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PEAK SIGNAL-TO-NOISE RATIO BASED ON THRESHOLD METHOD FOR IMAGE SEGMENTATION

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ABSTRACT

Binarization or thresholding is one problem that must be solved in pattern recognition and it has a very important influence on the sequent steps in imaging applications. Thresholding is used to separate objects from the background, and diminish the amount of data alter the computational speed. Recently, interest in multilevel thresholding has been altered. However, when the levels are altered, the computation time alters so single threshold methods are accelerated than multilevel methods. Moreover, for every new application, new methods are is acquired. In this work, a new algorithm which used the gain signal-to-noise ratio method as an indicator to segment the image is aimed. The algorithm which is used the DIBCO 2011 in printed and a handwritten image was tested. This method has a better performance than new methods, such as Kittler and Illingworth's Minimum Error Thresholding, potential difference and Otsu.

Keywords: *PSNR, Single Thresholding, Image Processing, Image Segmentation, Optical Character Recognition*

1. INTRODUCTION

One of the important stages of pre-processing in any application is Thresholding in image processing[1]. Thresholding can be used as a method to separate the foreground from the background of an image. This paper compares six thresholding methods: Otsu [2], Kittler and Illingworth [3], potential difference[4] , max entropy[5], multilevel threshold[6] and the unprecedented method aimed in this paper. Thresholding is one of the faultfinding steps in pattern recognition and has an important role on the consequent steps in image applications. The significant accusatives of thresholding are separating objects from the background; lessen the number of data and increasing computational speed. There are two types of thresholding: single and multilevel. Single can produce binary images (0, 1) and modifying the amount of the data, causing to alter in computational speed. Multilevel thresholding can produce an image with a range between 0 and 255 of pixel value [7-10]. Single thresholding requires be investigating and improving to find out the best way for to isolate the object, diminish the amount of data and alter the speed. Recently, there has been an important research in multilevel thresholding. However these solutions cannot diminish computational quickness because they use many levels. One time thresholding isolate the object better than multilevel thresholding. Moreover, for every new application, new methods are required to be developed. In addition, for mobile device applications, image-processing capabilities can be altered while requires less amount of storage, fewer processes, and battery saver. For new applications and devices thresholding should be better. Furthermore, this method can have a god influence in resource utilization [7-10] . Thresholding is useful in more applications e.g. Automated visual inspection for metal parts [11], automated Visual Inspection System for Press Part Sorting[12],Detecting Breaches and New Objects in Multiple Outdoor Images[1] , detection of Plane Object in Docking Guidance System[13], Fruit Detachment and Classification for Strawberry Harvesting Robot[14], Control System for car parking[15],crack detection for photo voltaic array and panels [16] Previously there was not current thresholding algorithm which can be used in whole applications. A multipurpose for one algorithm is needed to implemented in a

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wide range of pattern recognition applications. Some methods applied in real-time applications produce better results with controlled environments. This motivates the improvement of a different way to investigate global image thresholding. This method can be able to adapt to some way in another aim to illuminate such as day, night, sun, shadow, variable background intensity, shadows, smear, smudge, low contrast, bleed-through or show-through[7-10].In addition, some important things may be considered like handwriting recognition , which useful be useful in applications which can be used in mobile devices. One of the methods the high signal-to-noise ratio is used to measure the quality of images. The high signal-to-noise ratio (PSNR) is as a different for the segment in image. Some researches conclusion shows some good things of the aimed way compare to existing solutions. The algorithm can be the best alter the way of this work.

As a previous way we can name single thresholding and it was mentioned before the multilevel thresholding. After working the single thresholding we will have a black-and-white image (0 and 1 pixel values). consequently, the storage requirements are less than those required for multilevel thresholding [8] , and multilevel thresholding uses a wide range of pixel values. Second, To improve the speed of image processing a limited amount of data is compulsory to work with it. At last, single thresholding will isolate the foreground and background of images contrast to the multilevel thresholding and the object detection is quicker than multilevel thresholding[6]. Nowadays, some more topics have been considered in multilevel thresholding method. However, it has some significant point during the multilevel thresholding, one time thresholding warrants can cause better development. In fact, a new image-processing application in mobile devices is going to be significant, such as cell phones. In these devices, lack for a better algorithm for image processing is the cause and some limitations such as low storage capacity, battery life, and limited processes are another problem for this method. [9, 10].

2. THRESHOLDING TECHNIQUES

Thresholding is the step preceding the segmentation phase of image processing. Usually embedded in the blob-labeling process, thresholding has a very important role in this step because it segregates the significant objects from the background and directly influences the achievement rate in object-recognition applications. We sort thresholding methods into three techniques: single, multilevel and multi thresholding. Kittler and Illingworth's Minimum Entropy Threshold (MET)[2] and potential difference [3] are examples of single thresholding methods. Multilevel threshold methods, example of Arora et al.[5], apart object based on gray values. Multi- threshold [7] techniques decided on a selection of threshold values based on certain orderly such as number objects inside the image after threshold. the Consideration of some state-of-the-art methods in the following subsections is mentioned.

2.1 Single Thresholding

The usage of the single thresholding means one threshold value, t, change the image to black and white. The thresholding process is a very important step through the segmentation phase. It is also a very significant part of image processing and pattern recognition. Thresholding is carried out for distinctive reasons, for example to increase the computational fast or to reduce the storage space. The segmentation accuracy can be maximized by an appropriately chosen threshold value. The single threshold condition is given as:

$$f'(i,j)\begin{cases}1 & iff(i,j) > t\\ 0 & iff(i,j) \le t\end{cases} \quad (1)$$

Different approaches are used to automatically determine the threshold value. Methods such as local entropy, Kittler and Illingworth's MET [2], and potential difference [3] often use a gray level co-occurrence matrix as the population set to determine the appropriate threshold value.

2.2 Multilevel Threshold [6]

More than one threshold value is used in multilevel thresholding to change the image to a gray-scale image. Multilevel thresholding methods were become well because a single threshold is not always suitable for global segmentation. Arora et al. [6]proposed a multilevel threshold method that identifies threshold values globally based on a gray scale distribution. A recursive algorithm is applied to establish a sequence of threshold values based on the mean and standard deviation at each step. The multilevel algorithm is described in Algorithm 1.

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20th November 2013. Vol. 57 No.2

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Algorithm 1: The Multilevel Thresholding Algorithm by Arora et al. [6]

1	while increasing PSNR> 0.1 is true do
2	r=[a, b]. (in the first step a=0 and b=255)
3	Find the mean and standard deviation for all of the pixels in the image range r
4	t1=mean – k1* standard deviation; (k1 is a random number)
5	t2=mean + k2* standard deviation; (k2 is a random number)
6	The mean value of range (a, t1] is set as the threshold value of the partial range.
7	The mean value of range [t2, b) is set as the threshold value of the partial range.
8	a=t1+1
9	b=t2-1
10	end while
11	t1=mean
12	t2= mean+1
13	repeat step 6
14	Obtain new image with multilevel thresholding

2.3. Multi-Threshold[8]

Another approach is multi threshold that applies multiple threshold values[8]. This method uses a series of threshold values and computes the total number of blobs or objects in an image for each threshold. The peak threshold values are those with the highest total number of blobs as compared to their threshold neighbors. The Heuristic threshold algorithm is described in Algorithm 2.

Algorithm 2: The Multi Threshold Algorithm by Abdullah et al. [8]

Input: License plate images.		
Output: Threshold values.		
1		Start.
2		Obtain the histogram distribution.
3		Calculate the total number of gray-scale pixels according to three levels.
4	4.1	For (0< t < 256) step 10 is true do
	4.2	Obtain the total number of objects, numt, in the source image when the threshold value t is used.
	4.3	end for
5		Search for and select the peak values from num (1 … 255) .
6		Choose the selected threshold values if the number of objects is maximum.
7		Execute the character segmentation module.

2.4. OTSU'S Method For Thresholding

Otsu, in 1979, presented an unsupervised and nonparametric method of automatic threshold selection for image segmentation[2]. Bounding boxes of fragments are used as local areas for local threshold searching. The mean (μ), and variance (σ2) , of the pixel distribution, Pi= (P1, P2,…PMax), are used to select the optimal thresholds by maximizing the between-class variance.

2.5. Proposed Method For Thresholding

In the same spirit as[6, 8-10], proposed algorithm uses a gray-scale histogram, thresholding range and the Peak Signal-to-Noise Ratio (PSNR). Based on our experience, the mean value of the gray scale histogram is strongly connected to pixel intensity. We use the PSNR quality measure proposed by [6] because it can measure the similarities between the original image and the binarized image. A higher PSNR indicates more similarity between the two images. The PSNR value is defined as follows:

$$PSNR = 10 * \log_{10}\left[\frac{Max^2}{\frac{\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j)-K(i,j)]^2}{M*N}}\right] \quad (2)$$

In equation 2, Max is a maximum value in the image (for example, in a gray-scale image, Max is 255) while m and n are the height and weight of the image, respectively. I(i,j) is the original value of the image, and K(i,j) is the value after a change. Based on[8], we calculate $PSNR_s$ for every threshold value, in increments of 5, in the range between [1,256]. We calculate the difference between $PSNR_{(t)}$ and PSNR(original image). In this algorithm we calculate PSNR by using original image and each threshold value. *K1=16* and *k2=10* based on experiments.

Algorithm 3: Proposed Threshold Algorithm.

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	Input: column gray scale images, img.
	Output: The selected threshold values, t.
1	For (0<t<256) where (t = t +5) then find PSNRt of imgt by compare with the original image
2	If ((mean value/k1< PSNRt< mean value/k2))
3	then threshold=t
4	end for

3. RESULTS AND DISCUSSION

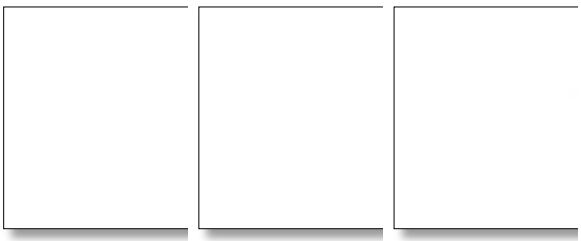
We have tested our proposed method using four image datasets: DIBCO 2011[12] (handwritten and printed images), standard images and. DIBCO 2011 data sets contain handwritten and printed images. The F-measure denotes the percentage of the binary image classification as shown below:

$$F-measure = \frac{2*recall*precision}{recall+precision}, \quad (3)$$

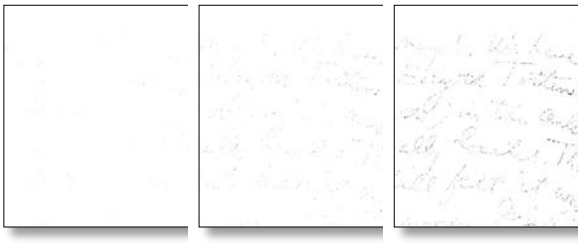
Where $recall = \frac{TP}{TP+FN}$ and $precision = \frac{TP}{TN+FP}$. TP is the true-positive value, FN is the false-negative value, and FP is the false-positive value. The PSNR measurement denotes the similarity between two images. A high PSNR value denotes high similarity between two images as defined by Equation 2.

The figure 1 below shows images after each threshold value and PSNR its corresponding.

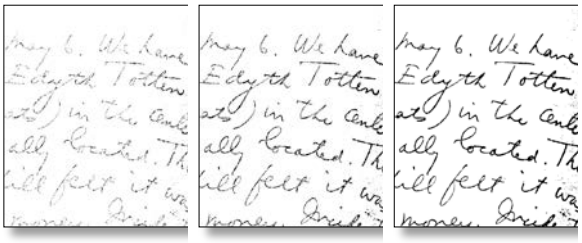
Mean value 175.773 result PSNR value 11.7518 threshold value PR1.PNG 65



Threshold value=5 Threshold value=10 Threshold value=15

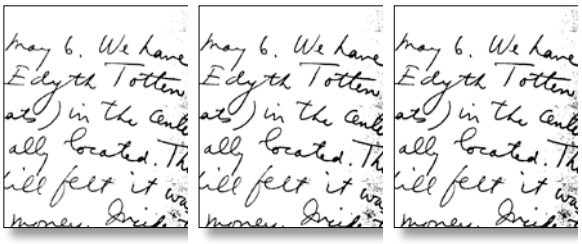


Threshold value=20 Threshold value=25 Threshold value=30 PSNR value = 52.2892



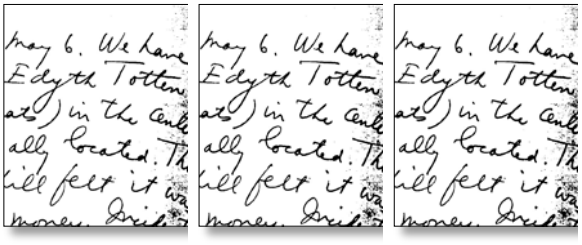
Threshold value= 35 Threshold value=40 Threshold value=45

PSNR value = 41.3784 PSNR value = 32.246 PSNR value = 24.6976



Threshold value=50 Threshold value=55 Threshold value=60

PSNR value = 19.3453 PSNR value = 15.6695 PSNR value = 13.186



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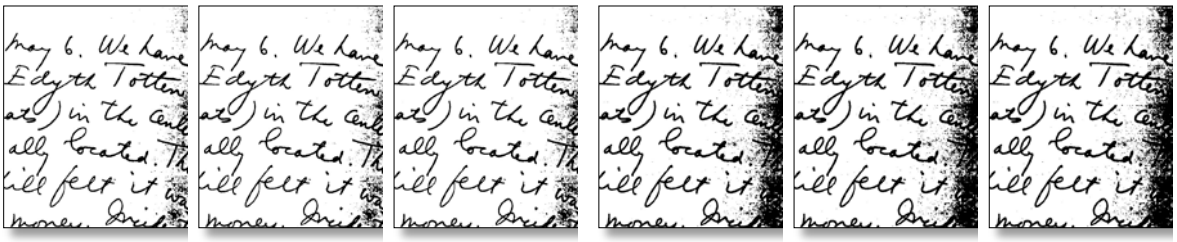
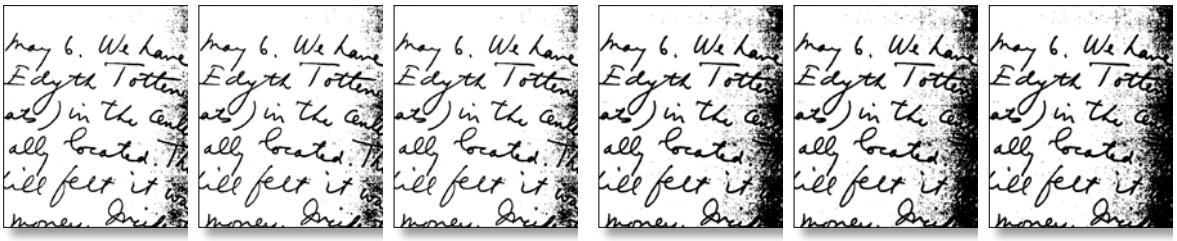
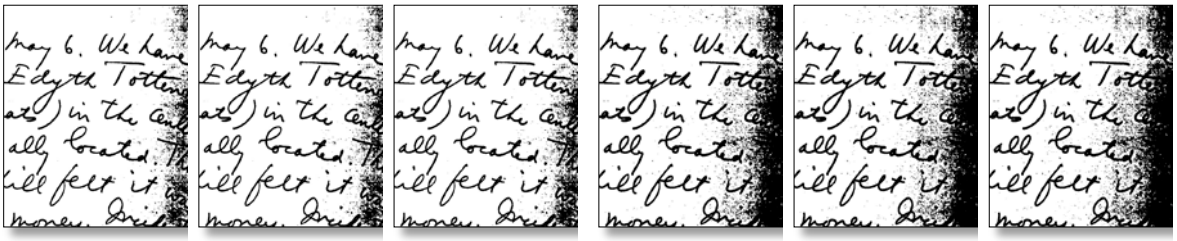
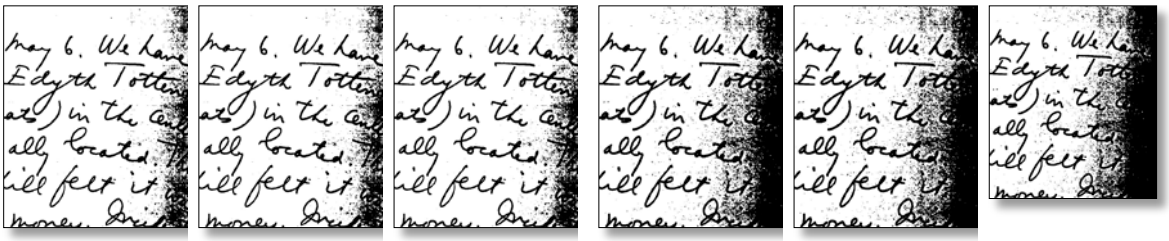
Threshold value=65	Threshold value=70	Threshold value=75	Threshold value=125	Threshold value=130	Threshold value=135
PSNR value = 11.7518	PSNR value = 10.9214	PSNR value = 10.4143	PSNR value = 8.20234	PSNR value = 8.04932	PSNR value = 7.89351
					
Threshold value=80	Threshold value=85	Threshold value=90	Threshold value=140	Threshold value=145	Threshold value=150
PSNR value = 10.0387	PSNR value = 9.72186	PSNR value = 9.45483	PSNR value = 7.7219	PSNR value = 7.5307	PSNR value = 7.31507
					
Threshold value=95	Threshold value=100	Threshold value=105	Threshold value=155	Threshold value=160	Threshold value=165
PSNR value = 9.22359	PSNR value = 9.0035	PSNR value = 8.8189	PSNR value = 7.05096	PSNR value = 6.7327	PSNR value = 6.34752
					
Threshold value=110	Threshold value=115	Threshold value=120	Threshold value=170	Threshold value=175	Threshold value=180
PSNR value = 8.65271	PSNR value = 8.49826	PSNR value = 8.3486	PSNR value = 5.8873	PSNR value = 5.35598	PSNR value = 4.74236
					
			Threshold value=185	Threshold value=190	Threshold value=195

Journal of Theoretical and Applied Information Technology
20th November 2013. Vol. 57 No.2

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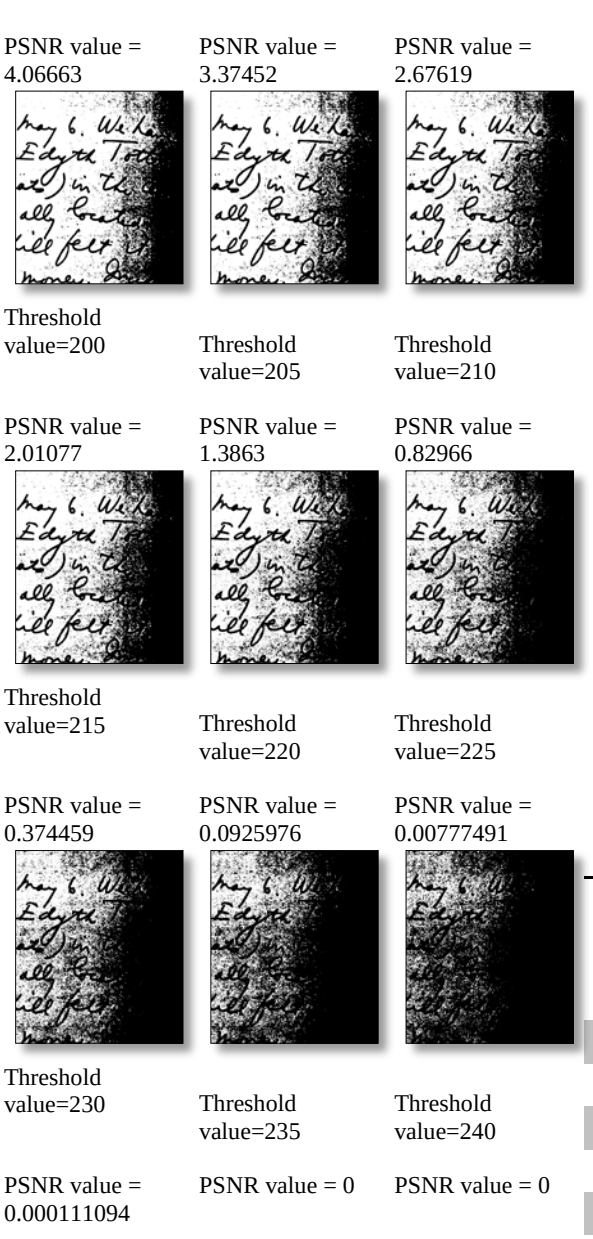

Figure 1: Each Images After Each Threshold Value And PSNR Its Corresponding.

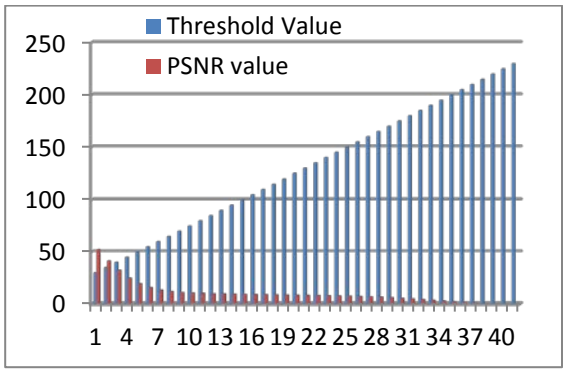

Figure 2: Compare Threshold Value And PSNR Value For One Image

Proposed algorithm Table 1 shows the F-measure and PSNR results for all approaches. In the printed category, the proposed method has the highest PSNR and an acceptable F-measure. For both the handwritten and standard images, results obtained using the proposed method. Figure 2 shows a bar chart in order to compare threshold value and PSNR value for one image.

Table 1: F-Measure And PSNR Results For Proposed Method And Pervious[9, 10] Method

Name of Images	Proposed method			Pervious method		
	f measure	PSNR	NRM	f measure	PSNR	NRM
hw1	55.209	11.011	30.794	68.244	9.417	7.854
hw2	84.044	17.647	1.758	92.22	21.302	2.617
hw3	80.542	14.985	7.68	18.183	1.689	36.7
hw4	60.491	10.229	15.123	64.412	11.253	16.331
hw5	72.491	13.146	21.557	89.387	16.059	4.55
hw6	62.777	11.396	11.562	37.042	11.986	37.751
hw7	60.19	12.962	6.064	60.19	12.962	6.064
hw8	45.988	9.576	6.403	46.144	14.789	35.003
Average	65.2	12.61	12.61	59.47	12.43	18.35

Table 1 shows the performance of the proposed method; using f-measure similarity between achieved image and the original one is significant. In the three images the performances are higher than 70% that contend an acceptable method for binarization. Table 1 also shows the result of previous version of proposed method. Obviously improved version of the proposed method gains the

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better result in thresholding. The performance of proposed method has been evaluated on the hand written images and printed images in the table 3 and 4 that results show a reliable and acceptable method for thresholding. Table 2 shows results for f-measure, PSNR, and NRM of pervious [9, 10] method in order to compare with old one. The result shows overall f-measure in pervious [9, 10] method is 59.47 compare to 65.21 in new approaches in hand written images (DIBCO 211)

Table 2: Compare Proposed Method And Pervious [9, 10] Method For Printed Images.

Name of Images	Proposed method			Pervious method		
	f measure	PSNR	NRM	f measure	PSNR	NRM
pr1	56.814	9.946	30.159	74.076	11.599	20.578
pr2	82.693	13.875	9.447	62.051	8.455	8.251
pr3	24.167	8.001	43.128	77.126	11.638	18.607
pr4	93.038	18.178	5.304	93.211	18.161	4.103
pr5	84.059	13.565	9.251	25.839	1.012	45.947
pr6	33.898	7.149	10.303	19.394	3.852	21.698
pr7	47.584	12.776	4.307	81.52	21.087	15.26
pr8	68.469	11.801	23.949	41.512	9.938	36.904
Average	61.34	11.91	16.98	59.34	10.71	21.4

Table 2 shows results for f-measure, PSNR, and NRM of pervious [9, 10] method in order to compare with old one. The result shows overall f-measure in pervious [9, 10] method is 59.34 compare to 61.34 in new approaches in printed images (DIBCO 211) .Table 3 shows mean value and PSNR and proposed threshold value for all images in standard images, handwritten and printed images in DIBCO 2011 dataset for OCR system.

Table 3: Mean Value And PSNR And Proposed Threshold Value For All Images

	mean	PSNR	Old threshold value	Proposed method threshold value
lake	122	3.14	145	40
Lena	110	3.79	165	65
Pepper	104	3.76	165	55
airplane	181	8.53	80	95
baboon	125	5.73	145	75
hw1	183	10.02	65	40
hw2	188	13.33	135	175
hw3	156	11.62	50	140
hw4	134	9.56	80	90
hw5	188	10.37	140	80
hw6	143	9.88	115	120
hw7	163	15.16	120	135
hw8	119	14.02	160	115
pr1	175	8.2	405	65
pr2	145	11.64	90	105
pr3	195	8.19	95	80
pr4	153	9.99	145	115
pr5	134	10	165	95
pr6	103	16.27	165	95
pr7	127	16.5	80	115
pr8	182	9.27	145	125

Table 4 shows comparison f-measurebetween proposed method and Bilal[17] and Niblck[16], Sauvola[11], method for DIBCO 2011

Table 4: Compare F-Measure Form Proposed With Other Methods

	F measure%
Proposed	63.27
Bilal[17]	84.97
Niblck[16]	39.59
Sauvola[11]	66.91

Figure 3 and 4 show all images in printed and handwritten dataset of DIBCO 2011. The first column show original images and the second column shows ground truth images and the third column shows result of proposed method. In the figure 3 and 4 show that; in the row 1 the text Image in column 3 has shown better result than the

Journal of Theoretical and Applied Information Technology
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original image, since the image has able to remove noise from the background of the object. But when it compared to column 2, column 2 still produce better image because it has very clear result / text image and it able to distinguish between the object (text) and any other noise background. The suggestion is try to improve the result by applying dilation to the main object to make the text of the object become clearer. Also try to remove any noise which is not needed as a background of the image. In the row 2 column3 is succeed to show the text image clearly compared from the original image which is the text on the original image shown a bit slightly maybe it because the column of the background image give influence to the text of the object image. In the row 3 is same explanation as above and in row 4 since the original image has defect background, so the result in column 3 shows good enough result since it could preserve the main object (text) from the original image. A little bit work in removing the unnecessary noise is necessary.

Figure 3: Result Of All Images In Handwritten Dataset Of DIBCO 2011

In the row 6, since the text of the original image between two of pages of the book, so the image that acquired from the scanning also affect to the result, at least column 3 still able to maintain the text of the image. In the row 7, column 3 the result is different from the original image, since the original image shows difficult object to distinguish between the main text and the noise text of the background. In the row 8, Column 3 clear text image has been shown but seems has more noise on the background.

Journal of Theoretical and Applied Information Technology
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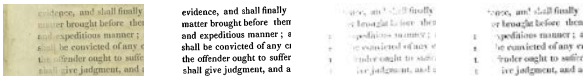
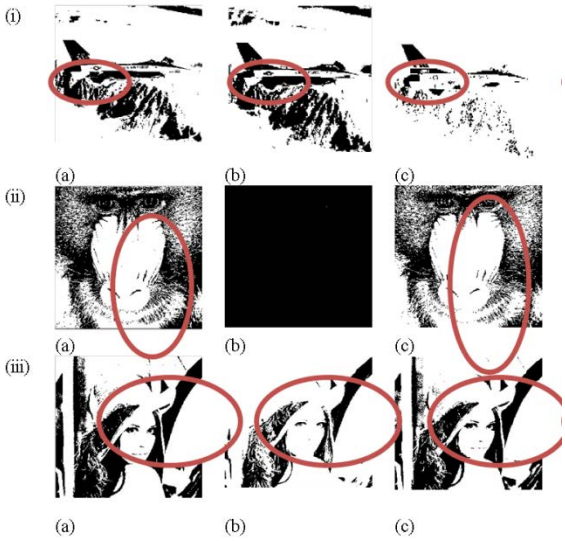


Figure 4: Result Of All Images In Printed Dataset Of DIBCO 2011

In the figure 1 and 2 show that; the last column is proposed method and explain result: Row 1: Column 3 has shown a bit blur text compare from the original image, maybe it because the original image has light column background of the paper, so column 3 tried to remove the noise from the original image with light background column but in the same time try to preserve / maintain the text of the image. Row 2: Column 3 tried to remove the background noise from the original image, since the original image has double text between the main text and the noise text from the background paper, but at least column 3 succeed to remove some part of the noise even couldn't remove it completely. Row 3: Column 3 it's not being able to show the clear result of the original text of the image, maybe cause the original image has very light column of the background. Row 4: Column 3 has succeeded to get better result from the original of image, since it could maintain the text of the image clearly. Row 5: Again column 3 succeed to get better result from the original of image since it could remove the background noise from the original image also still preserve the text clearly. Row 6: Column 3 still needs work to remove the noise from the background, since the original image has a lot of noise which is similar to the main text of the object. Row 7: Column 3 has shown clear the text of the image, but the problem from the original image since it has some texture on the paper so it give effect to the result .Row 8: Column 3 need a little bit work to make the text on the image become more clearer since the column of the background from the original image which is lightly is affect to the processing the result of the text. Figure 5 and 6 discuss the result of all the five methods which are Otsu [2], Kittler and Illingworth [3], potential difference[4] , max entropy[5], multilevel threshold[6], and proposed thresholding methods based on the results for (a) all the methods used except the proposed could not detect clearly words without noise. However, the proposed method could detect the all words and it can be read clearly. Using the proposed method, the (b) can be recognized clearly it can show the words clearly. For (c), the proposed methods can recognize more words than other methods and hat clearer than other methods. For (d) the proposed method has noise. For (e) the proposed method has very clear manuscript compare to other methods .Finally, we can conclude the proposed thresholding algorithm showed good to be applied for printed images. The proposed method can be solved different size fonts; a spotted, love quality image; thin pen stroke; low contrast and small size; a poor quality and very low contrast image; a non-uniform illumination; a non-uniform illumination with thin pen stroke ; low quality images but it has problem in local binarization where the stroke and small size pen in part of images.

Figure 5: Example To The Result Of Proposed Threshold Algorithm

Figure 6: The Results Of Thresholding Methods On Standard Images. (I) Airplane, (Ii) Baboon, And (Iii) Lena. The Images Obtained Using The (A) Otsu [2], (B)Kittler And Illingworth [3], (C) Max Entropy[5], (D) Potential Difference[4], (E) And Proposed Thresholding Methods Are Compared To The Original Images (F).



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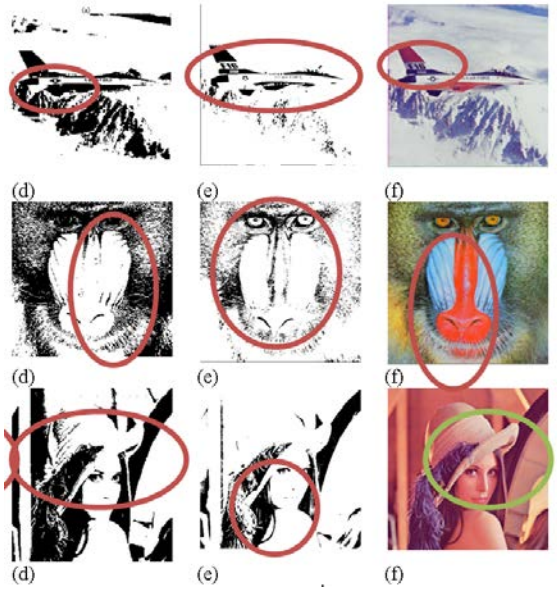

Figure 6: Compare The Result Of Proposed Threshold Method With Other Methods

Airplane in terms of (i) is segmented from mountain based on proposed method. In additional, the all parts of monkey face were detected especially manner of nose that segmented obviously in (ii) image. The segmentation was done properly on (iii) as some parts of eyes, hat and hair have were detected. Finally all images were segmented using proposed method better than other methods. Figure 4 shows; In comparison with other methods, the different regions of airplane were segmented properly. The F16 text on image was detected appropriately. In additional, the all parts of monkey face were detected clearly and, the eyes, nose and so on segmented obviously. Especially, the eyes on image was detected entirely clear than others obtained results. Furthermore, the various region of Lena image were detected in proposed method. The segmentation as one of important steps on image processing was implemented properly on this image as some parts of hat and hair has were detected better than other methods. We discuss three types of images: i) air plane ii) Baboon iii) Lena. Figure 6 discuss the result of my all the five methods which are Otsu [2], Kittler and Illingworth [3], potential difference[4] , max entropy[5], multilevel threshold[6], and proposed thresholding methods based on the results for Air plane all the methods used except the proposed could not detect the air plane number (F16). However, the proposed method could detect the number and it can be read clearly. Using the proposed method, the Baboon face can be recognized clearly it can show the nose and lips clearly, unfortunately, all the other methods showed unclear face of Baboon. For Lena, the proposed methods can recognize face and hat clearer than other methods. Finally, we can conclude the proposed thresholding algorithm showed good to be applied for standard images.

4. CONCLUSION

The proposed adaptive threshold method, based on the peak signal-to-noise ratio (PSNR), has the potential to be applied in OCR. Based on the experiments, the proposed algorithm achieves competitive results in standard, printed, and handwritten images. The proposed algorithms achieve better results compared with previous methods. However it produced slightly worse results compared to newer methods, such as multi-level thresholding. Recently, PSNR has been widely used as a stopping criterion in multilevel threshold methods for segmenting images. Alternatively, we have applied the PSNR as a criterion to determine the most suitable threshold value. We evaluated the proposed method with the license-plate recognition system. At the same time, we compared the proposed method with state-of-the-art multilevel and multi-threshold methods. The proposed method produced acceptable results in all conditions, such as different contrast or brightness.

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