# An Improved Image Segmentation Algorithm Based on Otsu Method

Kritika Sharma, M.E.- 4th sem(Communication),
Shri Shankarcharya Group of Institution, Bhilai, India

Chandrashekhar Kamargaonkar, Associate Professor, Faculty of Engineering,
Shri Shankarcharya Group of Institution, Bhilai, India

Monisha Sharma, PhD,Sr. Associate professor ,Faculty of Engineering,
Shri Shankarcharya Group of Institution, Bhilai, India

## Abstract

Image segmentation is one of the difficult research problems in the machine vision industry and pattern recognition. Thresholding is a simple but effective method to separate objects from the background. A commonly used method the Otsu method to improves the image segmentation effect obviously. It’s simpler and easier to implement. However it fails if the histogram is unimodal or close to unimodal. Under studying the principle of the Otsu method, an improved threshold image segmentation algorithm based on the Otsu method is developed. Because the optical threshold should near the cross where the object and the background intersect, the probability of occurrence at the threshold value should divide into two parts. Its half belongs to object and half belongs to background. Then we apply a new weight to the Otsu method, this weight can make sure that the result threshold value will always reside at the valley of the two peaks or at the bottom rim of a single peak. Moreover, it ensures that both the variance of .the object and the variance of the background keep away from the variance of the whole image.

**Keywords—** image segmentation, Otsu method, threshold, histogram.

## Introduction

In many applications of image processing, the gray levels of pixels belonging to the object are substantially different from the gray levels of the pixels belonging to the background. Thresholding then becomes a simple but effective tool to separate objects from the background. Thresholding technique has been widely used in machine vision Industry and image analysis. Over the years many image thresholding have been developed, the most often used method including: Minimum error thresholding, the Otsu method, Moment-preserving thresholding and so on. More recent studies about this subject can be found inSauvola and Pietikainen [12], and Sahoo [11] and so on. Otsu [10] proposed a dynamic thresholding selection method in 1979. This, in turn, fuelled interest in image-based texture synthesis algorithms. Such an algorithm should be able to take a sample of texture and generate an unlimited amount of image data which, while not exactly like the original, will be perceived by humans to be the same texture. There are however typical functions which are found in many computer vision systems. In image segmentation, the objects range from no defect, small defect, to large defect.

## Image Acquisition

A digital image is produced by one or several image sensors, which, besides various types of light-sensitive cameras, include range sensors, tomography devices, radar, ultra- sonic cameras, etc. Depending on the type of sensor, the resulting image data is an ordinary 2D image, a 3D volume, or an image sequence.

## Pre-processing

Both image enhancement and image segmentation are most practical approaches among virtually all automated image recognition systems. Feature extraction and recognition have numerous applications on telecommunication, weather forecasting, environment exploration and medical diagnosis. Image enhancement and image segmentation are major aspects for most automated image recognition systems. In a variety of areas in science and engineering, there are the increasing demands on novel image processing techniques. Image enhancement is the converting procedure into the better quality images for feature extraction and object recognition.

## Feature extraction

In pattern recognition and in image processing, feature extraction is a special form of dimensionality reduction. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant (much data, but not much information) then the input data will be transformed into a reduced representation set of features (also named features vector). Transforming the input data into the set of features is called features extraction. If the features extracted are carefully chosen it is expected that the features set will extract the relevant information from the input data in order to perform the desired task using this reduced representation instead of the full size input.

## Image Enhancement

We can define image enhancement as away to improve the quality of image, so that the resultant image is better than the original one, the process of improving the quality of a digitally stored image by manipulating the image with MATLAB software. It is quite easy, for example, to make an image lighter or darker, or to increase or decrease contrast. MATLAB also supports many filters for altering images in various waysImage enhancement techniques can be divided into two broad categories:

1. Spatial domain techniques, which operate directly on pixels, and

2. Frequency domain techniques, which operate on the Fourier transform of an image.

## Gabor filter enhancement technique

The Gabor filter [2] was originally introduced by Dennis Gabor, we used it for MRI images[5]. The Gabor function has been recognized as a very useful tool in computer vision and image processing, especially for texture analysis, due to its optimal localization properties in both spatial and frequency domain.

## Gabor filter

A Gabor filter is a linear filter whose impulse response is defined by a harmonic function multiplied by a Gaussian function. Because of the multiplication-convolution property (Convolution theorem), the Fourier transform of a Gabor filter's impulse response is the convolution of the Fourier transform of the harmonic function and the Fourier transform of the Gaussian function.

ISSN: 2278-0181
Vol. 1 Issue 6, August - 2012

Gabor filters are directly related to Gabor wavelets, since they can be designed for number of dilations and rotations. However, in general, expansion is not applied for Gabor wavelets, since this requires computation of biorthogonal wavelets, which may be very time-consuming n.

Gabor filters have been used in many applications, such as texture segmentation, target detection, fractal dimension management, document analysis, edge detection, retina identification, and image coding and image representation. A Gabor filter can be viewed as a sinusoidal plane of particular frequency and orientation, modulated by a Gaussian envelope.

h (x, y) = s(x, y) g(x, y)

s(x, y) : Complex sinusoid

g(x, y) : 2-D Gaussian shaped function, known as envelope

s(x, y) = $e^{-j2\pi(u_0 x+v_0 y)}$

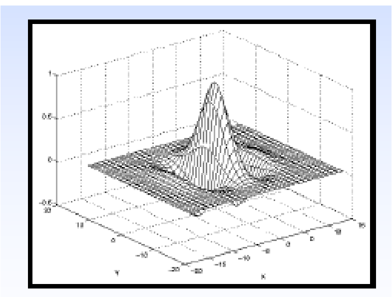
g(x,y)=

$$\frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{1}{2}\left(\frac{x'^2}{\sigma_x^2}+\frac{y'^2}{\sigma_y^2}\right)} \cos\,(2\pi f x')$$

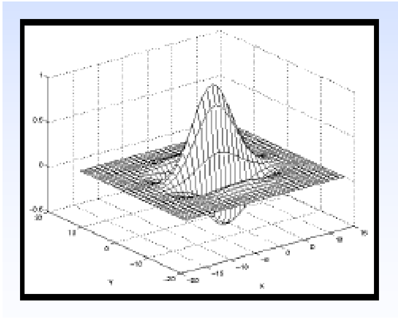
$$x' = x sin\theta + y cos\theta$$

$$y' = x cos\theta - y sin\theta$$

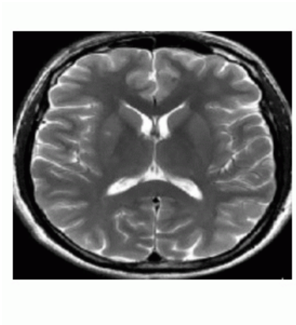
Where f is the frequency of the sinusoidal plane wave at an angle θ with the x-axis, and σx and σy are the standard deviations of the Gaussian envelope along the x and y axes, respectively.



**$0^0$ Orientation filter**



**$45^0$ Orientation filter**
**Fig 1.Gabor Function in the spatial domain**



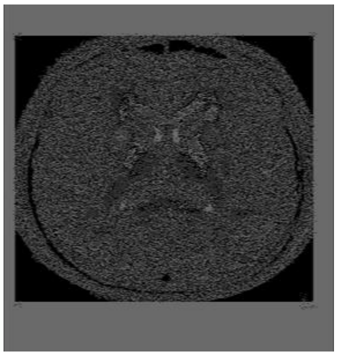


**Fig 2: Original Image** **Fig 3: Enhance by Gabor**

## Image segmentation technique

Segmentation divides an image into its constituent regions or objects. The segmentation of medical images in 2D, slice by slice has many useful applications for the medical professional: visualization and volume estimation of objects of interest, detection of Abnormalities (e.g. tumours, polyps, etc.), tissue quantification and classification, and more.

The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse.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 (edge detection). Each of the pixels in a region is similar with respect to some characteristic or computed property, such as colour, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic.

## Otsu Threshold Method

Otsu's thresholding technique[3] is based on a discriminant analysis which partitions the image into two classes $C_0$ and $C_1$ at gray level t such that $C_0$= {0,1, 2,....,t} and $C_1$= {t+1,t+2,...,L-1} where L is the total number of the gray levels of the image. Let the number of pixels at the $^{ith}$ gray level be $n_{th}$ , and n be the total number of pixels in a given image. The probability of occurrence of gray level i is

defined $$p_i = \frac{n_i}{n}$$

$C_0$ and $C_1$ are normally corresponding to the object of interested and the background, the probabilities of the two classes are w0 & w1

$$w_0 = \sum_{i=0}^{t} p_i \quad , \quad w_1 = \sum_{i=t+1}^{L-1} p_i$$

We used Otsu's method [4] using (gray thresh) function which Compute global image threshold using Otsu's method. Otsu's method is based on threshold selection by statistical criteria. Otsu suggested minimizing the weighted sum of within-class variances of the object and background pixels to establish an optimum threshold. Recall that minimization of within-class variances is equivalent to maximization of between-class variance. This method gives satisfactory results for bimodal histogram images. Threshold value based on this method will be between 0 and 1, after achieve this value we can segment an image based on it .

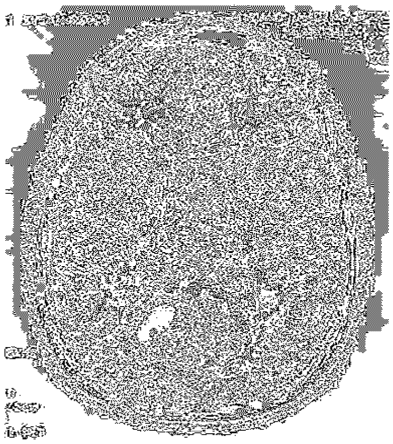


**Fig 4. Segmentation using ostu thresholding**

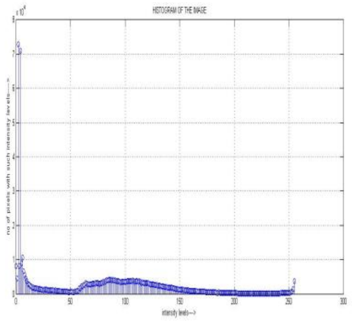
## Histogram and probability function

The dynamic range of the gray levels in an image provides global information on the extent or spread of intensity levels across the image. However the dynamic range does not provide any information on the existence of intermediate gray levels in the image. The histogram of an image provides information of the spread of gray levels over the complete dynamic range of the image across all pixels in the image.

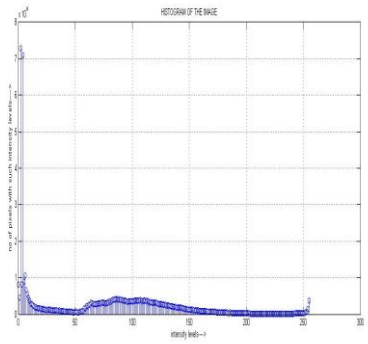
The distribution of gray levels over the full available range is represented by the histogram. The histogram provides quantitative information on the probability of occurrence of each gray level in the image.

The histogram is used to display the brightness of gray level component, showing the occurrence frequency of the pixel counts for each of 256 intensity levels. The occurrence of the gray level component is described as the co-occurrence matrices of relative frequencies. The probability function of gray level image is estimated from its histogram, which is formulated as, where p(k) is the probability distribution function and h(k) is the histogram function. In Figs. 3.4 and Figs. 3.5, the histograms and probability functions of the gray level original and enhanced images via gabor enhancing are plotted. The p(k) acts as the basis to determine quantitative measures[1].

$$p(k) = \frac{h(k)}{\sum h(k)}$$

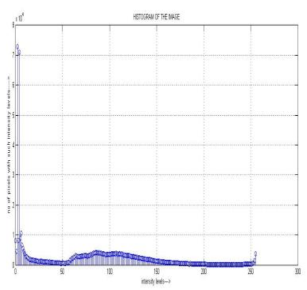


**a. histogram**

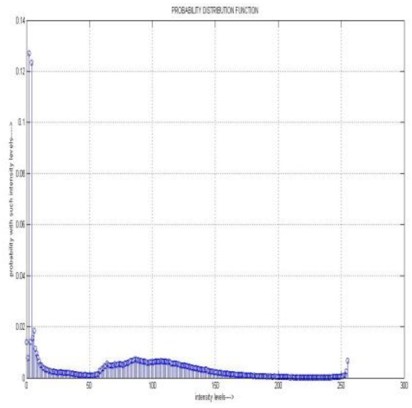


**b. probability function**

**Fig 5. histogram and probability function of original image**



**a. histrogram**



**b. probability function**

**Fig 6. histogram and probability function of enhanced image**

## Histogram and probability distribution function of segmented image

The histogram of an image provides information of the spread of gray levels over the complete dynamic range of the image across all pixels in the image. The histogram is used to display the brightness of gray level component, showing the occurrence frequency of the pixel counts for each of 256 intensity levels. we see that the components of the histogram in this image cover a broad range of the gray scale and it is reasonable to conclude that an image whose pixels tend to occupy the entire range of possible gray levels and, in addition, tend to be distributed uniformly, will have an appearance of high contrast and will exhibit a large variety of gray appearance of high contrast and will exhibit a large variety of gray tones[1].

## Conclusion

The histogram of an image provides information of the spread of gray levels over the complete dynamic range of the image across all pixels in the image. The histogram is used to display the brightness of gray level component, showing the occurrence frequency of the pixel counts for each of 256 intensity levels. we see that the components of the histogram in this image cover a broad range of the gray scale and it is reasonable to conclude that an image whose pixels tend to occupy the entire range of possible gray levels and, in addition, tend to be distributed uniformly, will have an appearance of high contrast and will exhibit a large variety of gray tones. We see that the components of the histogram are concentrated on the low (dark) side of the gray scale. Similarly, the components of the histogram of the bright image are biased toward the high side of the gray scale. In this image pixels are concentrated either at low side and at high sideThe probability function of gray level image is estimated from its histogram. It shows the probability with such intensity level. In this figure probability of higher intensity level and lower intensity level is high means more pixels are there with such intensity level.

## Reference

1] Zhengmao Ye , Habib Mohamadian , Yongmao Ye, " Gray level image processing using contrast enhancement and watershed segmentation with quantitative evaluation" IEEE conference on Digital object identifier ,CBMI 2008

[2] Mohamed, M.M. Abdel-galil, T.K. Salama, M.A. El-Saadany, E.F. Kamel, M. Fenster, A. Downey, D.B. Rizkalla "Prostate cancer diagnosis based on Gabor filter texture segmentation of ultrasound image". IEEE CCECE Canadian Conference on Medical Imaging, Vol. 3, pp. 1485- 1488, 2003.

[3] Liu Jianzhuang, Li Wenqing, "The automatic thresholding of gray-level picture via 2D Otsu method," IEEE International Conference on Circuits and Systems, June 1991 Acta Automatic Sinica, vol. 19, no. 1, pp. 101-105, 1993.

[4] WANG Hongzhi, DONG Ying, "An Improved Image Segmentation Algorithm Based on Otsu Method",proceeding of International Symposium on Photoelectronic Detection and Imaging, Vol. 6625, 66250I, 2008.

[5] Yachun Pang, Yuanzhi Shao, Li Li, "Breast lesion classification on MRI by texture Features", IEEE conference on Digital object identifier ,Information science and engineering (ICISE),2010

[6] Li Ma, Yajing Shan "Integration of Fractal and Grey-level Features for Texture Segmentation" IEEE Transaction on Image Processing, Vol. 5, pp. 3245-3672, 2008.

[7] N.A.Mohamed, M.N.Ahmed, A.Farag "Modified fuzzy c-mean in medical image segmentation" IEEE International Conference on Medical Imaging, Vol. 6, pp. 3429-3432, 1999.

[8] Ewout Vansteenkiste, Alessandro Ledde, Gjenna Stippel, Bruno Huysmans, Paul Govaert, Wilfried Philips "Segmenting Leukomalacia using Textural Information"

[9] H. Lee and R. H. Park, Comments on an optimal threshold scheme for image segmentation, IEEE Trans. Syst. Man Cybern, SMC-20, 741-742, 1990

[10]. J. Z. Liu and W. Q. Li, The Automatic thresholding of gray-level picture via two-dimensional Otsu method, Acta Automatica Si.19, 101-105, 1993

[11]. P. K. Sahoo, S.Soltani, A.K. Wong, and Y. C. Chan, A survey of thresholding techniques, Computer Vision Graphics, and Image Processing, vol.41, pp. 233-260, 1998

[12]. J. Sauvola and M .Pietikainen, Adative document image binarization, Pattern Recognition, vol.33, pp. 225-236,

ISSN: 2278-0181
Vol. 1 Issue 6, August - 2012

2000.

[13]. P.S. Liao, T.S. Chen, and P.C. Chung, A fast algorithm for multilevel thresholding, Journal of Information.

## Author Profile

**Kritika Sharma** is pusrsuing M.E. 4th sem(Communication) from Shri Shankarcharya Group of Institution, Bhilai,India. Her research interests include Digital Image Processing, Secure communication, Cryptography, Stenography, Stegnanalysis, Cryptanalysis, Error Codes.

**Chandrashekhar Kamargaonkar** is an associated professor in the department of Electronic & Communication Engineering at Shri Shankarcharya Group of Institution,.Bhilai India. He is M.E. Coordinator in the Department of Electronic &Communication Engineering at S.S.G.I. Bhilai India.He has more than 9 year experience in teaching. He has received Master Degree (M.E.) in digital electronics from S.S.G.M. College of Engineering, Shegaon India. His current area of research includes Image Processing, Digital Communication, Microcontroller & Embeded System.

**Dr. Monisha Sharma** is an Sr. associated professor in the department of Electronic & Communication Engineering at Shri Shankarcharya Group of Institution, Bhilai,India. She was awarded Ph.D.(Electronics)degree on “Development of Highly Secured Image Encryption algorithm using multi chaotic sequences” from C.SV.T.U., Bhilai on 2010. She has published more than 46 papers in national/ international journals/conferences. She Awarded as Chhattisgarh Young Scientist Award in 2008 for “Generation of secured image for Telemetry using Adaptive Genetic Algorithm” by C.G council of science and Technology Her research interests include Digital Image Processing, Secure communication, Cryptography, Stenography, Stegnanalysis, Cryptanalysis, Error code.