

# Study of Different approaches of Thresholding methods for Segmentation in Digital Image Processing

Yogesh Kumar  
Lecturer (Computer Science & Engg.)  
Govt. Woman Polytechnic College, Jaipur

**Abstract** — In image segmentation, an image is divided into different structures. Image segmentation is a very important step in the field of image analysis, visualization, representation and many more fields. In the image segmentation thresholding technique is the basic method which is used for the segmentation.

**Keywords**-.segmentation, image, processing, thresholding

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## 1. INTRODUCTION

Image segmentation is an important part in the division of an image into the different parts or categories. In the image segmentation, each pixel of the image is allocated a number of the region or category. In the good quality of segmentation, each pixel of the same region or category has same greyscale of variable values and the adjacent pixels, which are in different regions has different values.

Segmentation is a significant step in the image analysis. If segmentation is done according to the well manner, then all the stages of the image are made very simple. But if we used automatic segmentation algorithms then we get only partial success. Though manual involvement we can overcome this problem. Mainly there are three steps to segmentation, i.e. thresholding, edge-based methods and region-based methods.

In the first method, which is **thresholding**, each pixel is allocated to a region to the complete range of the values in which pixel lies. In the figure 1 some boundaries, that are obtained by the thresholding of the muscle fibers image. Some pixels that have values less than 128 are placed in one category, and others are placed in the different region. The boundaries between the neighboring pixels in the different categories are superimposed in the white on the original image. We can see that the threshold is successfully segmented in the image into the two major fiber types. [2]

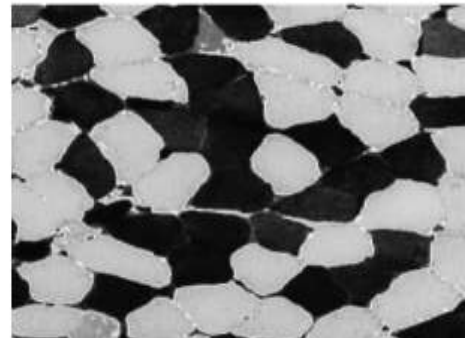


Figure 1: Boundaries that are produced by the three segmentations of the muscle fibers image by thresholding

In the second method which is **edge-based segmentation**, an edge filter is used, which is applied to the image. In the image, pixels are classified as the edge or non-edge, depends upon the output of the filter. Pixels, which are not divided by the edge, are allocated to the same category.

Figure 2 defines the boundaries of the connected areas after applying Prewitt's filter and it also shows eliminating of the non-border segments, which contain less than 500 pixels. [2]

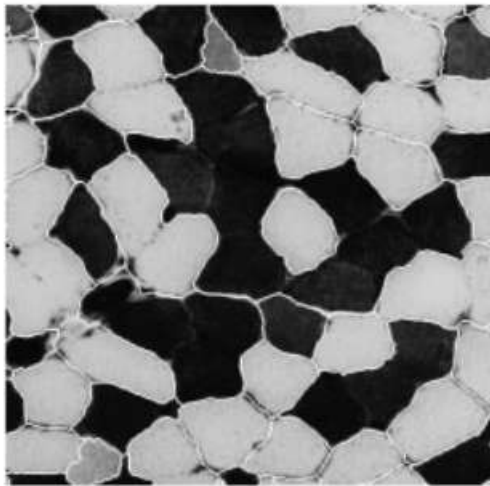


Figure 2: Boundaries that produced by three segmentations of the muscle fibers image: connected regions after the thresholding of the output of Prewitt's edge filter and removing small areas

The other third method is **Region-based segmentation** algorithms, in which neighboring pixels are grouped together and also they have similar values and splitting the groups, which are dissimilar in the value. Figure 3 describe the boundaries that are produced by the algorithms, that is based on the watersheds concept. [2]

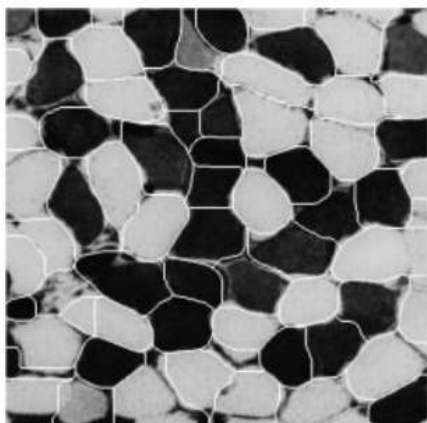


Figure 3: : Boundaries produced by three segmentations of the muscle fibers image: result produced by watershed algorithm [2].

## 2. THRESHOLDING METHOD FOR THE IMAGE SEGMENTATION

Thresholding method is the main step in the segmentation process. It is the first step in the any segmentation process. In past decades we have seen a great range of the different variety of segmentation method. So categorization of these method is important.

Single value thresholding is describes mathematically as follows:

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

Converting of a greyscale input image into a bi-level image is called Thresholding process. In thresholding process converting of the greyscale input image into a bi-level image is done by the help of optimal threshold. [5]

The main purpose of performing the thresholding process is take out the pixels that shows any object, which can be text, maps, graphs etc. In thresholding process the binarization object is a pixel that belongs to the regions with the strengths and the background regions with dissimilar intensities. [5]

## 3. HISTOGRAM-BASED THRESHOLDING

For the Histogram based Thresholding a simple algorithm is proposed , which is specified as:-

1. First of all  $t$  is set equal to the median pixel value, that is:

$$\sum_{k=0}^t h_k \geq \frac{n^2}{2} > \sum_{k=0}^{t-1} h_k,$$

Where  $n^2$  is the number of pixels in the  $n \times n$  image.

2. After that calculate the mean pixel value in each region for the values that are less than or equal to  $t$ :

$$\mu_1 = \frac{\sum_{k=0}^t k h_k}{\sum_{k=0}^t h_k}.$$

While, for the values that are greater than  $t$ , is given by:

$$\mu_2 = \frac{\sum_{k=t+1}^N k h_k}{\sum_{k=t+1}^N h_k}.$$

3. After that we will re-estimate the value of  $t$  as the half-way between the two means:

$$t = \left\lfloor \frac{\mu_1 + \mu_2}{2} \right\rfloor,$$

Where the values between the brackets denote integer part of the expression.

4. Follow the steps (2) and (3) again and again until the value of ' $t$ ' stops changing the value between the successive evaluations.

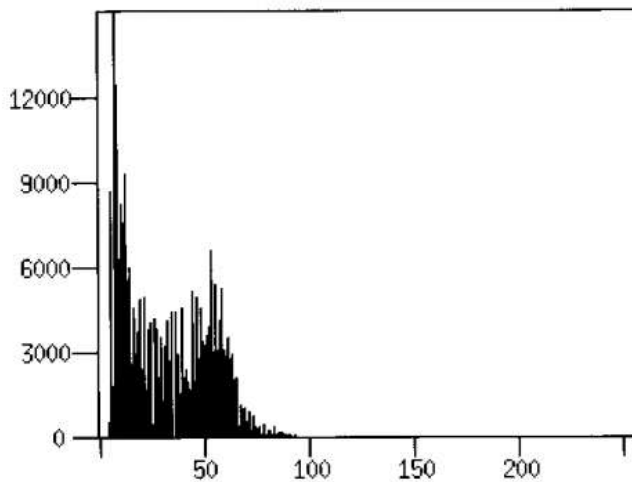


Figure 4: Histogram of soil image.

## 5. THRESHOLDING ALGORITHMS

We used mainly two types of thresholding algorithms: First one is Global thresholding algorithms and the other one is Local or adaptive thresholding algorithms. In the Global thresholding, a single threshold value is used for the all image pixels. In local or adaptive thresholding, different threshold values are used for the different-different local regions.

### Basic Global Thresholding:

In the Basic global thresholding techniques, separation is done by a single global threshold  $T$ . segmentation is done by scanning the image. Scanning is done pixel by pixel. After that labelling of the pixel as the object is done, that depends upon the value of the grey level, whether it greater or less than the value of the  $T$ .

Algorithm:

The following algorithm is used to obtain the initial value of threshold  $T$ :

1. First choose the initial estimate value for  $T$ .
  2. After that divide the histogram value using  $T$ , which produces two groups of pixels:
    - $G_1$  – is set of all the pixels with grey level values  $>T$ .
    - $G$  – is set of all the pixels with values  $\leq T$ .
  3. After that calculate the average grey level values  $m_1$  and  $m$  that is for the pixels in regions  $G_1$  and  $G_2$ .
  4. After that calculate a new threshold value that is:  

$$T = 1/2(m_1 + m_2)$$
- Repeat the process from the step 2 to 4 until the difference in  $T$  in the consecutive iterations is smaller than the predefined parameter  $T_0$ .

### Basic Adaptive Thresholding:

In the global thresholding, single value thresholding will be not effective when an image is divided into sub images individually. For overcoming this situation original image is divided into sub images and then exploit a different threshold value for segmentation each sub image. For efficient working we concentrate on the approach of subdivide the image and estimation of the threshold value for the resultant sub image. In this method the threshold value depends upon the position of the pixel value.

## 6. OPTIMAL THRESHOLDING

In optimal thresholding the process is based on the estimation of the histogram of an image and the sum of the two probability densities with the normal distribution that represents a different method that is called optimal thresholding. The threshold value is set to the closest value of grey level, which tends to minimum probability between the values of maxima of two normal distributions by which we get segmentation with minimum error.

## 7. PIXEL-LEVEL THRESHOLDING PROCESS

It is the pixel level thresholding in which a face with an image is scanned in to the computer.

Thresholding is a process of determining the pixel position whether it is black or white. It is supposed at some level as grey. Such a planning can be tricked by the inverse-color printing.

For the two level images we can either write our own thresholding program or we can directly use a gray-scale. This approach is far most costly than the binary bitmap approach, but it seems reasonable to the trade-off some low-resolution grey-scale for the high-resolution 2-level images.

## 8. CONCLUSION

Separation of an image into the different categories tends to the objects is called segmentation. Thresholding is the far better method for the separation of some light & dark areas or regions. The intensity value will be differ in different areas or regions and in each region it represent the object in a particular picture. [4]

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