Binarization Techniques used for Grey Scale Images

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ABSTARCT
Image binarization is important step in the OCR (Optical Character Recognition). There are several methods used for image binarization recently, but there is no way to select single or best method which is used for all images. The main objective of this paper is to present the study on various existing binarization algorithms and compared their measurements.
This paper will act as guide for fresher's to start their work on binarization.

Keywords:
Binarization, Threshold value, SNR, OCR

1. INTRODUCTION
The Binarization Method converts the grey scale image (0 up to 256 gray levels) in to black and white image (0 or 1). The result of OCR highly depends upon the binarization. The high quality binarized image can give more accuracy in character recognition as compared original image because noise is present in the original image [1]. In fact problem is that which binarization algorithm is appropriate for all images. The selection of most optimal binarization algorithm is difficult, because different binarization algorithm gives different performance on different data sets. This is especially true in the case of historical documents images with variation in contrast and illumination. The algorithms divide into two categories a) Global Binarization b) Local Binarization. The global binarization methods used single threshold value for whole image and the local binarization method where the threshold value calculated locally pixel by pixel or region by region. The figure (a) show the basic block diagram of binarization

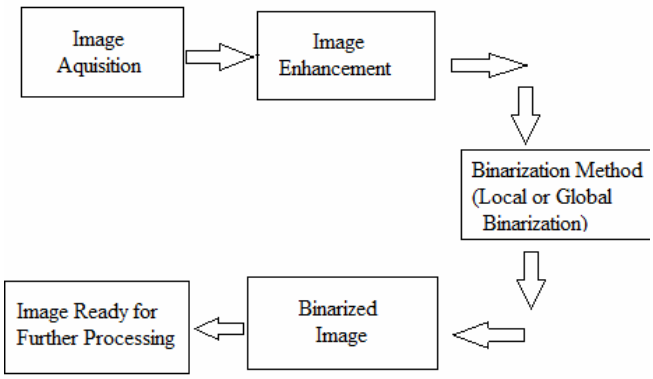

Fig.(a) **Block Diagram of Binarization**

This paper is organized in following sections: Section 2 describes the different binarization methods. Section 3 describes the work done by different researcher. Section 4 presents the conclusion.

2. BINARIZATION METHODS
This section classifies the some important local and global binarization methods that are currently used for binarization. For global binarization we choose:

1) Fixed Thresholding Method
2) Otsu Method
3) Kittler Method

For local binarization we choose:

1) Niblack Method
2) Adaptive Method
3) Sauvola Method
4) Bernsen Method

2.1 Global Methods
2.1.1 Fixed Thresholding Method
In Fixed Thresholding binarization method [2][3][4] fixed threshold value is used to assign 0's and 1's for all pixel positions in a given image. The basic idea for fixed binarization method is described as under.

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

T shows global threshold value. For various threshold values in fixed binarization methods the results are illustrated below.

Original image

THRESHOLD VALUE	OUTPUT
T=108	
T=128	
T=148	
T=160	

TABLE-2.1

As shown in table 2.1, outputs vary as given an input threshold value. From the above table it can be noticed that output at threshold T=160 is better for this image. But T=160 is not optimal threshold value for all the images. So it is very difficult to decide an optimal threshold value for a current input image. To overcome this difficulty we will discuss further more binarization techniques in which optimal threshold value is computed according to input image.

2.1.2 Otsu Binarization Method

In image processing, **Otsu**'s thresholding method is used for automatic binarization level decision, based on the shape of the histogram [5]. Otsu's thresholding method involves iterating through all the possible threshold values and calculating a measure of spread for the pixel levels each side of the threshold, i.e. the pixels that either falls in foreground or background. The aim is to find the threshold value where the sum of foreground and background spreads is at its minimum.

STEPS for Otsu Method

1. Separate the pixels into two clusters according to the threshold.

$q1(t) = \sum_{i=1}^{t} p(i) \quad and \quad q2(t) = \sum_{i=t+1}^{I} p(i)$

P represents the image histogram.

2. Find the mean of each cluster.

$$\mu1(t) = \sum_{j=1}^{t} \frac{ip(i)}{q1(t)} \; and$$

$$\mu2(t) = \sum_{j=t+1}^{I} \frac{ip(i)}{q2(t)}$$

3. Calculate the individual class variance.

$$\sigma_1^2(t) = \sum_{i=1}^{t} [i - \mu1(t)]^2 \; \frac{p(i)}{q1(t)}$$

and

$$\sigma_2^2(t) = \sum_{i=t+1}^{I} [i - \mu2(t)]^2 \; \frac{p(i)}{q2(t)}$$

4. Square the difference between the means.

$$\sigma_b^2(t) = \sigma^2 - \sigma_w^2(t)$$

$$= \; q1(t)[1 - q1(t)] \; [\mu1(t) - \mu2(t)]^2$$

5. Finally, this expression can safely be maximized and the solution is **t** that is maximizing $\sigma_b^2(t)$

2.1.3 Kilter and Illingworth Method

The kilter method [6] is used mixture of Gaussian distribution to find threshold value. In kilter Method the t is threshold that is used to segment the image into two parts background and foreground, both of the parts modelled by Gaussian distribution, $p_B(t)$ and $p_F(t)$, the $p_{mix}(t)$ mixture of these two Gaussian distribution.

$$p_{mix}(t) = \alpha p_B(t) + (1 - \alpha) p_F(t)$$

Where α is determined by the portions of background and foreground in the image.

2.2 Local Methods

2.2.1 Adaptive Binarization Method

Adaptive binarization method [7] is used for local binarization. In this a window of NxN blocks slide over the entire image and threshold value is computed for each local area under the window for binarization. The adaptive method give more accurate result as compared to global binarization in such conditions where the

image effected from bad shading , blurring, low resolution and non uniform illumination. In adaptive binarization any one of the technique like Niblack, Sauvola etc used to compute the local area threshold value.

2.2.2 Niblack Method

In Niblack method [8] the threshold value for the local area under the window is calculated pixel wise. The calculation of the threshold value is depending upon the local mean and standard deviation of window area. The threshold value is finding using following equation.

$$T_{Niblack} = m + k * s$$

$$T_{Niblack} = m + k\sqrt{\frac{1}{NP}\sum(p_i - m)^2}$$

Where m is the mean of local area pixels of an image and s is the standard deviation of local pixel area. The value of k is fixed to -0.2 by the author.

2.2.3 Sauvola Method

The Sauvola algorithm [9] is a modified form of Niblack algorithm. It gives more performance than Niblack under such conditions as light variation on document image, light texture etc. In the Sauvola modification, the binarization is given by:

$$T_{sauvola} = m * (1 - k * \left(1 - \frac{S}{R}\right))$$

Where m is the mean of pixels under window area, S is the dynamic range of variance and the value of k parameter may be in the range of 0-1.

According to [10], the Sauvola method is better than Niblack method when the gray-level images convert to the black n white images. The author fix the k=0.5 and R=128.

2.2.4 Bernsen method

Bernsen is local binarization method which computes the threshold value from the pixel of image [11]. The equation used for calculation of threshold value is given below:

$$T_{Bernsen} = (N_{low} + N_{high})/2$$

Where N_{low} and N_{high} are the grey level values of the window.

3. WORK DONE BY DIFFERENT RESEARCHERS

The lot of work has been done in past years. The Aroop Mukherjee and Soumen Kanrar [12] have done the comparison study between the various algorithms based on Binarization algorithms and propose a methodologies for the validation of Binarization algorithms. In this work they have developed two novel algorithms to determine threshold values for the pixels value of the gray scale image. Chien-Hsing Chou, Wen-Hsiung Lin, Fu Chang [13] has proposed a novel binarization method for document images produced by cameras. The proposed method divides an image into several regions and decides to binaries each region by Otsu method. The decision rules are derived from a learning process that takes training images as input. Tests on images produced under normal and inadequate illumination conditions. Madhuri Latha.G, Chakravarthy.G [14] used Improved Bernsen Algorithm approaches for License Plate Recognition (LPR) applied to the intelligent transportation system. The proposed LPR algorithm consists of three modules: 1) Locating the license plates; 2) Segmenting the characters; and 3) Identifying the license characters. Zhang zhi-yong, song yang [15] has done the binarization of licence plate using Otsu in mat lab. Konstantin's Ntirogiannis, Basils Gatos and and Ioannis Pratikakis [16] addresses a pixel-based binarization evaluation methodology for historical and written/machine-printed document images. In the proposed evaluation scheme, they modified recall and precision evaluation measures using a weighting scheme that diminishes any potential evaluation bias. Yi Wang, Bin Fang and Li-Jun Lan [17] proposed mathematic morphology filter will be used as a low-pass filter to improve the illumination of license plate. To eliminate the impact of illumination, average filter, Gaussian filter and median filter are chosen to filter the plate image respectively. They convert the gray-scale image to binary image by the local threshold obtained from the convolved image with illumination compensation coefficient.

4. CONCLUSION

Global thresholding method is better approach for calculate the threshold values of a grey scale images. But it doesn't give good results for colored image and under intensity illumination. For such kinds of images local thresholding methods can be used like as Sauvola, Niblack etc.

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