An Efficient Color Image Segmentation using Edge Detection and Thresholding Methods

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-- **Abstract** --

This paper to perform efficient color image segmentation by using the two image segmentation techniques that is edge detection and image Thresholding and comparing the result. Segmentation is the process of partitioning a digital image into multiple regions known as region of interest for further images analysis process we perform pre-processing steps which involves different operations to produce a clear digital image so that it can be used directly and efficiently for image segmentation. In edge detection technique and edge is typically extracted by computing the derivative of the Image function. Thresholding segmentation is method, which separates an image into two meaningful regions foreground and background through a selected threshold value. This work develops an image segmentation methods based on the modified edge scheme where different thresholds are automatically determined according to areas with varied contents in a picture, thus yielding suitable segmentation result in different areas. The iterative threshold selection technique is modified to calculate the initial-point threshold of the whole image or a particular block. The proposed method is demonstrated to take the least computational time for achieving fairly good segmentation performance in various image types.

Keywords **- Edge detection, Image enhancement, Image Segmentation, Pre-processing, Thresholding.**

I. INTRODUCTION

The color is important in the design and development of color vision systems. Color image carries more information than the grey image. The color is divided into three types. 1. True colour, 2.False colour, 3.Pseudo colour. A natural color rendition of image is called "true-colour" image. True colour the use of a 24-bit colour depth to display an RGB image. A false colour image is an image that depicts an object in colour that differs from the photographic image. A pseudo colour image is derived from a gray scale image by mapping each intensity value to a colour according to a table of function. Image means picture. There is a need to covert an analogue picture into digital because of ease of storing and processing it using computer. The image data is random in form. Image data is quite huge. The segmentation process is divide the image into homogeneous. Self-consistent regions, which should correspond to different objects in the scene. The process is achieved using only properties of the image. The basic property useful for image segmentation is its amplitude.

Segmentation is classified in the following way:

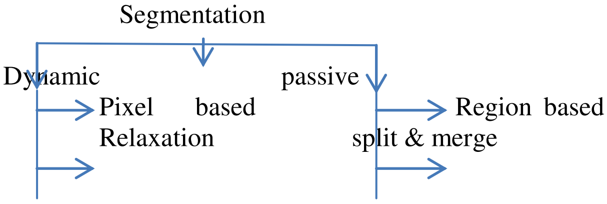


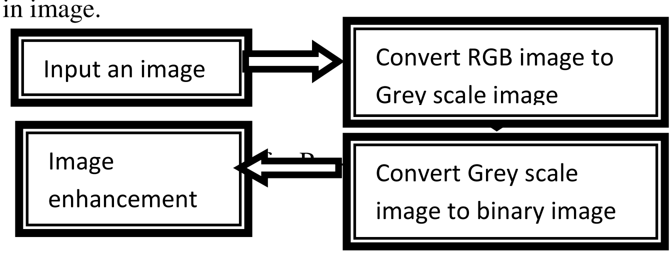
Fig.1 Classification of Segmentation

Image is a dimensional (2D) signal f(x,y),where the values of the function f(x,y) represent the amplitude or intensity of the image. Image has to be converted into discrete form using the sampling and quantization known collectively as digitization. in image processing ,the term 'image' is used to denote the image data that is sampled, quantized and readily available in a form of suitable for further processing by digital computers. One of the major objectives of image processing is to improve the quality of pictorial information for better human interpretation.

Segmentation is the process of partitioning a digital image into multiple regions and extracting meaningful region known as region of interest (ROI) for further image analysis. We have introduced two types of segmentation algorithms: 1.Edge detection, 2.Thresholding

2. PRE-PROCESSING

The image pre-processing refers to the initial processing of input image to correct the geometric distortions, calibrate the data radio metrically and eliminate the noise and clouds that present in the data. These operations are called pre-processing because they normally carried out before the real analysis and manipulations of the image data occur in order to extract any specific information. The aim is to correct the distorted or degraded image data to create a more faithful representation of the real image. Various pre-processing techniques are then used to enhance the image obtained. Several techniques like boundary enhancement, smoothening, filtering, noise removal, etc. can be applied to improve the quality of the image. The following figure 2 shows the pre-processing steps in image.



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2.1 Input image

The image is captured by a sensor (Eg. Camera), and digitized if the output of the camera or sensor is not already in digital form, using analogue-to-digital convertor. Take an input digital color image of plant leaves, flowers, animals, birds and etc., size should not exceed 115kb. The image file format should be any of the following: .jpg, .jpeg, .gif, .png.

Fig. 3. Input image

2.1.1 RGB image to gray scale image

Convert original color image to gray scale image .The value of pixel of image in color image is ranges from 0 to 224 whereas the value of pixel of image in gray image is ranges from 0 to 255.

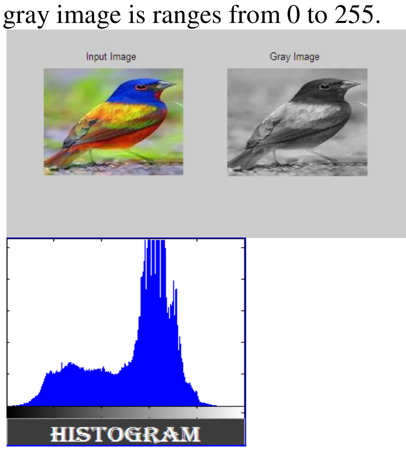

Fig. 4. RGB image to gray scale image

2.1.2 Gray scale image into binary image

Convert original color image to gray scale image .The value of pixel of image in Gray scale image is ranges from 0 to 255 whereas the value of pixel of image in binary image is ranges from 0 to 1.

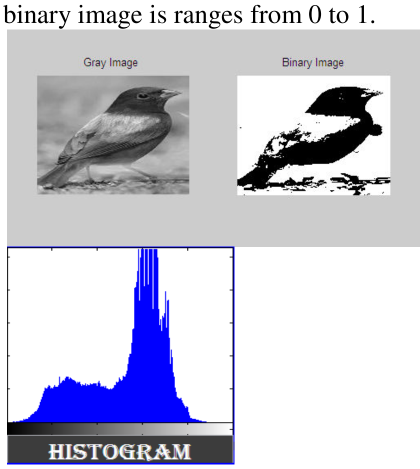

Fig. 5. Gray scale image into binary image

2.2 Image Enhancement

The process of manipulating an image so that the result is more suitable than the original for specific applications. The idea behind enhancement techniques is to bring out details that are hidden, or simple to highlight certain features of interest in an image. Next step in pre-processing is image enhancement. We perform image enhancement to enhance the contrast of grey image using Histogram equalization method.

Histogram is the graphical representation of the distribution of data. A common graph in statistics is called histogram. Histogram equalization is a method in image processing contrast adjustment using the image's histogram.

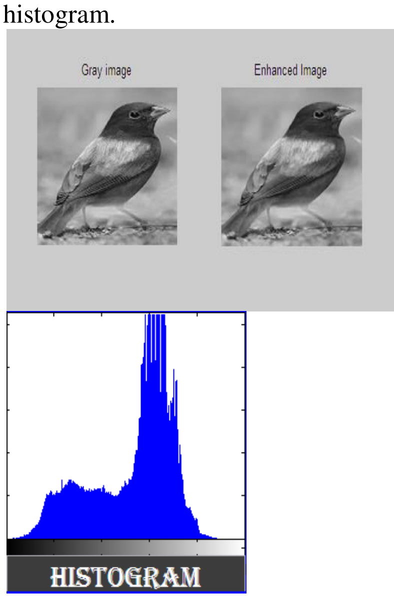

Fig. 6. Enhancement image

2.3 Image Segmentation

Image segmentation is a fundamental task in computer vision. Although many methods are proposed, it is still difficult to accurately segment an arbitrary image by any method alone. Segmentation refers to the process of partitioning a digital image into multiple segments (sets of pixels) (also known as super pixels). 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. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic(s).

2.4 Thresholding Method

Thresholding is the simplest method of image segmentation. From a gray scale image, thresholding can be used to create images. Thresholding methods are categorized into the following **six** groups:

Histogram shape: based methods, where, for example, the peaks, valleys and curvatures of the smoothed histogram are analyzed

Clustering: based methods, where the gray-level samples are clustered in two parts as background and

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foreground (object), or alternately are modeled as a mixture of two Gaussians.

Entropy: based methods result in algorithms th at use the entropy of the foreground and background regions, the cross-entropy between the original and binarized image, etc.

Object Attribute: based methods search a measure of similarity between the gray-level and the binarized images, such as fuzzy shape similarity, edge coincidence, etc.

Spatial: methods that use higher-order probability distribution and/or correlation between pixels.

Local: methods adapt the threshold value on each pixel to the local image characteristics.

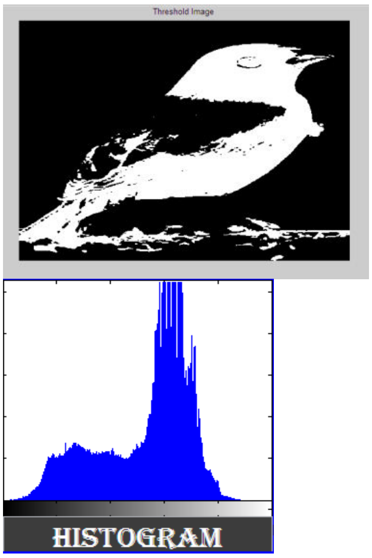


Fig. 7. Thresholding image

The range of intensity levels covered by objects of interest is different from the background.

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

Thresholding segmentation is a method, which separates an image into two meaningful regions: foreground and background, through a selected threshold value *T*. If the image is a grey image, *T* is an integer in the range of *[0..K]*, where *K* is the maximum intensity value. For example, if the image is an 8-bit gray image, *K* takes the value of *255* and *T* is in the range of *[0-255]*. Whenever the value of *T* is decided, the segmentation procedure is indicated by the following equation:

$$G_B(x,y) = \begin{cases} 1, \text{ if } G(x,y) > T \\ 0, \text{ if } G(x,y) \leq T \end{cases}$$

In equation (1), *G(x,y)* indicates the intensity value of pixel *(x,y)* in the grey image *G*. *GB* is the segmentation result. Actually it forms a binary image, in which each value of *GB(x,y)* gives the category (foreground or background) that the corresponding pixel belongs to. If *GB(x,y) = 1*, then pixel *(x,y)* in the image *G* is classified as a foreground pixel, otherwise it is classified as a background pixel.

Basic notations

G(x,y): The input gray image that we want to segment.
GB(x,y)*:* The segmentation result of *G*. It is a binary image, the value of *GB(x,y)* is either or *1* indicating the corresponding pixel *(x,y)* in G belongs to background or foreground respectively.
K: The maximum possible intensity value defined by *G*. If *G* is an 8-bit gray image, then *K* takes the value *255.*
T: The thresholding value. It is an integer within the range *[0..K].*
N: The total number of pixels in *G*. If *G* has *width = w*, and *height = h*, then of course *N = w h.*

2.5 Edge Detection

An edge is a set of connected pixels that lies on the boundary between two regions that differ in grey value, the pixel on edge are called edge points. In an image, an edge is a curve that follows a path of rapid change in image intensity. Edges are often associated with the boundaries of objects in a scene. Edge detection is used to identify the edges in an image, see fig.9.Edge provides a number of derivative estimators, each of which implements one of the definitions. For some of these estimators, you can specify whether the operation should be sensitive to horizontal edges, vertical edges, or both. Edge returns a binary image containing 1's where edges are found and 0's elsewhere.

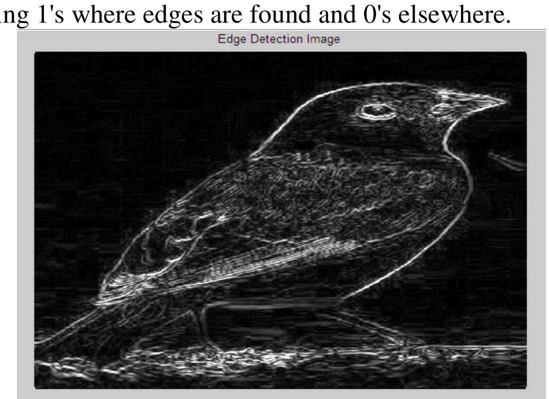


Fig.8. Edge Detection image

The function looks for places in the image where the intensity changes rapidly, using one of these two criteria:

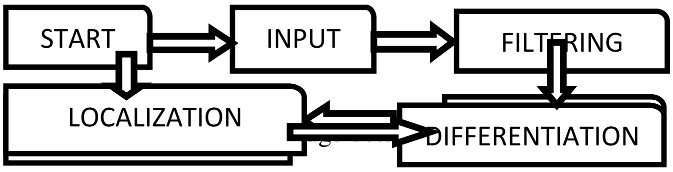
- Places where the first derivative of the intensity is larger in magnitude than some threshold
- Places where the second derivative of the intensity has a zero crossing

Edge is typically extracted by computing the derivative of the image function. Some of the edges that are

normally encountered in image processing are as follows:
1. Step edge, 2.Ramp edge, 3.Spike edge, 4.Roof edge.

2.5.1 Stages in edge detection

The main aim of edge detection is to detect the sharp changes in image brightness, which can capture the important events and properties. This is done in three stages.



Filtering: The input image is filter to get maximum performance for the edge detectors.it involves smoothing,where the noise is suppressed without effecting the true edges.in addition this phase uses a filter to enhance the quality of the edges in the image.

Differentiation: This phase distinguish the edge pixels from other pixel.if the pixel have the same value,the difference is 0.this means that there is no transition between the pixel.

Localization: In this stage detected edges are localized.the localization process involves determining the exact location of the edge.the sharp and connected edges are then displayed.

2.5.2 First-order derivatives

The gradient of an image *f*(*x*,*y*) at location (*x*,*y*) is defined as the vector:

$$\nabla \mathbf{f} = \begin{bmatrix} G_x \\ G_y \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial x} \\ \frac{\partial f}{\partial y} \end{bmatrix}$$

The magnitude of this vector:

$$\nabla f = \text{mag}(\nabla \mathbf{f}) = \left[G_x^2 + G_y^2\right]^{1/2}$$

The direction of this vector:

$$\alpha(x, y) = \tan^{-1}\left(\frac{G_x}{G_y}\right)$$

The used edge detection technique in image segmentation is Sobel Edge Detection.

Sobel Edge Detection

Sobel edge detector uses the masks as shown in the figure below to digitally approximate the first order derivatives G*x* and G*y* [3].

$$G=\left[G_x^2 + G_y^2\right]^{1/2}$$
$$=\{[(z_7 + 2z_6 + z_9) - (z_1 + 2z_4 + z_7)]^2$$
$$+[(z_3 + 2z_6 + z_9) - (z_1 + 2z_4 + z_7)]^2\}^{1/}$$

In its most common usage, the input to the operator is a gray scale image, as is the output. Pixel values at each point in the output represent the estimated absolute magnitude of the spatial gradient of the input image at that point.

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

-1	0	1
-2	0	2
-1	0	1

Image neighbourhood

sobel mas

$$G_y=(z_3 + 2z_6 + z_9)-(z_1 + 2z_4 + z_7)$$

3. COMPARISION

3.1. Root Mean Square Error

The Root mean square error (*erms*) is a measure, which calculates the average magnitude of the error. The equation for the *erms* is given below. The difference between the forecast and corresponding observed values are each squared and then averaged over the sample. Finally, the square root of the average is taken. Since the errors are squared before they are

$$e_{rms} = 1/MN[\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} [\hat{f}(x,y) - f(x,y)]^2]^{1/2}$$

averaged, the *erms* gives a relatively high weight to large errors. The input image is represented as *f* (x,y), output image *f* (x,y) and the error with e(x,y).

And the total error between two images is:

$$e(x,y) = \hat{f}(x,y) - f(x,y)$$

The rms error *erms* between input and the output is given as

$$\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} [\hat{f}(x,y) - f(x,y)]$$

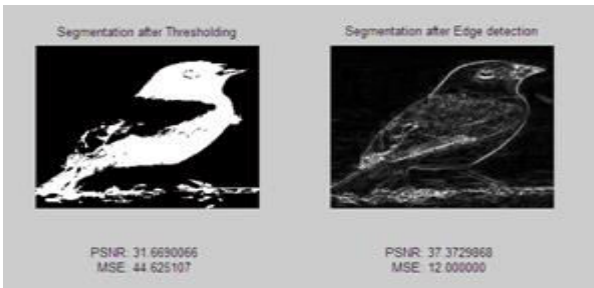


Fig. 10.Comprison

4. CONCLUSION

In this paper, we propose an approach for image segmentation based on low-level features including color, edge, and spatial information. The proposed method uses thresholding and edge detection technique for segmentation. The pre-processing techniques are then used to enhance the image obtained. The uniform regions are identified via a Thresholding operation on a newly defined homogeneity histogram. While the homogeneity is calculated for an image pixel, both local information and global information are considered. Thresholding segmentation is a method, which separates an image into two meaningful regions: foreground and background, through a selected threshold value *T*. 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. Edge provides a number of derivative estimators, each of which implements one of the definitions. For some of these estimators, you can specify whether the operation should be sensitive to horizontal edges, vertical edges, or both. Edge returns a binary image containing 1's where edges are found and 0's elsewhere.

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