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AN IMPROVED HYBRID BINARIZATION TECHNIQUE FOR DEGRADED DOCUMENT DIGITIZATION

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ABSTRACT

In document analysis, binary image representation is essential format. In previous studies, different techniques are implemented and tried and true for different types of degradation in document image. But none of these methods are competent to properly extract the text from degraded background. However, few thresholding techniques are available but due to complex nature it cannot solve all binarization problems. This paper evaluates a hybrid document image binarization technique which uses both local and global thresholding that divides the text from badly degraded document images accurately. The proposed method involves specialized evaluation technique for binarization to test samples from DIBCO 2009-13 dataset which have contrast parameter selection.The method uses both local image contrast and gradient to enhance the poor quality old script images and define edge pixels correctly. To evaluate the proposed work performance, we compare it with Otsu, Sauvola, Niblack, Bernsen and LMM method. The proposed method adapts all the binarization problems and brings highest 94.97% accuracy and gives superior performance compare to all other state-of-art techniques.

KEYWORDS: Binarization, degraded document image, old script images, local image contrast, local image gradient, thresholding.

INTRODUCTION

In document analysis, binary image representation is essential format. An old script image analysis is a considerable research task in the area of image processing and pattern recognition. The text extraction is a segmentation of text from degraded background. the accuracy of the binarization process shows the performance of the in document analysis applications so we have to increase the accuracy of binarization processes.This segmentation of degraded text old script image have specific issues to deal such as how to select clear text strings on the leading side of page from the actively sipping, dominating, overlaying and interfering images arising from the back side. Fig 1 shows Samples of poor quality old script images from DIBCO dataset. This old script degradation can be restored using image binarization technique. Primarily image binarization approach is a segregation of pixel amounts in two different class, white as background and black as fore. The thresholding technique plays essential role in restoration of fore from background of old script image.

On a large scale Binarization techniques are classified as global and local thresholding. Due to high inter/intra transformation enclosed in the text stroke and old script background over different old script images, a single thresholding approach is not suitable to clarify the different issues. Global thresholding is favored when the images are having equal contrast extension on background and fore. This method, determine a particular threshold amount for the whole old script, the gray scale amount is use to assign every pixel of old script image as fore or background. Local adaptive thresholding is adopted for restoring the fore pixel from old script image with background large contrast change and noise. In this techniques, on the basis of grayscale amount of neighboring pixels, select a particular threshold amount for each pixel.

This paper explores old script binarization techniques that elongate previous adaptive contrast method and perform some parameter variation during contrast construction of degraded old script image to get better results. The method

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uses both local image contrast and local image gradient which adaptively select the contrast of the image so the method is fair to uneven illumination at text and background side. In the proposed approach, adaptive contrast construction is estimated by selecting contrast parameters at particular range for given DIBCO and HDIBCO datasets which strengthen the overall performance and increases accuracy of the proposed technique.

Fig 1 Degraded document Images

RELATED WORK

There are many thresholding techniques are estimated for binarization of degraded old script images. The global thresholding technique like otsu's method gives good results but it do not form clear bimodal pattern and takes too much time to for multilevel threshold selection. There are some adaptive thresholding techniques are also available, which perform local thresholding in particular window size for every old script pixel and that can finely accord with various degradation types in old script images. In this window based thresholding technique, the local window based threshold is estimated using mean and standard variation of image pixels in a local neighborhood window so for processing it is mostly rely on window size. In this estimated work, considering some global and local window size based method and analyzes their performance over each other.

First, we see the, *Otsu's* [1] method which is very popular and well known. It is global thresholding technique which is most efficient as compared to other. An Otsu's method based on clustering determination of the grayscale data of degraded image and designs two clusters of the Gaussian distribution of pixels of the image. The class variance of the both classes of pixels is minimized by obtaining optimal threshold value using the iterative application of the algorithm. Later perform a conversion of a gray level image to a binary image by histogram shape-based image thresholding. The optimum threshold is computed with disjoining two classes (e.g. Foreground and background) so that their joined spread (intra class variance) is minimal.

In the proposed method, for segmentation of text and background pixels both local image contrast and local image gradient is important because text and background pixels are having some certain image contrast so they are effectively used in different degraded document images. In The modified Local adaptive method proposed by *Bernsen* [4] which estimates the local threshold with a mean value of minimum and maximum intensities of pixels within a window. The threshold value is set using the mid range intensity value of pixel within a local window, which is the mean of the minimum $I_{low}(i,j)$ and maximum $I_{high}(i,j)$ of gray values.

$$C(i,j) = I_{high}(i,j) - I_{low}(i,j) \dots\dots(3)$$

Where, $C(i,j)$denotes the contrast of an image pixel (i, j). The pixel will be sort into text or background by comparing minimum and maximum intensities. If the local contrast $C(i,j)$ is smaller than the threshold, then the

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pixel is appointed as background and vice-versa. The method, not perform well on degraded document images with a complex background.

The improvement on Bernsen's method is an LMM method [6] which well handles the documents with a complex background. The method comes out with local image contrast and normalization factor. Here the normalization factor is compensates for the image variation in the document background. The local image contrast is evaluated as,

$$C(i,j) = \frac{I_{max}(i,j) - I_{min}(i,j)}{I_{max}(i,j) + I_{min}(i,j) + \varepsilon} \quad \ldots\ldots\ldots (4)$$

Here, ε is a positive value which is added in case the local maximum is equal to 0. First, find contrast $C(i,j)$ of image on area over the text stroke boundaries. So to find the contrast of image consider pixel within both bright and dark region, image pixels inside bright regions, the denominator is large, which results in a relatively low image contrast, for image pixels in dark regions, the denominator is small, which give high image contrast. The limitation of the technique is, it cannot handle document images with bright text having bright background properly. [6]

The disadvantages of the LMM method are overcome by *Gatos's* [5] method. This method is a local adaptive thresholding technique for image binarization, enhances the quality of degraded document images, and does not need any parameter tuning. In this technique, a background surface calculation is done by interpolating neighboring background intensities. The thresholding technique is applied by integrating the estimated background surface with the original image. The up-sampling technique is included, to obtain efficient greater quality binary image. It is very easy and useful method for binarization of degraded document, but gets fail in binarization of low resolution images. In figure 1 the fourth image shows the small image contrast in text stroke edges and this problem of degradation can be removed using LMM method, but it will give some drawbacks in the processing of bright pixels of an image.

To overcome the drawback of over normalization in bright text pixel region of LMM method Bolan Su, Shijian Lu proposed an adaptive contrast method. In this adaptive contrast technique they use both local contrast and local image gradient of the image for contrast enhancement and further pixel classification to find foreground and background text stroke pixel. This paper evaluate optimize algorithm which give higher accuracy over all above thresholding techniques for degraded document images. In this paper, parameter selection is important and using this we achieve better results in terms of accuracy as compared to previous binarization techniques for DIBCO datasets.

PROPOSED SYSTEM

This section evaluates a proposed binarization technique for degraded manuscript images. The input is taken as a degraded old script image, first contrast image map is established and then get it together with canny edge map to find text stoke edge pixels. Then local thresholding is accomplished using text stroke edge pixel to segment text from background of old script image. After that post processing is carry out for further improvement in old script images.

1) Preprocessing

The old script image Pre-processing involves color conversion, histogram, and histogram equalization helps to recover the quality and clarity images. Histogram equalization is specific image enhancement techniques. This method delivers the intensities of the images. Through this, increases contrast of the areas from local contrast to higher contrast. After that filtering is performed, it modifies and enhances the quality of image. The algorithm is assign to the amounts of the pixels in the neighborhood of the equivalent input pixel which execute amount of any given pixel in the output image. In propose method the mean filtering is performed.

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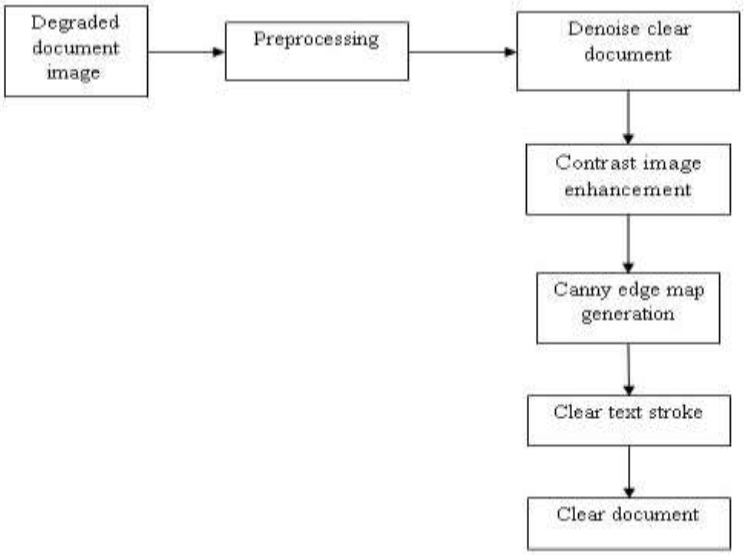

Fig 2 Overview of the binarization algorithm

2) Contrast image enhancement

The image gradient is highly used for the edge detection. And it is used to find out text stroke edges of image with uniform background and many non-text edges from background with non-uniform image variation due to noise, uneven lighting, bleed-through, etc. The image gradient is get normalized to compensate this image variations from background and extract text stroke edges properly.

In LMM method, it suppresses image variation of background using difference between local maximum and minimum intensity. But it will not extract bright text properly from document image and image get over-normalized. So combine image contrast with image gradient and vary some parameters for it to get accurate results as follow,

$$C_a(i,j) = \alpha C(i,j) + (1-\alpha)\big(I_{max}(i,j) - I_{min}(i,j)\big) \ldots (3)$$

$C(i,j)$ gives local image contrast of document image from equation (3) and $I_{max}(i,j) - I_{min}(i,j)$ is local image gradient. Consider 3*3 image to find image gradient,

The value of α is properly assign so that it will give high contrast image.

$$\alpha = \left(\frac{Std}{128}\right)^{\gamma} \ldots . (4)$$

In our propose work we vary the value of γ parameter in particular range so it will enhance contrast of the image and increase the overall accuracy for all DIBCO dataset.

3) Edge pixel detection

The adaptive contrast map at extracted text stoke edges is larger than old script background. Therefore use Otsu's thresholding technique to find text stroke edge pixels. It select high contrast pixels from both the sides of text stroke because it use difference of local high and low intensity in local window to evaluate contrast map of old script image. The Canny's edge detection operation performed in combination with contrast binary edge map for further improving.

The Canny's edge detector have good detection and localization property which reduce the probability of false positive as well as false negatives and the identified edge need to be as near as possible to the positive edges. The canny's edge detector, must recover distinct point only for every edge point. The pixels which exist in both high contrast image pixel map and canny edge map are only arise in edge detector output, which supports to select stroke

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edge pixels properly.

4) Local Threshold Estimation

The edge detector properly observed the high contrast text stroke edge pixels, so now we easily select the text from its background. From this we notice that the text pixels are near to the observed text stroke edge pixels. And, there is a recognizable intensity change into the high contrast stroke edge pixels and the surrounding background pixels. Consider the edge map, if edge pixel tagged 0 and pixel next to it tagged 1 are perfectly identify. And other wrongly detected pixels are removed. The old script image text can thus be selected based on the observed text stroke edge pixels as follows:

$$R(x,y) = 1 \quad E_{dg} > E_{mean} + E_{std}$$
$$= 0 \quad Otherwise$$

In the remaining edge pixel, find out the adjacent detected edge pixels which are like the two sides of text. After that calculate the distance between the two adjacent detected pixels which helps in finding the stroke edge width by using most regularly appearing adjacent edge pixel.

5)*Post-processing*

In post processing find out the all connected edge pixels from the edge map and remove those do not connect with other edge pixels. After that for each connected edge pixel find its neighborhood pixel pairs, they either belongs to foreground or background or both. Then compare the map with intensity of input image, the pixel with lower intensity to foreground class (text), and the other to background class.

EXPERIMENTAL ANALYSIS

In propose work, Fig.1. (b) shows some image variation in background so we establish contrast map to this image using local contrast, local gradient and proposed method for given sample image Fig.1 (b). The local image contrast shows good result, but it cannot handle small intensity variations properly and not detect thin text stokes from the document image shows in Fig 4 (d). So next we use local image gradient, it well preserve thin text strokes and suppress background variations but give limitation in processing of bright text stoke image pixels shows in Fig 4 (e).

As compare local image contrast and local image gradient, in our proposed work, Equation (3) establish excellent contrast map by varying γ parameter in a define range. Due to proper variation in γ, we get weighted value of local image contrast and image gradient which helps to detect all edges of old script image properly than the above two methods i.e. proposed method shows in Fig 4 (f).

In this experiment, we compare our proposed method with other state-of-the-art techniques on DIBCO 2009, 2010, 2011, 2012 and 2013 datasets Shows in Fig 3, which give accuracy evalution results for proposed and previous techniques.. These methods include Otsu's method, Sauvola's method, Niblack's method, Bernsen's method, LMM method. The datasets are composed of old script images that suffer from several common document degradations such as smear, smudge, bleed-through and low contrast. The dataset contains testing images that consists handwritten old scripts plus printed old scripts with ground truth images.

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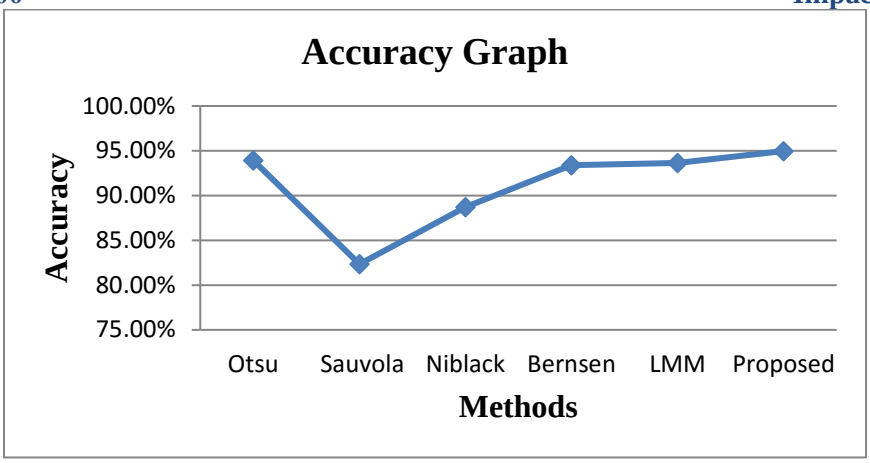

Fig 3 Accuracy : evaluation results for all DIBCO datasets

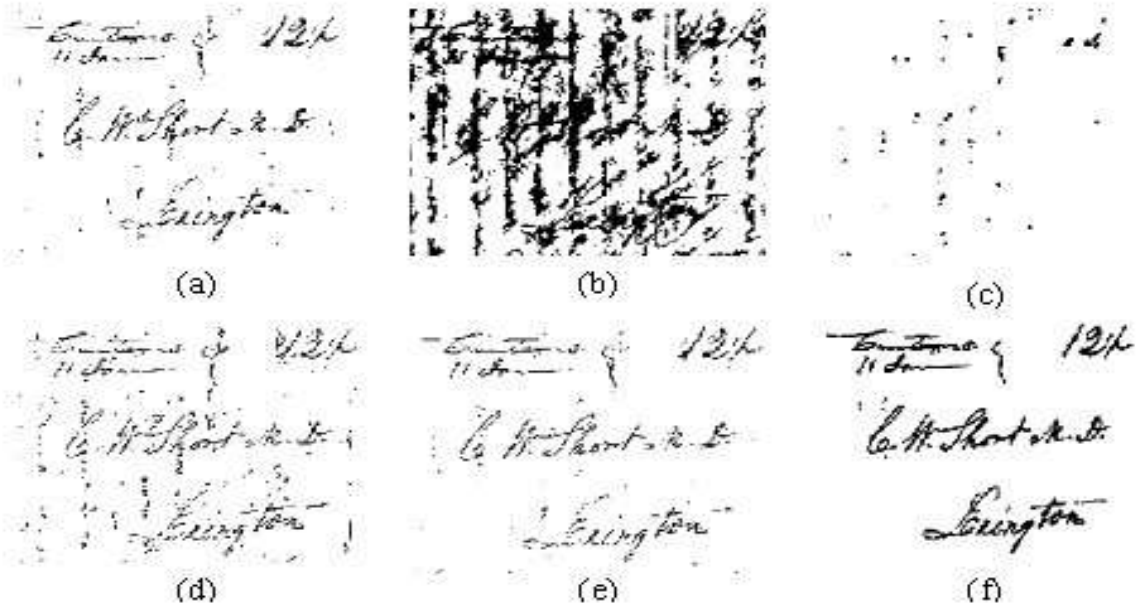

Fig 4 Binarization result of sample document image from DIBCO2013 (HW05) (a) Otsu's (b) Sauvola's (c) Niblack's (d) Bernsen's (e) LMM (f) Proposed

The proposed method involves several parameters, most of which can be automatically analyzed based on the statistics of the input script image. This makes proposed technique more stable and easy-to-use for old script images with number of degradation. We also calculate the evaluation results for F-Measure, PSNR, NRM, and MPM for particular range amount of γ. It automatically selects γ from given rang of values and overall accuracy score for DIBCO 2009-13 dataset is 94.97%. And it also gives high F-Measure, PSNR compare to previously proposed technique.

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CONCLUSION

The document image analysis is an important research area in the field of image processing and pattern recognition. Binarization can become a challenging job under varying illumination and noise So many state-of-art techniques are get fail and not give reasonable results with all type of degraded document images. A number of fragments provide to complicate the thresholding theory including surround illumination, inadequate contrast. The proposed method is simple and robust, only few parameters are involved. Moreover, it works for different kinds of degraded document images from DIBCO dataset. This proposed method present an adaptive image contrast; it is a combination of the local image contrast and the local image gradient that is liberal to text and background variation created by various types of document degradations. The γ parameter is selected in particular range. In this adaptive contrast parameter range it give highest result in term of accuracy and F_Measure over all DIBCO dataset degraded document images. The proposed method has been tested on the various DIBCO datasets and achieves highest accuracy and F_Measure score.

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