Study of Image Segmentation using Thresholding Technique on a Noisy Image

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Abstract: ***Image segmentation is often used to distinguish the foreground from the background of an image. The focus of this paper is an attempt to study Image Segmentation using Thresholding Technique on an image corrupted by Gaussian Noise as well as Salt and Pepper Noise which is implemented using MATLAB version 7.12.0.635 (R2011a) software and the results obtained are studied and thereby discussed, highlighting the techniques performance.***

Keywords: Image Segmentation, Image Thresholding, Noise, MATLAB.

1. Introduction

In computer vision, segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as superpixels). Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) 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. The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Due to the importance of image segmentation, a number of algorithms have been proposed but based on the image that is inputted the algorithm should be chosen to get the best results [1].

In many vision applications, it is useful to separate out the regions of the image corresponding to objects in which we are interested from the regions of the image that correspond to the background. Thresholding often provides an easy and convenient way to perform this segmentation on the basis of the different intensities or colours in the foreground and background regions of an image [2]. Image segmentation is a fundamental yet still challenging problem in computer vision and image processing. In particular, it is an essential process for many applications such as object recognition, target tracking, content-based image retrieval and medical image processing, etc. Generally speaking, the goal of image segmentation is to partition an image into a certain number of pieces which have coherent features (color, texture, etc.) and in the meanwhile to group the meaningful pieces together for the convenience of perceiving. In many practical applications, as a large number of images are needed to be handled, human interactions involved in the segmentation process should be as less as possible [3].

2. Image Segmentation

Segmentation subdivides an image into its constituent regions or objects. The level of detail to which the subdivision is carried depends on the problem being solved. That is segmentation should stop when the objects or regions of interest in an application have been detected [4]. The goal of image segmentation is to cluster pixels into salient image regions, i.e., regions corresponding to individual surfaces, objects, or natural parts of objects [5]. Image is formed in the eye and in the camera by the amount of illumination reflected by an object [6]. In computer vision, image processing is any form of signal processing for which the input is an image, such as photographs or frames of videos. The output of image processing can be either an image or a set of characteristics or parameters related to image. The image processing techniques like image restoration, image enhancement, image segmentation etc. [7].

Image segmentation is a fundamental yet still challenging problem in computer vision and image processing. In particular, it is an essential process for many applications such as object recognition, target tracking, content-based image retrieval and medical image processing, etc. Generally speaking, the goal of image segmentation is to partition an image into a certain number of pieces which have coherent features (color, texture, etc.) and in the meanwhile to group the meaningful pieces together for the convenience of perceiving [8].

3. Image Thresholding

Threshold is one of the widely methods used for image segmentation. It is useful in discriminating foreground from the background. By selecting an adequate threshold value T, the gray level image can be converted to binary image. The binary image should contain all of the essential information about the position and shape of the objects of interest (foreground). The advantage of obtaining first a binary image is that it reduces the complexity of the data and simplifies the process of recognition and classification. The most common way to convert a gray-level image to a binary image is to select a single threshold value (T). Then all the gray level values below this T will be classified as black (0), and those above T will be white (1). The segmentation problem becomes one of selecting the proper value for the threshold T. A frequent method used to select T is by analyzing the histograms of the type of images that want to be segmented. The ideal case is when the histogram presents only two dominant modes and a clear valley (bimodal). In this case the value of T is selected as the valley point between the two modes. In real applications histograms are more complex, with many peaks and not clear valleys, and it is not always easy to select the value of T [9].

$$g(x,y) = f(x) = \begin{cases} 1, & if\ f(x,y) > T \\ 0, & if\ f(x,y) \leq T \end{cases}$$

Any point (x,y) in the image at which f(x,y)> T is called an object point; otherwise, the point is called a background point. In other words, the segmented image *g(x,y),* is given by [4].

3.1 Basic Global Thresholding

In an image, when the intensity distributions of objects and background pixels are sufficiently distinct, it is possible to use a single (global) threshold applicable over the entire image. In most applications, there is usually enough variability between images that, even if global thresholding is a suitable approach, an algorithm capable of estimating automatically the threshold value for each image is required. The Global Thresholding uses an iterative algorithm which consists of the following basic steps.

1. Selecting an initial estimate for the global threshold, *T.*
2. Segmenting the image using g(x,y) = $f(x) = \begin{cases} 1, & if\ f(x,y) > T \\ 0, & if\ f(x,y) \leq T \end{cases}$ which will produce two groups of pixels G_1 consisting of all pixels with intensity values > *T,* and G_2 consisting of all pixels with values $\leq T$.
3. Calculating the mean intensity values m_1 and m_2 for pixels in G_1 and G_2.
4. Compute a new threshold value: $T = \frac{1}{2}(m_1 + m_2)$
5. Repeat steps 2-4 until the mean values and in successive iterations do not change.

This algorithm works well in situations where there is a reasonably clear valley between the modes of the histogram related to objects and background [4].

4. Experimental Results

This section presents the results obtained from Global Thresholding using Iterative algorithm which was carried out for the study. This type of image segmentation was implemented using MATLAB version 7.12.0.635 (R2011a) software on a colored image with pixel size of 500x699 which was taken in Beijing, P.R China. The figures below show the experimental results.

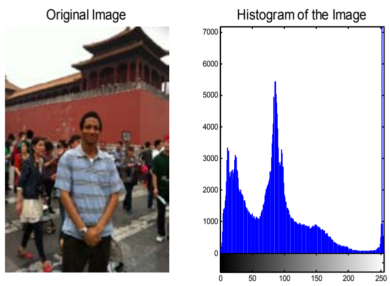

Figure 1. (a) Showing Original Colored Image (b) Histogram of the Original Image

The above figure 1 (a) shows a colored image and figure 1 (b), shows the histogram representation of the colored image. From the above figure, it was observed that, the histogram has reasonably clear valley between the modes related to objects and the background.

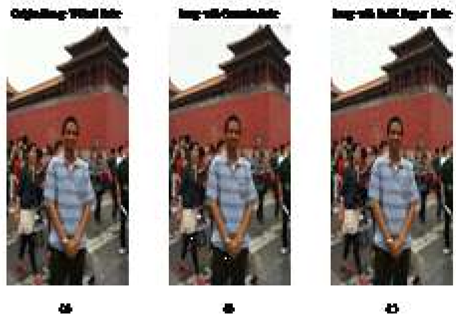

Figure 2. (a). Image without noise (b) Image after applying Gaussian Noise (c) Image after applying Salt and Pepper Noise

In figure 2 (b), it can be observed that, Gaussian noise was added to the original image and in figure 2(c) Salt and Pepper was added to the original image,

Figure 3. (a). Shows grayscale Image with Gaussian noise (b) Thresholded Image with Gaussian Noise

For the figure 3(a) above, the image with Gaussian Noise was first converted to grayscale then global thresholding using iterative algorithm was performed on the image. The object was successfully separated from its background. In figure 3(b), it can be observed that the white (1) represents the foreground and black (0) represents the background.

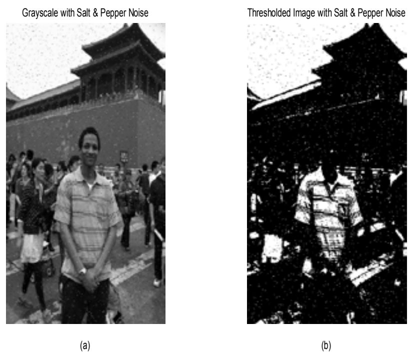

Figure 4. (a). Grayscale Image with Salt and Pepper Noise (b) Thresholded Image with Salt and Pepper Noise

For the figure 4(a) above, the image with Salt and Pepper Noise was first converted to grayscale and global thresholding using iterative algorithm was performed on the image. The object was successfully separated from its background. In figure 4(b), it can be observed that the white (1) represents the foreground and black (0) represents the background.

5. Conclusions

Image segmentation is often used to distinguish the foreground from the background. The focus of this paper is an attempt to study and perform Image Segmentation using Thresholding Techniques on images with Gaussian Noise as well as Salt and Pepper Noise using MATLAB version 7.12.0.635 (R2011a) software. The study made use of the Iterative algorithm for the purpose of Image Thresholding on an image with pixel size 500x699 and the results obtained in the experiment were studied thereby highlight the performance of this image segmentation technique.

From the results obtained, figure 1 (a) shows a colored image and figure 1 (b), the histogram representation of the colored image. It was observed that, the histogram has reasonably clear valley between the modes related to objects and background. In the Figure 3(a), the image with Gaussian Noise was first converted to grayscale and global thresholding using iterative algorithm was performed on the image. The object was successfully separated from its background. In figure 3(b), it was observed that the white (1) represents the foreground and black (0) represents the background. In the Figure 4(a), the image with Salt and Pepper Noise was first converted to grayscale and global thresholding using iterative algorithm was performed on the image. The object was successfully separated from its background. In figure 4(b), it can be observed that the white (1) represents the foreground and black (0) represents the background. This technique of image segmentation by using Image Thresholding performed on an image corrupted with two different kinds of noise successfully separated the object from the background. Thus the background of the image is represented as black and the object represented as white (1) as seen in the figures above.

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