLAB software is used to analyse the different techniques and output is studied. The logarithm operator method shows that an image can be compressed by replacing each pixel value with its logarithm. The output from watershed transformation technique shows that we can separate two merged objects and can analyze it in the best manner. The wavelet transform technique help us to analyse horizontal, diagonal, and vertical two dimensional views of an image.

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