A review on various methods of image thresholding

Author :- Er.Nirpjeet kaur
Assistant Professor, Deptt Of Computer Science and Engineering, IET Bhaddal, Ropar
Email-id:-njeet4u@gmail.com Co-

Author :-Er Rajpreet kaur
Assistant Professor, Deptt Of Computer Science and Engineering, BBSBEC Fatehgarh Sahib
Email-id:-rajpreet_j@yahoo.com

Abstract

Recent years have witnessed the rapid growth of degraded images due to the increasing power of Computing and the fast development of Internet. Because of this tremendous increase of quality of degraded images, there is an urgent need of image Content description to facilitate automatic retrieval. Image is described by several low level image features, such as color, texture, shape or the combination of these features. This paper study various thresholding techniques .

Keywords: Thresholding,binarization,threshold value.

I).Introduction

Quite often that old documents are suffering from background damage .These have damaged background for example such as: have varying contrast, smudges, dirty, presence of seeping ink from the other side of the document, uneven background. In order to remove background noise and become more legible, these document images require specialized processing. Thresholding techniques are image segmentations based on image-space regions. The fundamental principle of thresholding techniques is based on the characteristics of the image . It chooses proper thresholds *n T* to divide imagepixels into several classes and separate the objects from background. When there is only a single threshold *T* , any point (*x, y*) for which *f* (*x, y*) *T* is called an object point; and a point (*x, y*) is called a background point if *f* (*x, y*) *T* According to the aforementioned discussion ,thresholding can be viewed as an operation to gain threshold *T* in the following equation:

$T \quad M[x, y, p(x, y), f(x, y)] \quad 1$

In this equation, T stands for the threshold; *f* (*x, y*) is the gray value of point (*x, y*) and *p*(*x, y*) denotes some local property of the point—such as the average gray value of the neighborhood centered on point (*x, y*) . Based on (1),

thresholding techniques can be mainly divided into global, local, and dynamic thresholding techniques.

1) Global thresholding*:* When *T* depends only on *f* (*x, y*) (in other words, only on gray-level values) and the value of *T* solely relates to the character of pixels, this thresholding technique is called global

thresholding technique . There are a number of global thresholding techniques such as: minimum thresholding, Otsu, optimal thresholding, histogram concave analysis, iterative thresholding,entropy-based thresholding, MoM-keeping thresholding and so on.

2) Local thresholding*:* If threshold *T* depends on both *f* (*x, y*) and *p*(*x, y*) , this thresholding is called local thresholding . This method divides an original image into several sub regions, and chooses various thresholds*Ts* for each sub region reasonably. After thresholding, discontinuous gray levels among sub images must be eliminated by gray level filtering technique. Main local thresholding techniques are simple statistical thresholding, 2-D entropy-based thresholding, histogram-transformation thresholding etc.

II) Discussion on various methods of thresholding

1 ***Otsu[6]*** based on the variance of pixel intensity. Otsu's thresholding method 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 fall in foreground or background. It consist of two classes with in class variance and between class variance In Otsu's method we exhaustively search for the threshold that minimizes the intra-class variance, defined as a weighted sum of variances of the two classes:

$$\sigma_w^2(t) = \omega_1(t)\sigma_1^2(t) + \omega_2(t)\sigma_2^2(t)$$

Weights ω_i are the probabilities of the two classes separated by a threshold *t* and σ_i^2 variances of these

classes.

Otsu shows that minimizing the intra-class variance is the same as maximizing inter-class variance:

$$\sigma_b^2(t) = \sigma^2 - \sigma_w^2(t) = \omega_1(t)\omega_2(t)\left[\mu_1(t) - \mu_2(t)\right]^2$$

which is expressed in terms of class probabilities ω_i and class means μ_i which in turn can be updated iteratively. This idea yields an effective algorithm.Algorithm Compute histogram and probabilities of each intensity level

1. Set up initial $\omega_i(0)$ and $\mu_i(0)$
2. Step through all possible thresholds $t = 1 \ldots$ maximum intensity
    1. Update ω_i and μ_i
    2. Compute $\sigma_b^2(t)$
3. Desired threshold corresponds to the maximum

2. ***Bernsen*** calculates local thresholds using neighbours. The method uses a user-provided *contrast threshold*. The *threshold* is set at the midgrey value (the mean of the minimum and maximum grey values in the local window). If the *local contrast* (max-min) is below the *contrast threshold* the neighbourhood is considered to consist only of one class.

if (local_contrast < contrast_threshold)

pixel = (mid_gray >= 128) ? object : background else
pixel = (pixel >= mid_gray) ? object : background

3.Niblack[9] uses local mean and standard deviation and managed to threshold the characters from its background. However, it failed to remove noise from the background. Furthermore, the algorithm is sensitive to the k value. Although with the optimum value of k (-0.1), noise is still visible on the background .

pixel = (pixel > mean + k * standard_deviation) ? object : background

4.Yanowitz and Bruckstein's[10] post processing algorithm was applied to the Niblack's algorithm, worse results were produced on the characters. This is due to the smoothing operation of the mean filter that generates a blurring effect on certain parts of the characters. When the edge operator was applied, edges were detected on the characters. Due to these factors, unwanted white stripes were created on the characters. However, with the mean filter the algorithm managed to remove noise from the background.

5.***Sauvola*** presents a method specialized on document images that applies two algorithms in order to calculate a different threshold for each pixel. Sauvola's algorithm managed to reduce the background noise problem that faced by the Niblack's algorithm. However, the background noise is still visible. Furthermore, the weak strokes of the characters are not properly threshold by the algorithm.The weak noise pixels on the background managed to be eliminated by the Background Subtraction method. Since the threshold value is applied globally, this technique tends to threshold the smaller and darker background pixels

pixel = (pixel > mean * (1 + k *(standard_deviation / r - 1))) ? object : background

6 ***The Yanni and Horne's*** iterative thresholding method produced almost similar results as the Background Subtraction algorithm. For some images with the uneven illumination this technique failed to threshold weak foreground and generated more noise in the backgrounds.

4. Conculsion

In this paper we compare different methods of thresholding .These approaches aiming at removal of background noise from historical and ancient documents. This way, we attempt to combine the advantages of global and local thresholding, that is, better adaptability of various kinds of noise at different areas of the same image based on low computational and time cost.

5. **References**

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