

## The Effect of Window Size Changing on Satellite Image Segmentation Using 2D Fast Otsu Method

T. A. Naji

Department of Physics, College of Education Ibn-Al-Haithem, University of Baghdad

Received in: 17June 2011, Accepted in: 20September 2011

### Abstract

Multispectral remote sensing image segmentation can be achieved using a multithresholding technique. This paper studies the effect of changing the window size of the two dimensional (2D) fast Otsu algorithm that presented by Zhang. From the results, it shown that this method behaves as a search machine for the valleys (an automatic threshold), between the gray levels of the histogram with changing the size of slide window.

**Keywords** Image Segmentation, (2D) Fast Otsu method, Multithresholding Automatic thresholding (2D) histogram image.

### Introduction

Image segmentation plays an important role in image analysis and computer vision system, this is the process for subdividing an image into the homogeneous regions. Among all segmentation techniques, the automatic thresholding methods are widely used tools for image segmentation as a preprocessing step, because of their advantages of simple implement and time saving. Otsu's method is one of thresholding methods and frequently used in various field. This is used to automatically perform histogram shape-based image thresholding, or the reduction of a gray level image to a binary image. Two dimensional (2D) Otsu method behaves well in segmentation images of low signal to noise ratio than one dimensional (1D), but it gives satisfactory results only when the numbers of pixel in each class are close to each other [1, 2, 3, and 4].

This paper studies the effect of changing the slide window size of the (2D) fast Otsu algorithm, for image segmentation based on the value of central gray level of the highest frequency on the (2D) histogram image of the slide window selection. The changing of slide window size is set manually by the user and it depends on the content of the images.

### Samples of Test Scenes

Three available scenes for different Iraq's regions (shown in fig(3a, 5a, 6a)) which comprise 581.7 km<sup>2</sup>, have been chosen and used for testing the introduced segmentation algorithm; these are:

- **Al Ramadi**: located in Al-Anbar provenience west of Baghdad. The available scene was TM exposure at March 04, 1990. This region lies between latitudes. 33° 27' 21.44" N to 33° 14' 14.05" N, and longitudes 43° 29' 17.91" E to 43° 44' 36.64" E. This region represents Alluvial Plain; the hot desert climate prevails in the sedimentary plain and the western plateau. It contains some vegetation cover, many soil and rock erosion noticed.

No.	1	Vol.	25	Year	2012	2012	السنة	25	المجلد	1	العدد
-----	---	------	----	------	------	------	-------	----	--------	---	-------

- **Al Razzazah**: located between Karbala and Ramadi proveniences. This region lies between latitudes.  $32^{\circ} 47' 59.07''$  N to  $32^{\circ} 34' 49.06''$  N, and longitudes  $43^{\circ} 47' 58.44''$  E to  $44^{\circ} 3' 4.22''$  E. The scene (TM taken at 1987) represents Alluvial Plain.
- **Al Fit'ha**: situated north Salah al- Den province. This region lies between latitudes  $35^{\circ} 20' 26.29''$  N to  $35^{\circ} 6' 45.46''$ , and longitudes  $43^{\circ} 18' 38.39''$  E to  $43^{\circ} 35' 9.45''$  E. The general features are the merge of the lower-Zab with the Tigris Rivers, and vegetation cover can be detected. This image was ETM+ exposure at March 19, 2002.

The map location of these scenes was shown in fig (1).

## Algorithm

To study the effect of window size changing using (2D) fast Otsu method, the following steps can be performed:

- 1) Applying the (2D) fast Otsu method on the test images using different sizes for the slide windows.
- 2) In each slide window, two variables are computed; the central gray level (GL) of the slide window and the slide window local mean for the highest frequency in the (2D) histogram image.
- 3) Plot between the computed central gray level from step (2), and window size.
- 4) Find the flat area from the curve, because it represents the optimum threshold value (valley).

## Experimental Results

In order to study the influence of increasing size of slide window of the (2D) fast Otsu algorithm that presented by Zhang. Three different regions of Iraq are used which has the (827×866) pixel with (256) gray level intensities, the choice of these study area was influenced by the variety of spatial and ecological land. This study was performed using 64-bit computer platform of core 2 Due 2.2GHz processor and MATLAB Ver. 2009a language.

The new histogram had counted using slide window with two variables which are the central gray level (GL), and local mean of the slide window, as a (2D) histogram image. This (2D) histogram used to the extension of the Otsu threshold algorithm possibility. The highest frequency on (2D) histogram image of the slide window which represent the possible split point (threshold value) of the central gray level. For example, fig. (2) illustrates the (2D) histogram via (3D) feature space plot with window size (50×50) pixel, the maximum peak at central gray level and local mean are 120, 114 respectively, where the (x-axis) and (y-axis) represent the central gray level (GL) of the slide window, and the slide window local mean respectively.

The increasing of window size is started from less value as 5 to higher value as 400. When the small window size has been chosen (as 5, 15, and 25), the small difference between the central gray level (GL) and local mean of the slide window have been obtained.

This is due to the small window size mean small land coverage which mean less land features and more homogeneously in the slide window, and viceversa. The central gray level (GL) and local mean values are similar (as Al Razzazah image, take window size 5), and are near (as Al-Ramadi and Al Fit'ha images, take window size 5, 15, and 25) as shown in

In order to determine the optimum threshold value (valley) a plot is drawn between the possible threshold values that is found using the (2D) histogram with the window size, where the flat area represent the optimum threshold value (valley) to separate the regions (classes). This valley was selected from the windows that have stability value of the central gray level (GL), the under lined stability value is shown in table (1). The curves are verified in fig. (3c), fig. (5c), and fig. (6c) showed a true number of valleys between the gray levels of the histogram for extracting the objects from their background.

In order to compare between the fast Otsu and the (2D) fast Otsu methods, the threshold values selection (valleys) for the tested scenes using fast Otsu method are listed in table (2). Two valleys from Al Ramadi scene has been derived, so that fig. (4) illustrates the classification of this scene with these valleys implementing

## Conclusions

From the obtained result, the following conclusions can be derived:

- 1- The (2D) fast Otsu algorithm can be used as search machine for the valley between the histogram peaks, as shown in fig. (3b, 3c), fig. (5b, 5c), and fig. (6b, 6c).
- 2- Changing the window size in the (2D) fast Otsu algorithm has contrarily relationship with the gray level of the histogram. Starting with small window size will force the algorithm to search the high gray level area in the histogram, while taking larger window size will slide the searching area for a valley in to smaller gray level in the histogram, as shown in fig. (3c), fig. (5c), and fig. (6c).
- 3- If the algorithm finds a gray level for a valley, changing the size of the slide window will not change the found gray level until it finds another valley, as shown in fig. (3b, 3c).
- 4- It is seen from fig. (3c) and fig. (6c), the detected threshold gray level (valley) will appear as a flat curve.
- 5- From the comparison between the result of the fast Otsu algorithm and the (2D) fast Otsu, it is found that there is no match between the threshold gray level values, as shown in table (2).
- 6- Scanning the histogram with (2D) fast Otsu algorithm (by changing the window size) will give us the true number of valley in the histogram better than the other Otsu algorithms that force the algorithm to split the histogram to (n) number of bans even if
- 7- the histogram doesn't have enough number of valley to give an accurate splitting bans (classification).

## References

- 1- Zhang J. and Hu, J. (2008), Image segmentation based on 2D Otsu method with histogram analysis, IEEE, International conference on computer sciences and software engineering: 105.
- 2- Sahoo, P.K.; Soltani, S. and Wong, A.K.C. and Chen, Y.C. (1988), A survey of thresholding techniques, Computer Vision, Graphics, and Image processing 41: 233-260.
- 3- Otsu, N. (1979), A Threshold Selection Method from Gray-Level Histograms, IEEE Transactions on System, Man, and Cybernetics, SMC-9 (1), January.
- 4- Sezgin, M. and Sankur, B. (2003), Survey over image thresholding techniques and quantitative performance evaluation. Journal of Electronic Imaging, 13 (1): 146–165.

**Table (1): Gray Level & Local Mean Values with Window Size Variation Using 2D Fast Otsu Method**

Window Size	Al-Ramadi Image		Al-Razzazah Image		Al Fū'ha Image	
	Gray Level	Local Mean	Gray Level	Local Mean	Gray Level	Local Mean
5	121	118	113	113	91	94
15	<u>120</u>	116	102	104	81	83
25	<u>120</u>	115	97	100	80	85
50	<u>120</u>	114	89	97	78	85
55	<u>120</u>	114	86	96	78	84
75	<u>120</u>	113	80	89	<u>75</u>	91
100	119	112	77	88	<u>75</u>	97
125	<u>72</u>	78	70	97	<u>75</u>	105
150	<u>72</u>	82	66	101	67	107
187	<u>72</u>	84	<u>60</u>	107	54	94
210	<u>72</u>	87	<u>60</u>	107	48	100
250	<u>72</u>	91	54	108	39	112
300	69	94	48	108	28	123
350	69	98	44	108	17	129
400	66	103	43	107	9	134

Table (2): Threshold Values Using Fast Otsu Method

Fast Otsu	Thresholds			
	Al-Ramadi Image		Al-Razzazah Image	Al Fit'ha Image
	1	2	1	1
	72	154	132	129

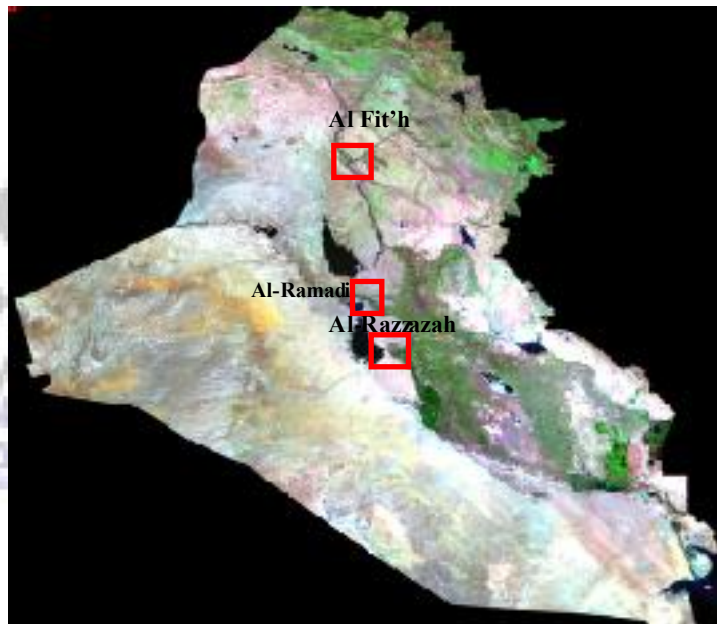


Fig. (1): Location Map of the Test Scenes in ALRamadi, Al Razzazah, and Al Fit' Regions

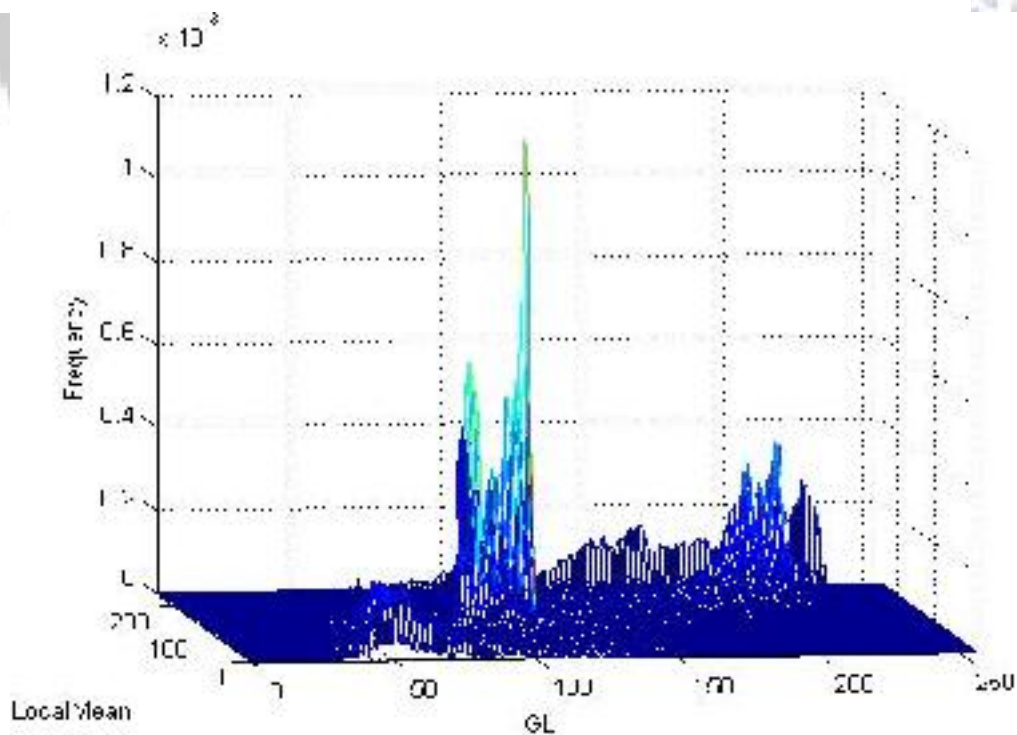
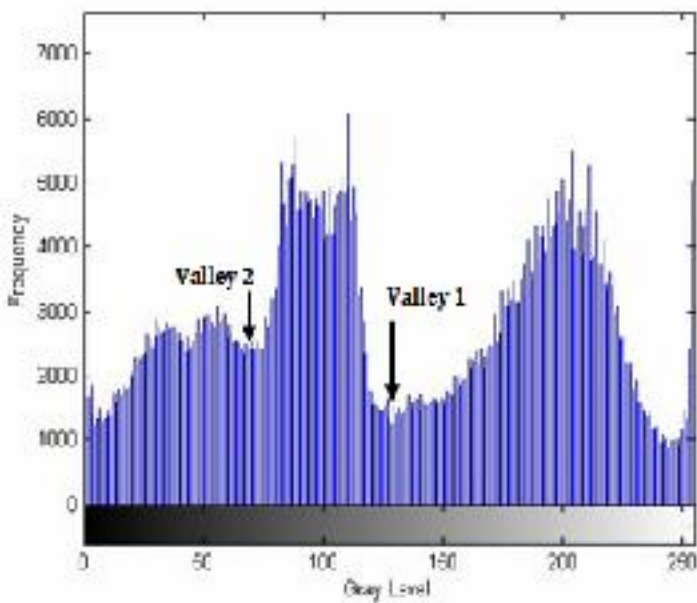
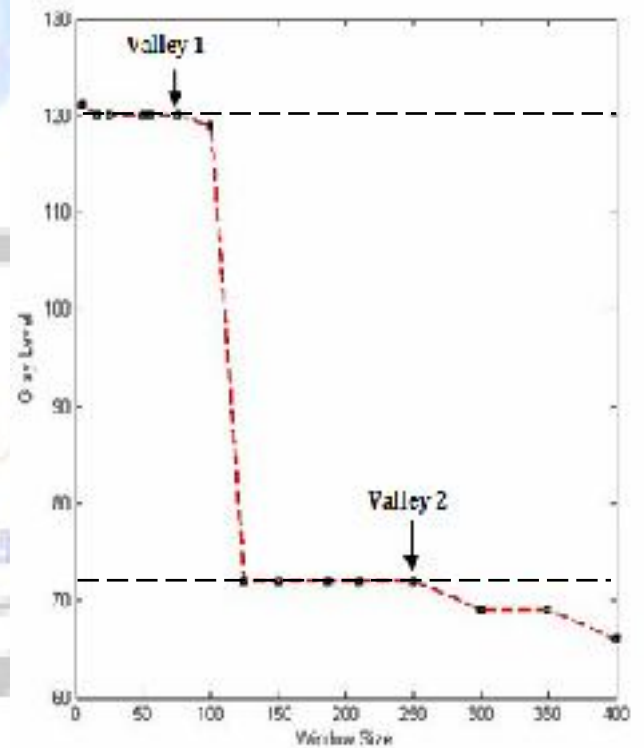


Fig. (2): 3D Feature Space Plot of 2D Fast Otsu Method with Window Size 50, the Maximum Peak at Central Gray Level &amp; Local Mean are 120, 114 Respectively.



b



c

Fig. (3) :Al Ramadi Image, and its Histogram (a & b), (c) Window Size Changing Curve with the Gray Level of Al Ramadi Image by Using 2D Fast

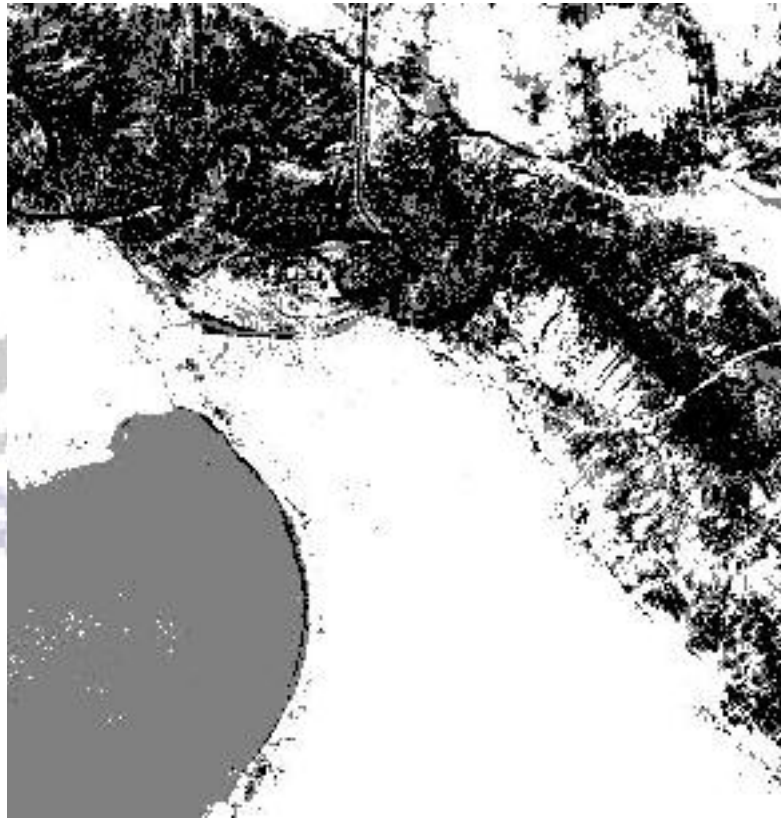


Fig. (4): Classified Image of Al Ramadi with 2

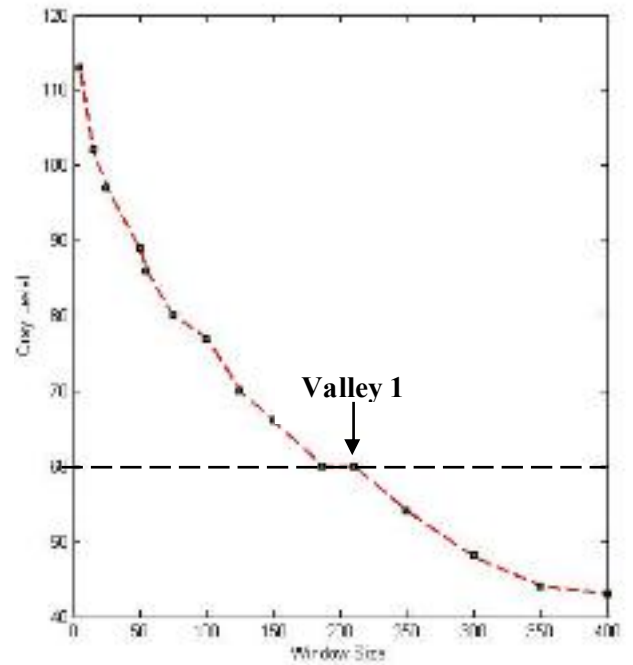
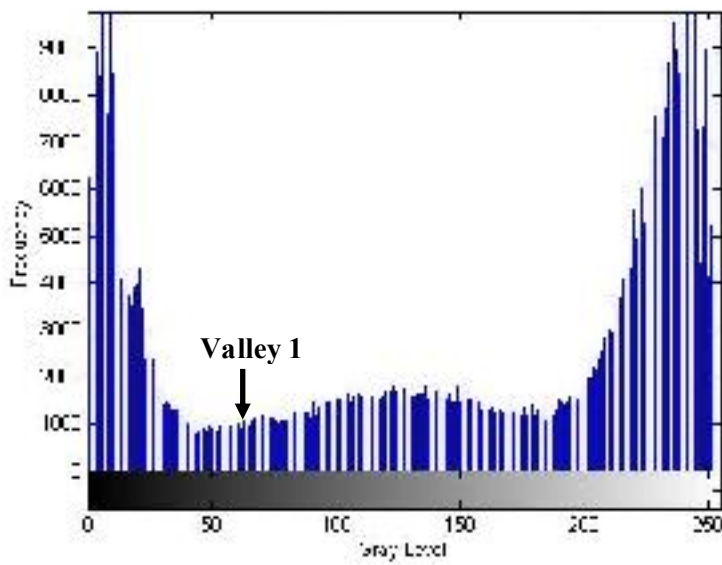
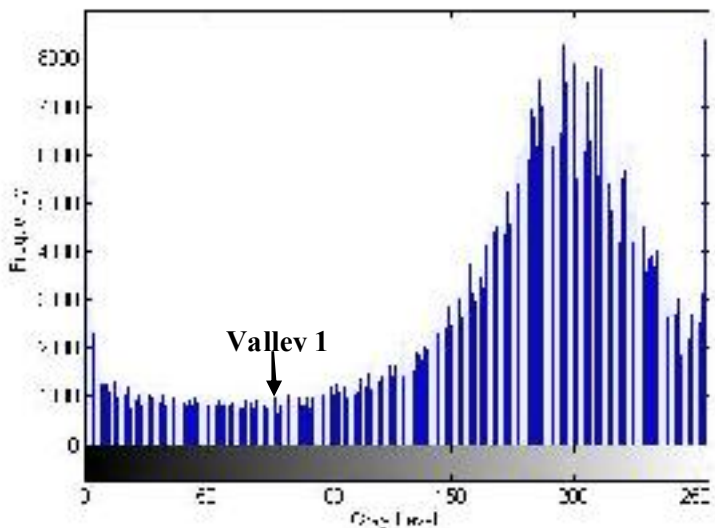


Fig. (5): Al Razzazah Image, and its Histogram (a & b), (c) Window Size Changing Curve with the Gray Level of Al Razzazah Image by Using 2D Fast Otsu Method

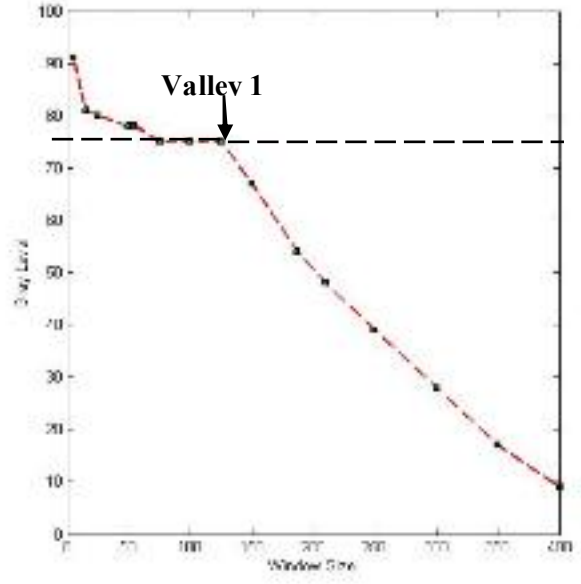




a



b



c

Fig. (6): Al Fit'ha Image, and its Histogram (a & b), (c) Window Size Changing Curve with the Gray Level of Al Fit'ha Image by Using 2D Fast Otsu Method

## تأثير تغير حجم النافذة لتقسيم الصورة الفضائية بأستعمال طريقة أوتسو السريعة الثنائية الأبعاد

تغريد عبد الحميد ناجي  
قسم الفيزياء، كلية التربية، جامعة بغداد

استلم البحث في : 17 حزيران 2011، قبل البحث في : 20 ايلول 2011

### الخلاصة

يتم عادةً تقسيم صور الاستشعار عن بعد المتعددة الاطراف بأستعمال تقنية حد العتبات. درس هذا البحث تأثير تغير حجم النافذة لخوارزمية أوتسو السريعة ذي البعدين التي قدمت من قبل الباحث زنك. كما هو معروض بالنتائج، تتصرف هذه الطريقة كماكنة بحث عن الوديان (حد العتبة الآلي) بين المستويات الرمادية للمخطط التكراري بتغير حجم النافذة المنزقة.

الكلمات المفتاحية تقسيم صورة، طريقة أوتسو السريعة الثنائية الأبعاد، حد العتبات، حد العتبة الآلي، صورة المخطط التكراري الثنائي الأبعاد.



