



Otsu based segmetation for Thermal image

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Abstract: Image segmentation is the fundamental approach of digital image processing. Among all the segmentation methods, Otsu method is one of the most successful methods for image Thresholding because of its simple calculation. Otsu is an automatic threshold selection region based segmentation method. Using MATLAB and image processing tool all function performed and simulate the result.

Keywords: Image processing, Otsu algorithm, Segmentation, Thresholding.

I. Introduction

Image processing:

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image [1].

Applications of image processing:

- ❖ Interest in digital image processing methods stems from two principal application areas:
- ✓ Improvement of pictorial information for human interpretation, and
- ✓ Processing of scene data for autonomous machine perception.
- ❖ In the second application area, interest focuses on procedures for extracting from image information in a form suitable for computer processing.

Examples include automatic character recognition, industrial machine vision for product assembly and inspection, military recognizance, automatic processing of fingerprints etc.

Thresholding is an important technique in image segmentation applications. The basic idea of Thresholding is to select an optimal gray-level threshold value for separating objects of interest in an image from the background based on their gray-level distribution. While humans can easily differentiable an object from complex background and image Thresholding is a difficult task to separate them. The gray-level histogram of an image is usually considered as efficient tools for development of image Thresholding algorithms. Thresholding creates binary images from grey-level ones by turning all pixels below some threshold to zero and all pixels about that threshold to one. If $g(x, y)$ is a threshold version of $f(x, y)$ at some global threshold T , it can be defined as,

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

$$\text{if } f(x, y) \geq T = 0, \text{ otherwise}$$

Thresholding operation is defined as:

$$T = M[x, y, p(x, y), f(x, y)].$$

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 this, there are two types of Thresholding methods[1][2].

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.

2) Local Thresholding: If threshold T depends on $f(x, y)$ and $p(x, y)$, this Thresholding is called local Thresholding. This method divides an original image into several sub regions, and chooses various thresholds T for each sub region reasonably [3]. Otsu method is type of global Thresholding in which it depend only gray value of the image. Otsu method was proposed by Scholar Otsu in 1979. Otsu method is global Thresholding selection method, which is widely used because it is simple and effective [4]. The Otsu method requires computing a gray level histogram before running. However, because of the one-dimensional which only consider the gray-level information, it does not give better segmentation result. So, for that two dimensional Otsu algorithms was proposed which works on both gray-level threshold of each pixel as well as its Spatial correlation information within the neighborhood. So Otsu algorithm can obtain satisfactory segmentation results

when it is applied to the noisy images [8]. Many techniques thus were proposed to reduce time spent on computation and still maintain reasonable Thresholding results. In [9], proposed a fast recursive technique that can efficiently reduce computational time. Otsu's method was one of the better threshold selection methods for general real world images with regard to uniformity and shape measures. However, Otsu's method uses an exhaustive search to evaluate the criterion for maximizing the between-class variance. As the number in classes of an image increases, Otsu's method takes too much time to be practical for multilevel threshold selection [10].

II. Otsu method for thresholding

Otsu's method is used to automatically perform clustering-based image Thresholding or, the reduction of a gray level image to a binary image. The algorithm assumes that the image contains two classes of pixels following bi-modal histogram (foreground pixels and background pixels); it then calculates the optimum threshold separating the two classes so that their combined spread (intra-class variance) is minimal [7].

Method:

In Otsu's method we exhaustively search for the threshold that minimizes the intra-class variance (the variance within the class), defined as a weighted sum of variances of the two classes:

$$\sigma_w^2(t) = q_1(t)\sigma_1^2(t) + q_2(t)\sigma_2^2(t)$$

Where the class probabilities are estimated as:

$$q_i(t) = \sum_{i=1}^t P(i)$$

Finally, the individual class variances are:

$$\sigma_1^2(t) = \sum_{i=1}^t [i - \mu_1(t)]^2 \frac{P(i)}{q_1(t)} \quad \sigma_2^2(t) = \sum_{i=t+1}^L [i - \mu_2(t)]^2 \frac{P(i)}{q_2(t)}$$

After some algebra, we can express the total variance as...

$$\sigma^2 = \sigma_w^2(t) + q_1(t)[1 - q_1(t)][\mu_1(t) - \mu_2(t)]^2$$

Advantages:

- ❖ No specific histogram shape assumed.
- ❖ Works well, stable.
- ❖ Extension to multilevel Thresholding possible.
- ❖ For N thresholds and M+1 grey levels, optimization of class separation needs maximum search in a (M + 1)N array

Drawbacks:

- ❖ When optimization function is flat, false maxima may occur.
- ❖ The method tends to artificially enlarge small classes to obtain 'better separation': small classes may be merged and missed.

III. Simulation results:

In MATLAB thermal image is used as input image by **imread** function and can show and write by **imshow** and **imwrite** function using image processing tool

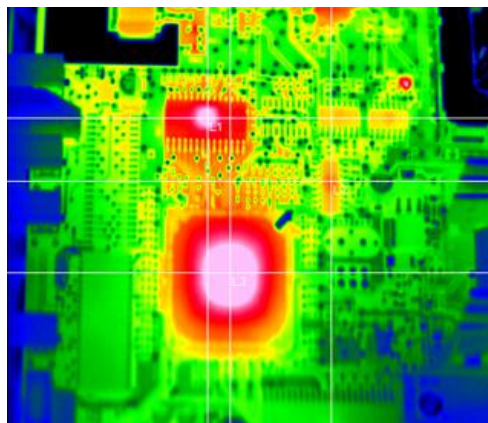


Figure 1 Thermal image

For each image pixel with red, green and blue values of (R, G, B) by below equation we can convert RGB image to grayscale.

$$R' = G' = B' = (R+G+B) / 3 = 0.333R + 0.333G + 0.333B$$

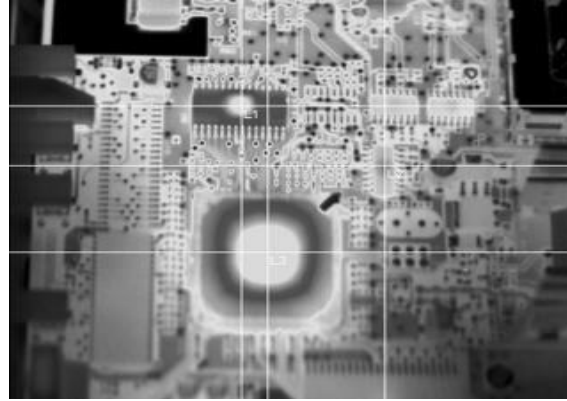


Figure 2 Gray scale image

By otsu Thresholding algorithm gray scale image is convert to Thresholding image as below,

Steps:

1. Compute the normalized histogram of the input image. Denote the components of the histogram by p_i , $i=0, 1, \dots, L-1$.
2. Compute the cumulative sums, $P1(k)$, for $k = 0, 1, \dots, L-1$.
3. Compute the cumulative means, $m(k)$, for $k = 0, 1, \dots, L-1$.
4. Compute the global intensity mean, mG .
5. Compute the between-class variance, for $k = 0, 1, \dots, L-1$.
6. Obtain the Otsu's threshold, k^* .

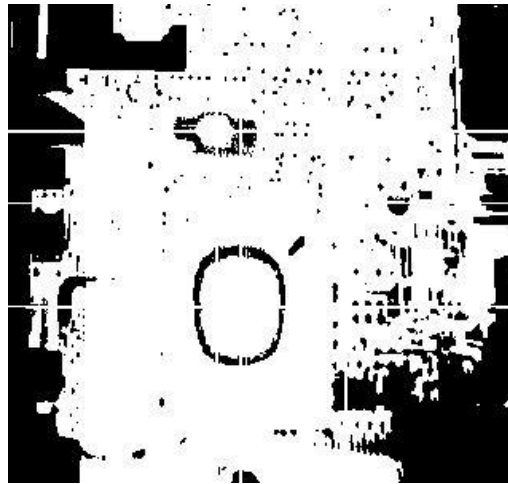


Figure 3 Thresholding image

IV. CONCLUSION

In this paper, the Otsu Thresholding method has been proposed for image segmentation. This method performs better results than the other Thresholding methods and produces suitable binary images, which can be used in further processing stages like fault diagnosis and image analysis. The Otsu method is one of very efficient methods to threshold the gray images. However, its computation would become more complex. The experimental results show that the Otsu threshold method can be obtained easily with a better result of image segmentation.

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