# " A Hybrid approach for Image Segmentation "

# " الية مهجنة لتقطيع الصور "

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## Abstract

This research presents an improved approach for segmentation by using the relationship between pixels which are similar and discontinuous**.**

In similarity relation ,Thresholding segmentation approach is used by finding a good threshold level .Then merging and splitting the pixels of image according to this threshold value. Then Merging the pixels that are grater or equal to the threshold value in gray level and splitting the pixels that are less than threshold value by making the value of these pixels zero so the object will be segmented.

In discontinuity relation ,edge deduction is used by splitting the object using sobel operator and merging the lines by using Hough transform**.** The image in result will be binary image representing the object that was separated from its back ground**.**

Finally the resultant image is an image contains the objects that has the high brightness in similarity thresholding segmentation, but in discontinuity the resulting image is objects contain high frequencies mean that the objects have many edges.

Simply it is known that the background has few edges and at many times contains low frequencies so the object here will be segmented by Hough transform segmentation, and also the object that have more brightness will be segmented from the background especially when the background is less brightness.

This research is very useful to construct a medicine application applied on MRI ( Magnetic Resonance Imaging ) used to recognize any tumors,….etc.

this research is programmed using Visual Basic 6 and shows a good results.

**الملخص**

في البحث الموسوم "الية مهجنة لتقطيع الصور" والذي يعتمد على اساس العلاقات بين النقاط المكونة للصورة .وهذا الاساس يعتمد اما على اساس التشابه بين النقاط او على اساس الاختلاف بين النقط.

اساس التشابه تم باستخدام طريقة العتبة المختارة فيتم تقسيم وربط النقاط اعتمادا على مبدا العتبة يتم ربط النقاط التي هي اكبر من قيمة عتبة المستوى الرمادي والتقسيم على اساس قيم الاقل من العتبة المستوى الرمادي و تحويلها الى قيم صفرية فلذلك سينفصل الشكل او الكائن .

اساس الاختلاف يعتمد على تحديد و اكتشاف الكائن باستخدام محدد النقاطsobel وربط النقاط والخطوط باستخدام Hough Transformفالصورة الناتجة binary image تمثل الكائن الواحد و ستقسم وتفصل عن الخلفية.

اخيرا النتائج هي صور تحتوي على كائنات منفصلة و متقطعة مفصولة عن الخلفية و الكائنات تحتوي على الاضاءة الاعلى تقطع في اساس التشابه , والكائن الذي يحتوي على ترددات اعلى سيفصل في اساس الاختلاف.

ببساطه من المعروف بان الخلفية تحتوي على تفاصيل وحدود اقل و ترددات اقل لهذا سيتم فصل الكائنات باستخدام hough transform وكذلك الكائن الحاوي على لضاءة اعلى ايضا يمكن فصله بسهولة عن الاضاءة الاقل و هي الخلفية .

يمكن الاستفادة من هذا البحث في التطبيقات الطبية الخاصة ببرمجة الجهاز المعروف بالرنين المغناطيسي (MRI ) .

تمت البرمجة باستخدام الفيجوال بيسك 6 و اظهر التطبيق نتائج جيدة.

## 1. INTRODUCTION

Digital images and digital videos are, respectively, pictures and movies that have been converted into a computer-readable binary format consisting of logical 0's and 1's. Usually, by an image we mean a still picture that does not change with time, whereas a video evolves with time and generally contains moving and/or changing objects. [1]

One aspect of image processing that makes it such an interesting topic of study is the amazing diversity of applications that use image processing or analysis technique. Virtually every branch of science has sub disciplines that use recording devices or sensors to collect image data from the universe around us.[1]

Mathematically, an image is a two-dimensional light intensity function f (x, y), where f, is the brightness value or gray-level at a point ( x, y ). When both x, y and f are discretized, we get a digital image. The elements of the array are called pixels.[2]

## 2. Image Enhancement

The main objective of enhancement technique is to process an image so the result is more suitable than original image for a specific application. Spatial filter is typically done for noise removal or to perform some type of image enhancement.

These operators are called spatial filters to distinguish them from frequency domain.

The spatial filters are:

1. **Mean**: Adds a "softer" look to an image.
2. **Median:** This median value is used to smoothen the noise with the background.
3. **Enhancement:** Highlight edges and details within the image.[8]
4. **sharpening** : the principal objective of sharpening is to highlight fine detail in an image or to enhance detail that has been blurred. Uses of image sharpening vary and include applications ranging from electronic printing and medical imaging to industrial checkup and independent management in military systems. Table1 shows the sharping masks that had been used in the research. [5]

| | | |
|---|---|---|
| **0** | **-1** | **0** |
| **-1** | **5** | **-1** |
| **0** | **-1** | **0** |

A

| | | |
|---|---|---|
| **-1** | **-1** | **-1** |
| **-1** | **9** | **-1** |
| **-1** | **-1** | **-1** |

B

Table 1 A and B the sharping masks

## 3. Image Segmentation

Image segmentation is an important aspect of digital image processing. It basically aims at dividing an image into sub parts based on certain feature. Features could be based on certain boundaries, contour, color, intensity or texture pattern, geometric shape or any other pattern. It provides an easier way to analyze and represent an image. In all segmentation is a process of assigning a label to pixels pertaining similar characteristics.[2]

Segmentation also refers to the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. 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.
Full segmentation: Individual objects are separated from the background and given individual ID numbers (labels). Partial segmentation: The amount of data is reduced (usually by separating objects from background) to speed up further processing, Image is divided into separate regions that are homogeneous with respect to a chosen property such as brightness, color, reflectivity, texture,…, etc. [11]
Segmentation is often the most difficult problem to solve in image analysis. 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 are similar with respect to some characteristics or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic.[4][6]

**3.1 Types of segmentation**

There are Four types of segmentation as follow:
1) Thresholding: Based on pixel intensities, often using the shape of the histogram for automation.
2) Region-based Group similar pixels: region growing, merge & split.
3) Edge-based: Search for discontinuities in the image, and try to connect objects or borders.
4) Match-based : Comparison to a template.

**a. Segmentation Based On Two Basic Properties Of Intensity Values**

There are two basic properties of intensity values such as follows:
1. ***Similarity:*** using the techniques Thresholding, region growing, split and merge.
2. ***Discontinuity***: using edges detection operations.

**1. Similarity Segmentation**- Thresholding
as threshold T for pixel intensity classifies every pixel as belonging to
objects (foreground) or background.
- Fixed thresholds: the same value is used in all images.
-Optimal thresholding: based on the shape of the current image histogram. Search for valleys, Gaussian distributions etc.
-Local or dynamic thresholding : The image is divided into overlapping sections which are thresholded one by one.
Lighting conditions are extremely important, and it will only work under very controlled circumstances. [4]
A thresholded image g(x, y) is defined as:

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

where 1 is object and 0 is background[5]

**2. Discontinuity Segmentation :Edge-based**

It based on the idea that edge information in an image is found by looking at the relationship a pixel has with its neighbors. if a pixel's gray level value is similar to those around it there is probably not edge at that point. However, if a pixel has neighbors with widely varying gray levels, it may represent an edge point. In other words, an edge is defined by a discontinuity in gray-levels values. Ideally, an edge separates two distinct objects. in practice, apparent edges are caused by changing in color or texture or by the specific lighting conditions presents during the image acquisition process.
Edge detections is also used to found complex object boundaries by marking potential edge points corresponding to places in an image where rapid changes in brightness occur. After these edge point have been marked, they can be merged to form a line and object outlines.

The Sobel edge detection is used in this research where it's masks look for edges for both horizontal and vertical directions and then combine this information into a single metric,Table2 shows both horizontal and vertical masks for Sobel edge detection operation.

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

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

a. Horizontal Mask b. Vertical Mask

Table2 The Sobel masks

These masks are each convolved with the image. At each pixel location we now have two numbers: $s_1$ corresponding to the result from the row mask, and $s_2$ from the column mask. these magnitude will be use to compute two metrics, the edge magnitude, and the edge directions which are defined as follows:

Edge magnitude is $\sqrt{{s_1}^2 + {s_2}^2}$, and Edge direction is $\tan^{-1}\left[\frac{s_1}{s_2}\right]$

The edge detection is perpendicular to the edge itself because the direction specified in the direction of the gradient, along which the gray levels are changing.[6]

One powerful global method for detecting edges is called the Hough Transform. Let us suppose that we are looking for straight lines in an image. If we take a point (*x*', *y*') in the image, all lines which pass through that pixel have the form y'=m x +c [13]

Represent all edge points (xi, yi ) as lines in a and b parameter space from equation for straight line y=ax +b.

Look for points a, b were many lines meet = edge points from a line.

Divide parameter space into accumulator cells.[4]

To detect straight lines in an image, we do:

1. Quantize (m, c) space into a two-dimensional array *A* for appropriate steps of *m* and *c*.
2. Initialize all elements of *A*(m, c) to zero.
3. For each pixel (*x*', *y*') which lies on some edges in the image, we add 1 to all elements of *A*(*m*, *c*) whose indices *m* and *c* satisfy *y*'=*mx*'+*c*.
4. Search for elements of *A*(*m*, *c*) which have large values -- Each one found corresponds to a line in the original image.[12]

One useful property of the Hough Transform is that the pixels which lie on the line need not all be contiguous.

For example, all of the pixels lying on the two dotted lines in Fig.2 will be recognized as lying on the same straight line. This can be very useful when trying to detect lines with short breaks in them due to noise, or when objects are partially occluded as shown in Figure 1.

On the other hand, it can also give misleading results when objects happen to be aligned by chance, as Indeed, this clearly shows that one disadvantage of the Hough Transform method is that it gives an infinite line as expressed by the pair of m and c values, rather than a finite with two well-defined endpoints.

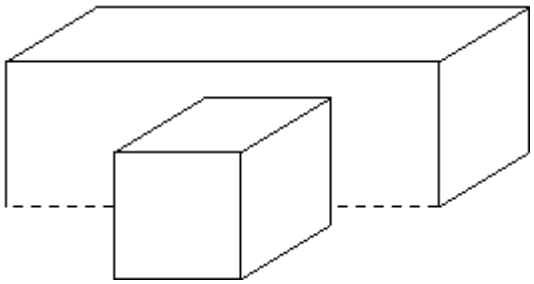

Figure 1 partial occluded objects

## 4. PRACTICAL ISSUES

The practical work is composed of six stages:

1. image acquisition.
2. Read image data.
3. Preprocessing.
4. Segmentation.
5. Post processing.
6. Result.

In this research the working based on the properties of intensity values, which are

***-Similarity****:* Thresholding, split and merge
(combine between threshold and split and merge)

***-Discontinuity*****:** Hough transform.

**Project Over view:**

As mentioned this research is consist of six steps .These steps will discussed in detail.

### A. Image Acquisition:

Our project Work on Binary Bitmap images ( BMP) because it's value is natural and easy in work, Then take the header of this image and put it in binary file to take the height and width of the image, its very efficient on work than scale ( width and height ) of picture box specialty when the image smaller than the picture box.Figure2 shows the original image that the work start with.


Figure 2 BMP image

So here the width of this image is 204 and height is 276 but the picture scale width is 249 and scale height is 321 ,here we can see the difference between both by using image information we can work just on its width and its height.

**B -Image Enhancement ( Preprocessing ):**

**B.1 Preprocessing On Image That Segmented By Using The Discontinuity Relation:**

Sharping filter is used in discontinuity segmentation to produce the edges and remove the detail of image because image sharpening is working on high frequency of image, and the edge is the high frequency. Image discontinuity is working by edge deduction then edge linking so we have to produce the edges. Image enhancement is used as preprocessing and post processing. Figure3 shows the image after applying Sharping filter.


Figure3 Image after Applying Sharp Filter.

As we can see the difference between the original image sharp image with high frequencies pixels that found on edges.

We need sharp because when we work on discontinuity relation between pixels because the first step to split the object is edge deduction and this process is work on edges so we have to produce the edges.

**B.2 Preprocessing On Image That Segmented By Using The Similarity Relation:**

Smoothing filter will used in this method because we want to work on the detail of the image not it's edges. So mean filter is used in this method to remove the edges and produce the detail. The details of an image are important in this method because we have to produce the brightness.

Figure 4 shown an original image and the smoothen image, The difference between the original image and the smoothing image is that the smoothing image is blurred and more detail.

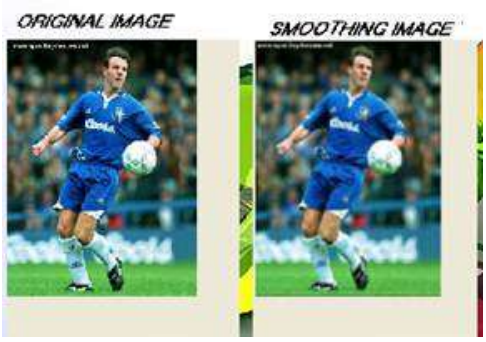


Figure 4 Image after applying Smooth filter

**C -Image on Gray Scale:**

on both method of segmentation(similarity and discontinuity), converting the image into Gray Scale Representation because the Gray image is easy to work on its pixels value and our project depend on brightness of the object, so it can be very clearly to work on gray images than color image.

**D -image segmentation :**

In this step, implement two algorithms in our project the first one is Hough transform algorithm (use discontinuity relation), and the other is thresholding algorithm(use similarity relation).

**D. 1-Segmentation By Hough Transform Algorithm:**

In this algorithm, it is necessary to detect the edges then linking the edges. edge detection is applied by using sobel equation the edges will be detected of the original image to split the object as we will see in Figure5.

edge linking is applied by Hough transform this algorithm is used to link the edges that results from sobel operator.

Figure 5 shows the original image and the image segmented by Hough transform.

**D. 2 Segmentation By Using Thresholding Algorithm:**

In this algorithm, first finding the threshold value and then segment the object depending on this value the result will be image that has the high or equal to brightness of the threshold value on this step we could draw the binary image resulting of threshold and also we could draw the gray pixel itself and then found each pixel, the color of it meaning that we draw the color brightness object, as shown in Figure 6.

Figure 6 shows the original image and the binary result image from the threshold algorithm then the gray pixel itself and the color image resulting from

We find that the threshold value of this image is 97 and it will change with another image depending on the brightness degree of this image.
The binary resultant image produces parts of the object that will be more bright than others, this image called binary image because the pixel that has value is grater or equal to the threshold value, it will take the value (255) and the pixels that have less than the threshold value will be (0) mean that it produces the object that has more brightness, also do it on the third result gray image but with difference that the pixel that have grater or equal the threshold value will store in a matrix that contain the pixels of the object and that less than threshold value is stored in another array as the background pixels, and so on the color result image with different that we will draw the red, green and blue for brightness image.

**E. Image Enhancement ( Post Processing ) :**

In this step enhance the image resulting from segmentation know we ask our self how we will do that the answer is when the resulting image is contain only high frequencies so we will apply smooth enhance process on it and on the low frequencies image we will apply sharp on it.

On the research when Hough transform segmentation is applied so the resulting image is high frequency image so we will apply smoothing enhance process by using mean filter, and on threshold segmentation the result image is low frequencies image so we will apply sharpening enhancement on the resulting image.

**E.1 Post Processing On Resulting Image From Hough Transform Segmentation Algorithm:**

In this step apply smoothing on the resulting image to remove the high frequencies and produce the detail of the image. the result image we can see that the image contain more detail.

**E.2 Post Processing On Resulting Image From Thresholding Segmentation Algorithm:**

In this step apply sharpening on the resulting image to remove the low frequencies pixels and produce the edges of the image. after applying sharp filter on the result image we can see that the image contain more edges, as shown in figure 7.

Figure 7 shows the resulting image after color thresholding anf after post processing.

## 5. Conclusion:

At the end, we can Say that the segmentation is part of image understanding , mean that the image is partitioned into objects and their background these objects can be split from their background depending on any segmentation base such as brightness, color, texture, or other segmentation base type.

By using two different methods for segmentation, first is depend on discontinuity relation between neighbors' pixels and this method is split the edges of the object from its background then the result is objects that have high frequency pixels, we know that the background edges is less than its objects so Hough transform algorithm is split the objects from their background depending on the edges of the image, this is one method for segment.

The second method is to split the objects depending on the brightness of the image so The resulting image that segmented is the brightness parts of the images, this technique can be useful in medical devices such as the devices that connect to the MRI (Magnetic Resonance Imaging ) scan that convert the signal into digital image the converting process is depending on segmentation process such as the brightness of the pixels, in medical each bright degree of pixel meaning something ,so here we can make to the image detection.

**FUTURE WORK**

1.we can include frequency transformation such as Fourier, wavelet transformation.

2. Using another type of segmentation such as clustering,…etc.

3.Use another base on segmentation such as texture, color,...etc.

4.Use segmentation in image recognition or other application.

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