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A Novel Boundary based Image Segmentation for Image Classification and Analysis

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ABSTRACT

The main aim of this paper is to propose a new method for image segmentation. Image Segmentation is concerned with splitting an image up into segments that each holds some property distinct from their neighbor.
Segmentation consists of three types of methods which are divided on the basis of threshold, edge and region. Thresholding is a commonly used enhancement, whose goal is to segment an image into object and background. Edge-based segmentations rely on edges found in an image by edge detecting operators. Region based segmentations basic idea is to divide an image into zones of maximum homogeneity, where homogeneity is an important property of regions. Edge detection has been a field of fundamental importance in digital image processing research. Edge can be defined as a pixels located at points where abrupt changes in gray level take place in this paper one novel approach for edge detection in gray scale images, which is based on diagonal pixels in 2x2 region of the image, is proposed. This method first uses a threshold value to segment the image and binary image and then the proposed edge detector. In order to validate the results, seven different kinds of test images are considered to examine the versatility of the proposed edge detector. It has been observed that the proposed edge detector works effectively for different gray scale digital images. The results of this study are quite promising.

Keywords: Discrete Domain, ROI, Edge Detection, Homogeneousness and Classification

1. INTRODUCTION

Digital image processing is a general term for the wide range of techniques that exist for interpreting or modifying digital images in different ways [1]. Principle application of digital image processing is machine perception of visual information, as used in robotics [2, 3, and 4]. An image may be defined as a 2D function $f(x, y)$, where x and y are spatial coordinates and amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When all values of x, y and f are finite and discrete then such image is called as Digital Image. A digital image is defined by a finite values function over a discrete domain z^2 suppose the digital image domain D, which is proper subset of z^2, is a matrix of size $M \times N$ i.e.,

$$D = \{(x, y) : x = 1, 2, 3\ldots M - 1, M; y = 1, 2, 3\ldots N - 1, N\}$$

An image may be considered to contain sub-images sometimes referred to as regions of interest (ROIs) or simply regions [5]. Middle level of digital image processing involves tasks such as segmentation (partitioning an image into regions or objects), description of those objects to reduce them to a form suitable for computer processing and classification (recognition) of individual objects [6, 7]. In this level of digital image processing, inputs are images, but outputs are attributes extracted from those images such as edges. Edges can be defined as locations where the values of adjacent points differ sufficiently. Edges in the paradigm of image processing and computer vision provide valuable information towards human image understanding [8, 9]. Thus, edges play important role in human picture recognition system. Naturally, edge detection has become a serious challenge to the image processing scientists, and since the last two decades, in particular, numerous publications have been detailing methodologies for edge detection. Edges are the representations of the discontinuities of image intensity function.

Edge detection algorithm is a process of detection of these discontinuities in an image. Edge detecting an image significantly reduces the amount of data and filters out useless information, while preserving the important structural properties in an image [10]. There are many ways to perform edge detection like the Gradient method and the Laplacian method [11]. The Gradient method detects the edges by looking for the maximum and minimum in the first derivation of the image. The Laplacian method searches for zero crossings in the second derivation of the image to find edges.

Selection of Threshold Value

Image Thresholding is an image processing technique in which the points of an image at or near a particular value are highlighted. When a threshold value is applied onto a gray scale image, this highlighting can be done by converting all pixels below threshold value to black, and all pixels above that value to white. Thus a threshold edge is produced between the blacks and white regions. Because there are two possible output values, threshold creates a binary image. If T is a threshold value, then any pixel (x, y) for which $f(x, y) > T$ is called an object point; otherwise the pixel is called a background pixel. In general, the threshold can be chosen as the relation, $T = T[x, y, p(x, y), f(x, y)]$ where $f(x, y)$ is the gray level of he pixel (x, y) and $p(x, y)$ denotes some local property of this pixel - for example, the average gray level of a neighborhood centered on (x, y). A threshold image $h(x, y)$ is defined as $h(x, y) = 1$ if $f(x, y) > T$; otherwise $h(x, y) = 0$. Thus, pixels labeled 1 correspond to objects, whereas pixels labeled 0 correspond to the background.

When T depends only on $f(x, y)$ (i.e., only on gray level values), the threshold is called global. If T depends on $f(x, y)$ and $p(x, y)$, the threshold is called local. If T depends on the pixel position (x, y) as well as $f(x, y)$ at that pixel position, then it is called dynamic or adaptive threshold. In the proposed scheme to detect edges, global threshold value is used.

Procedure to Select Suitable Threshold Value

Step1: Select an initial estimate for T.

Step2: Segment the image using T. This will produce two groups of pixels:

R_1 consisting of all pixels with gray level values $> T$, and

R_2 consisting of pixels with gray level values $<= T$.

Step3: Compute the average gray level values u1 and u2 for the pixels in region R_1 and R_2.

Step4: Compute a new threshold value

Set $T_{new} = (\mu_1 + \mu_2)/2$ and Set $T_{old} = 0$

Step5: while ($T_{new}! = T_{old}$) do

μ_1 = Mean gray level of pixels for which $f(x, y) >= T_{new}$

μ_2 = Mean gray level of pixels for which $f(x, y) <= T_{new}$

Set $T_{old} = T_{new}$

Set $T_{new} = (\mu_1+\mu_2)/2$

End while

Step6: Suitable threshold value

Set T=Tnew

Step7: Stop

In digital image processing, an image defined in the real world is considered to be a function of to real variables, for example, $f(x, y)$ with f as the amplitude of the image at the real coordinate position (x, y). A spatial filter mask may be defined as a (template) matrix w of size $m \times n$. Assume that $m = 2a$ and $n = 2b$, where a, b are nonzero positive integers. Smallest meaningful size of the mask is 2 × 2. Such mask coefficients, showing coordinate arrangement and Image region under the above mask is shown as:

$W(0, 0)$	$W(0, 1)$	$f(x, y)$	$f(x, y + 1)$
$W(1, 0)$	$W(1, 1)$	$f(x + 1, y)$	$f(x + 1, y + 1)$

Basic Idea Behind Edge Detection

a. Classification of all pixels that satisfy the criterion of homogeneousness.

b. Detection of all pixels on the borders between different homogeneous areas.

In the proposed scheme, first create a binary image by choosing a suitable threshold value. Filter mask is applied on the binary image to detect edge pixels. Set Filter mask coefficients $w(0,0)$, $w(1,1)$ equal to 1 and $w(0, 1)$, $w(1, 0)$ equal to ×, as shown below:

1	×
×	1

Move the filter mask on the whole image and find the gray level value of each pixel of the image under the × of the filter mask in each masking step. If homogeneousness does not exit between neighbors (except diagonal pixel) of the pixel then under the × of the mask, the pixel is an edge pixel, otherwise not. By taking decision about the two pixels in the mask, major problem of processing border pixels in the image is solved. Only two pixels (first and last) in the whole image are left. These two pixels have to be processed separately.

Proposed Algorithm

Step1. Create a binary image by choosing a suitable threshold value.

If (f(x, y) > threshold value), then

Set f(x, y) =1, otherwise

Set f(x, y) =0

End if

Step2. Find edge pixel in binary image:

2.1 Create a mask, w, with dimensions 2×2.

Set $w(0, 0) = w(1, 1) = 1$

Set $w(1, 0) = w(0, 1) = \times$

2.2 Create an M×N output image, g:

For all pixel coordinates, x and y, do

Set g(x, y) = f(x, y)

End for

2.3 checking for edge pixels

2.3.1 process whole image except first and last pixels

for y = 1 to N-1 do

for x = 1 to M-1 do

If (gray level values of $f(x, y+1)$, $f(x, y)$ and $f(x+1, y+1)$ are equal)

Then, $f(x+1, y)$ is not an edge pixel,

And

Set $g(x, y+1) = 0$

Otherwise, $f(x+1, y)$ is an edge pixel

And

Set $g(x, y + 1) = 1$

End if

End for

End for

2.3.2 process first pixel of the image

if (gray level values of $f(1, 1)$, $f(1, 2)$ and $f(2, 1)$ are equal),

Then $f(1, 1)$ is not an edge pixel,

And

Set $g(1, 1)$=0 otherwise $f(1, 1)$ is an edge pixel

And

Set g(1, 1)=1

End if

2.3.3 process last pixel of the image

if (gray level values of f(M, N), f(M, N-1)and f(M-1, N) are equal)

then f(M, N) is not an edge pixel,

And

Set g(M, N)=1

End if

Step3. Stop

Results and Discussions

First, in order to evaluate the performance of the proposed scheme for edge detection, a standard test image of brain, tiger and finger prints are taken. Global threshold value was calculated for that image using above procedure for calculating suitable threshold value on its edge was detected using proposed procedure. Threshold value for those images of all gray level values lie between 0 and 1 when image in normalized form. The result of edge detection has been observed that the proposed method for edge detection works well.In order to validate the results about the performance of proposed scheme for edge detection; seven different test images are considered. Global threshold values calculated by the threshold evaluation procedure for different test images are given in table. The results of edge detections for these test images are shown. From the results; it has again been observed that the performance of the proposed edge detection scheme is found to be satisfactory for all the test images.

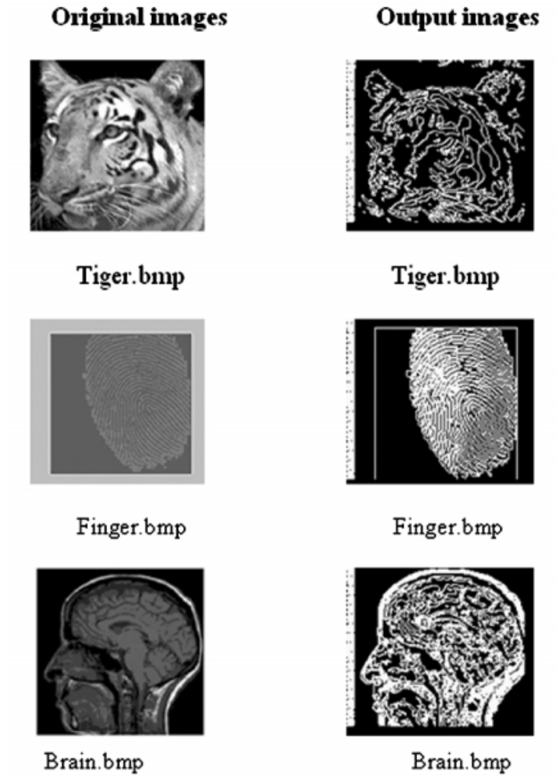

Table
Threshold Values for Different Standard Images.

S.No	*Image*	*Threshold value*
1	Tiger	0.075830
2	Finger print	0.083817
3	Skull	0.040524

2. CONCLUSIONS

In our proposed method, an attempt is made to develop as a new technique for edge detection. Experimental results have demonstrated that the proposed scheme for edge detection works satisfactorily for different gray level digital images. The theoretical principles and systematic development of the algorithm for the proposed versatile edge detector is described in detail. The technique has potential future in the field of digital image processing. The work is under further progress to examine the performance of the proposed edge detector for different gray level images affected with different kinds of noise.

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