A Survey on Degraded Document Image Binarization Techniques

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Abstract-**the method of segmentation in the image binarization technique is the major technique used for the separation of pixel values into dual collections, black as foreground and white as background. The degraded images of a document are segmented by using the image binarization technique in order to acquire the clear images exact to that of the original images of documents. Thresholding process is the well-known technique used for the binarization of the document images. Global and local thresholdingtechnique are the two important types of the thresholding process. Earlier many techniques have been proposed for this binary documentation process. Thus this work presents a survey about the document image binarization techniques**.

1. INTRODUCTION

Document image binarization tries to extract only the text stroke pixels from the gray-scale document images, and is usually performed in the document preprocessing stage [1]. It is an active research area and has been studied for decades because it is important for the ensuing document image processing tasks such as optical character recognition and document layout analysis.

Binarization has been a subject of intense research interest during the last ten years. Most of the developed algorithms rely on statistical methods [2], not considering the special nature of document images. However, recent developments on document types, for example documents with mixed text and graphics, call for more specialized binarization techniques.

In general, approaches that deal with document image binarization are either global or local. In a global approach, threshold selection leads to a single threshold value for the entire image. Global thresholding has good performance in the case that there is a good separation between the foreground and the background. However, very often [3], document images are exposed to degradations that weaken any guaranty for such a separation. Unlike global approaches, local area information may guide the threshold value for each pixel in local (adaptive) thresholding techniques. These techniques have been widely used in document image analysis because they have a better performance in extracting the character strokes from an image that contains spatially uneven gray levels due to degradations.

To analyze the document, its image is binarized before processing it. It is nothing but segmenting the document background & the foreground text. For the confirmation of document image processing task an accurate document image binarization technique is a must. After years of studies in document [4] image binarization, the thresholding of degraded document images is still found to be a challenging task because of the high inter/intra variation between the text stroke and the document background across various document images. The stroke width, stroke brightness, stroke connection, and document background vary in the handwritten text within the degraded documents. Moreover, bleed through degradation is observed in historical documents by variety of imaging outputs.

The problems commonly seen in the document images captured [5] by these imaging device including: (1) poor contrast due to the lack of sufficient or controllable lighting, (2) non-uniform image background intensity due to uneven illumination and, (3) immoderate amount of random noises due to limited sensitivity of imaging sensor and lack of adjustable camera's exposure time and aperture time.

Specifically, in the first stage of the proposed binarization technique, a parameter estimation algorithm (PEA), is used to detect the best PS values of every document binarization technique. The estimation is based on the analysis of the correspondence between the different document binarization results obtained by the application of a specific binarization technique to a document image, using different PS values. The proposed method is based on the work of Yitzhaky and Peli (2003) which has been proposed for edge detection evaluation. In their approach, a specific range and a specific step for each one of the parameters is initially defined.

The best values for the PS are then estimated by comparing the results obtained by all possible combinations of the PS values. The best PS values are estimated using [6] a receiver operating characteristics (ROC) analysis and a Chi-square test. In order to improve this algorithm, a wide initial range for every parameter is used and in order to estimate the best parameter value an adaptive convergence procedure is applied. Specifically, in each iteration of the adaptive procedure, the parameters' ranges are redefined according to the estimation of the best binarization result obtained. The adaptive procedure terminates when the ranges of the parameters values cannot be further reduced and the best PS values are those obtained from the last iteration.

In order to combine the best binarization results obtained by the independent binarization techniques (IBT) using their best PS values, the KSOM neural network (Strouthopoulos et al., 2002; Haykin, 1994) is used as the final stage of the proposed method. Specifically, the neural network classifier is fed using the binarization results obtained from the application of the IBT and a corresponding weighing value that is calculated for each one of them. After the training stage, the output neurons specify the classes obtained, by using a mapping.

2.METHODOLOGY

2.1 Comparison of Some Thresholding Algorithms for Text/Background Segmentation in Difficult Document Images.

In document image processing, the image is analyzed to

convert the grey scale image into binary image and retrieving the foreground by removing the background these are the most important steps.For extracting the noise free foreground text and for effective thresholding the document images, the several algorithms are already proposed. But still there are some disadvantages such as poor image quality. Therefore to overcome such drawbacks the new thresholding algorithms is proposed here. The various 'difficult' document images are chosen here where the foreground consists of handwritten text with some noise. The proposed algorithms are performed on the document image and these algorithms are compared with some existing algorithms. Some of the algorithms used and compared here are Proposed Mean-Gradient Technique, Quadratic Integral Ratio Technique,Background Subtraction Technique, Yanowitz and Bruckstein Technique and Improved Niblack's Technique. Finally, the quality of the thresholding is evaluated using the Precision and Recall analysis of the resultant image.

2.2 Iterative Multimodel Subimage Binarization for Handwritten Character Segmentation.

The Binarization techniques are classified into global and local algorithms in which Global thresholding algorithms uses a single threshold and Local thresholding algorithms uses a separate threshold for each pixel. In this paper, a new kind of Binarization was proposed where the input image is separated into many sub images. Each sub image provides a numerical model for the handwritten text that can be used to optimize the binarization of other sub images which was based on the grey-level and stroke-run features. The proposed method uses these models to iteratively arrive at the optimal threshold for each sub image. It is performed on different types of document images where prior knowledge about the disruptiveness of the sub images is not obtainable. Finally, the experimental results showed better performance and the improvement in binarization quality when compared with other well-established algorithms.

2.3 Efficient Computation of Adaptive Threshold Surfaces for Image Binarization.

The drawback of the binarization of grey level images was it reconsidered the nonuniform illumination. In this paper, anEfficient Computation of Adaptive Threshold Surfaces for Binarization of the image was proposed. The Adaptive Threshold Surfaces Method constructs the binary image by the use of threshold value. The threshold value is chosen by the successive over relaxation (SOR) as the solution of the Laplace equation, and then this value was compared with each pixel in thegrey level image to create abinary image. The high image gradient value denotes likely the edges of the object and alsothere the image values which was between the object and the background grey levels.This work also proposes a various method to evaluate an adaptive threshold surface. The experimental results had proved that the threshold surface constructed which has less complexity, smooth and also better visual and binarization performance.

2.4 Text Extraction and Document Image Segmentation Using Matched Wavelets and MRF Model.

The problem of extracting the textual data in the image is addressed in this paper and the novel method is proposed for this purpose using globally matched wavelet filters. The wavelet filters was estimated based on the clustering technique using a collection of ground truth images.The text extraction scheme had extended for the segmentation of document images into text, background, and picture components. The Multiple and the Fisher classifiers had been used as clustering technique for classification.The Fisher classifier is frequently used for two-class classification problems. Even though it was extended to multiclass classification so far the classification accuracy reduces due to the overlapbetween nearby classes. A Markov random field (MRF) is also formulated to provide contextual information of the image based on pixel labellingschemefor refinement of the segmentation results.The experimental result shows the effectiveness of the proposedmethod.

2.5 A Recursive Thresholding Technique for Image Segmentation.

A Recursive Thresholding method for Image Segmentation was proposed in this paper which is performed by extending the Otsu's method.This method is based on discriminant analysis and the threshold operation is considered as the dividing the pixels of an image into foreground and background.The proposed method establishes the necessity for new technique in the field of document processing for the analysis of the document.The new approach had implemented in the range of document images, especially real-life bank checks. This approach extracts the brightest homogeneous object from aninput image at each recursion, and eliminates the darkest homogeneous object after the last recursion. The recursive method is developed without any restrictions on the number of objects in the digital image. The experimental results showed the importance and the utility of the new approach for the specified class of document images of bank checks presented.

2.6 Document Image Binarization Using Background Estimation and Stroke Edges

Document imagebinarization is often performed in the preprocessing stage of different document image processing related applications such as optimal character recognition(OCR) and document retrival..It converts a gray scale document image into a binary document image and accordingly facilities the ensuring tasks such as document skew estimation and document layout analysis.The text stroke edges are then detected based on the local image variation within the compensated document image.After that ,the document text is extracted based on the local threshold that is estimated from the detected text stroke edge pixels.Therefore,it is more suitable for the compensation of the variation of the document image contrast that often results from certain document degradation such as uneven illumination and smear.Finally the document text is segmented by a local threshold that is estimated based on the detected text stroke edges..We detect the text stroke edges based on the local image variation.Before the evaluation of the local image variation ,the global variation of the document image contrast is first compensated so that the text stroke edges can be better detected in the ensuring operations.The signal at each sampling pixel is estimated by the median intensity of the document image pixels within a local one dimensional neighborhood window.

3. PERFORMANCE EVALUATION

The performance evaluation of DIBCO techniques

- Otsu's methoddoesnot give satisfactory results on any of the test input document images as it is a global thresholding algorithm and degradations generally has local variance noise.

- Niblack's and Bernsen's method produces great amount of background noise.

- Sauvola's method overcomes the background noise problems but produces thinned and broken characters. In variable contrast image it often does not capture foreground pixels in low contrast regions.

- Kim's method has good result in maximum input document images but suffers from variable strength of characters, i.e. somewhere it is thick or joined and somewhere it is thin or broken, in some input cases. The running time of this method is extremely large as compared to proposed.

- Gatos' method uses Sauvola's method as an intermediate step to extract information about foreground pixels as a result of it inherits some of the problems of Sauvola's method like: not capturing foreground pixels in low contrast regions of variable contrast image. It has thick characters causing merging of characters in low resolution document images.

- Pai's method is based on histogram to detect blocks. It properly handles non-uniform illuminated images but fails in very low or very high illuminated document images.

- Valizadeh's method is quite good and works well in most of the document images but leaves some noise in area not containing text. It also second worst running time among methods used in this literature.

4.EVALUATION MEASURES

The evaluation measures of degraded document images are given in the below table,

Method	Time (sec)	F measure (%)	PSNR (dB)	NRM ($\times 10^{-2}$)	IND
Otsu	0.01074	84.114	14.506	3.420	0.711
Pai	0.02650	60.081	9.102	8.872	0.392
Niblack	1.66380	43.356	6.321	16.480	0.204
Sauvola	1.67060	52.441	12.039	32.229	0.355
Bernsen	1.38260	59.564	9.406	12.128	0.323
Proposed	2.49380	88.694	16.660	6.868	0.774
Gatos	4.33850	87.238	16.410	9.935	0.757
Kim	37.36700	86.284	15.334	3.866	0.740

- **Gatos:** It achieved second rank for all the among all methods on the basis of F-measure (87.238, 81.110, and 70.940 respectively) and PSNR (16.410, 15.647, and 14.399 respectively).

- **Kim:** It achieved third rank on the basis of F-measure (86.284, 70.246 respectively) and PSNR (15.334, 13.306 respectively). F-measure and PSNR are 15.371, and 0.377 respectively.

- **Otsu:** Otsu's method achieved fourth rank and having 84.114 F-measure and 14.506 PSNR. It has ninth and fifth rank (F-measure: 15.371, PSNR: 0.377) and (F-measure: 65.171, PSNR: 12.191).

- **Valizadeh:** It has fifth rank on the basis of F-measure (70.869) and PSNR (12.794). It has fifth and fourth rank achieved F-measure: 37.404, 65.627, PSNR: 6.038, 12.175, respectively.

- **Pai:**Pai's method has sixth rank, 60.081 F-measure and 9.102 PSNR. It has seventh rank for the achieved F-measure: 32.131, 33.172, and PSNR: 4.241, 5.984 respectively.

- **Bernsen:** This method has seventh rank on the basis of F-measure (59.564) and PSNR (9.406). It has third and ninth rank achieved F-measure: 73.581, 28.934, and PSNR: 13.494, 5.321, respectively.

- **Sauvola:**Sauvola's method has eighth rank among all the methods on the basis of F-measure (52.441) and PSNR (12.039). It has fourth and sixth rank achieved F-measure: 56.790, 40.320, and PSNR: 20.291, 12.576, respectively.

- **Niblack:** It has lowest (ninth) rank, F-measure and PSNR. It has sixth and eight rank achieved F-measure: 37.400, 40.320, and PSNR: 5.271, 4.979 respectively.

5.CONCLUSION

This paper presents a survey of document image binarization combination framework that improves the performance of reported document image binarization methods. The given framework divides the image pixels into three categories based on the binary results of given document binarization methods. All the pixels are then projected into a feature space. The pixels in foreground and background sets can be viewed as correctly labeled samples, and used to determine the label of those uncertain pixels. A classifier is then applied to iteratively classify those uncertain pixels into foreground and background. Experiments over the dataset of recentDIBCO 2009 and H-DIBCO demonstrate superior performance of our proposed framework.

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