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Survey on Restoration of Degraded Document using Different Thresholding Techniques

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Abstract

Documents are degraded normally by the disturbance caused in the background . These are known as bleed-through effect, (ie) a pattern that interferes with the main text due to seeping of ink from the reverse side. These degradations must be removed to improve human or automatic readability. Degraded documents will have background noise ,changes in contrast and illumination ,so it is best to use local thresholding methods to restore foreground. Comparative study on some local adaptive thresholding methods such as niblack, sauvola, wolf and feng are done and analyse its quality over different images. The quality of the image is measured in terms of PSNR and correlation.

Keywords:Degradeddocument,Bleed-through,Niblack,Sauvola,Wolf,Feng

Introduction

Historical document images are normally degraded by various reasons which are preserved in the form of scanned images. In case of double sided documents with low quality of carrying medium, then the foreground text in the document will get distortion by the background side. This type of distortion is usually referred as bleed-through. The ink transfers from the back side to the front side of the page make the two texts to sensibly correlated.

This document degradation can be restore using image binarization technique. Image binarization is the process of separation of pixel values into two groups, white as background and black as foreground. In restoration of foreground from background thresholding plays a major role in images. Thresholding can be categorized into global thresholding and local thresholding.

Global thresholding is suitable only when the images are having uniform contrast distribution of background and foreground. But when we take degraded document images, there exists background noise or variation in contrast and illumination. In such cases, restoring the foreground pixels can be done with the help of local adaptive thresholding.

Global binarization methods such as one proposed by Otsu try to find a single threshold value for the whole document. Then each pixel is assigned to page foreground or background based on its gray value. Global binarization methods are very fast and they give good results for typical scanned documents. For many years, the binarization of grayscale documents was based on the global thresholding algorithms. If the illumination over the document is not uniform, for instance in the case of scanned book pages or camera-captured documents, global binarization methods tend to produce marginal noise along the page borders.

To overcome these complexities, local thresholding techniques have been proposed for document binarization. These techniques estimate a different threshold for each pixel according to the grayscale information of the neighbouring pixels. Section 2 describes niblack, sauvola, wolf, feng thresholding methods. Section 3 describes the architecture flow for restoration of degraded document. Section 4 describes experimental results and discussions.

Methodology

This section describes some locally adaptive thresholding techniques with its advantages and disadvantages.

Niblack Thresholding Method

Niblack's method [1] is based on the calculation of the local mean and of local standard deviation . Niblack's algorithm calculates a pixel-wise threshold by sliding a rectangular window over the gray level image. The threshold in the pixel (x,y)

is decided by the expression: The computation of threshold is based on the local mean m and the standard deviation s of all the pixels in the window and is given by the equation 1 below:

$$T(x,y) = m(x,y) + k * s(x,y) \quad (1.1)$$

where m(x,y) and s(x,y) are the average and the standard deviation of a local area respectively. K is the niblack factor. If we give k value as -0.1 it will separate the text from background but the text may get break. As setting the value of k = -0.2 produces objects separated well enough from background, here the text will not get break.

Sauvola Thresholding Method

In Niblack some noises may present in non-text regions, so some preprocessing, post processing methods require to remove the noise. This method [2] claims to improve on the Niblack method especially for stained and badly illuminated documents. It adapts the threshold according to the local mean and standard deviation. The threshold at pixel (x,y) is calculated as

$$T(x,y) = m(x,y) * [1 + k * \left[1 - \frac{s(x,y)}{R}\right]] \quad (1.2)$$

where m and s are as in Niblack , and Sauvola suggests the values of k = 0.5 and R is dynamic range of image gray value standard deviation, R is fixed to 128. Thus the contribution of the standard deviation becomes adaptive. For example in the case of text printed on a dirty or stained paper the threshold is lowered.

Sauvola improve niblack method by impose a hypothesis on the grey value of text and non-text pixels –text pixels have near 0 grey values and non text pixels have near 255 grey values.

Sauvola outperforms niblack for well scanned document images,but it faces difficulties in images that do not agree well with hypothesis (ie) Documents images captured at insufficient illumination, especially when the grey values of text and non-text pixels are close to each other.

Wolf Thresholding Method

Christian wolf propose [3] this method. It determine the local threshold value by normalizing the contrast and the mean gray value of image

$$T = (1-k) * m + k * M + k * \frac{s}{R} * (m - M) \quad (1.3)$$

where K is fixed to 0.5,M is the minimum gray value of the image and R is set to maximum gray value standard deviation. This method degrade when there is notable change of background's gray values across the image, as the local threshold value is based on the minimum gray value and maximum standard deviation of local gray values computed from the whole image.

This method in most cases outperforms its predecessors. However, degradation is observed in its performance if there is a sharp change in background gray values across the image. This is due to the fact that the values of M and R are calculated from the whole image. So even a small noisy patch could significantly influence M and R values, thus eventually calculating misleading binarization thresholds

Feng Thresholding Method

Instead of calculating dynamic range of gray-value standard deviation for the whole image in wolf method, Feng method [4] calculating it locally introducing the notion of two local windows, one contained within the other. The values of local mean m, the minimum gray-level M, and standard deviation s are calculated in the primary local window while the dynamic range standard deviation R is calculated in the larger window termed as 'secondary local window'. Binarization threshold is then computed as:

$$T = (1 - C_1) * m + C_2 * \left(\frac{s}{R}\right) * (m - M) + C_3 * M$$

where C2 = k1 (s/Rs)γ and C3 = k2 (s/Rs)γ. Three coefficients used to allow more flexible and adaptive weighting. Based on the experimental experiences of authors, γ is set to 2 while the values of other parameters, C1, k1 and k2 are proposed to be in the ranges 0.1-0.2, 0.15-0.25 and 0.01-0.05 respectively. These value of coefficient are set to calculate a separate text regions from non-text regions effectively.

Basic Flow for Restoration of Degraded Document

This section describes about the basic architecture flow to restore the degraded documents. The figure 1 describes the flow of the system

Image Preprocessing

Recto-verso degraded color image is first taken as a input image from the source. First step is to change the RGB color modality image to HSV image. HSV is used to separate image intensity from color information. Hue represent the color type. Saturation represent the vibrancy of the color. Value represent the brightness of color. From the HSV image its is now easy to convert into grayscale. The grayscale of the input image is obtain. Eventhough the grayscale image may have noise and blur in it. An image may be "dirty" with speckles/dots on an image,dots can be modeled as impulses (salt-and-pepper or speckle) or continuously varying (Gaussian noise).

Noise can be removed by taking mean or median values of neighbouring pixels. It is first pre-process to remove the noise in the image. Each pixel is corrupted by a noise value, independent of neighbouring pixels. Apply filtering methods in the

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noisy image. The point spread function was calculated for a blurred image.The blur and noise can be reduce by using wiener filtering methods. This wiener filter remove the noise by taking account of blurred image and the point spread function. Now the grayscale image without blur is obtain.

Image Restoration

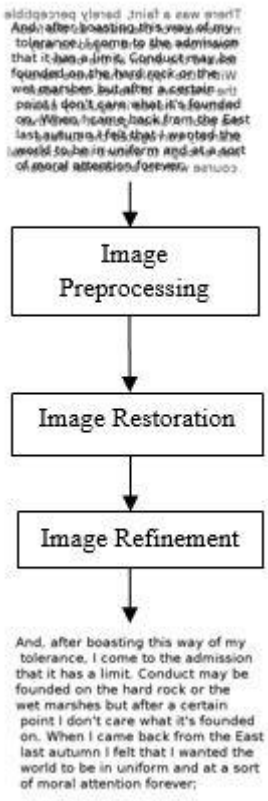
After the removal of blur and noise, now its the time to separate the foreground and the background of the image. To extract the foreground various local thresholding method is used. Niblack is taken as a basic thresholding method. Then apply sauvola ,wolf, feng threshold for all images.

Each method is based on the calculation of the local mean and of local standard deviation of the image. When the pixel value is greater than this threshold value then the foreground text will get separated from the background. Else it will display the error.

Image Refinement

The separated image is now undergo into refinement process for better visualization. The post-binarization refinement improves the appearance of the binary images and text readability, especially in documents with red ink characters and line gaps or holes.

Input : Degraded Recto-Verso Image



Output : Separated Recto Image

Fig 1 Architecture of proposed system

Refinement consists of the successive erosion followed by dilation operation, and opening on the negative image to remove the remaining black pixels that not belong to the text characters. The refinement significantly improves the image quality for most of the image types since it clarifies the background area, by clearing up the appearance of the text, especially when it is applied to images after all thresholding methods

Experimental Results and Discussions

A set of degraded image is processed by all thresholding method and take all output images for evaluating the quality of images. The quality of the resultant images using different thresholding methods are evaluated using PSNR and Correlation. It is a good one for measure comparing restoration result of the same image. For evaluating PSNR both ground truth image and restored image is needed.It is found that feng method has good similarity of images than all other thresholding.

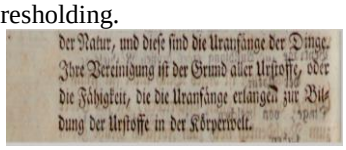


Fig 2.1 Input Degraded Image

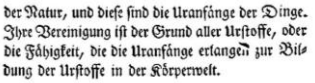


Fig 2.2 Ground truth Image

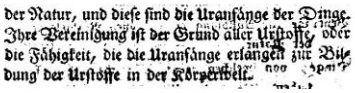


Fig 2.3 Resultant Image using Niblack

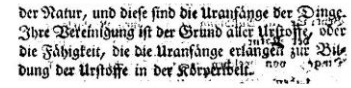


Fig 2.4 Resultant Image using Sauvola

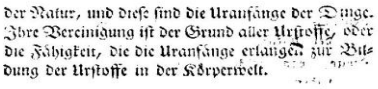


Fig 2.5 Resultant Image using Wolf

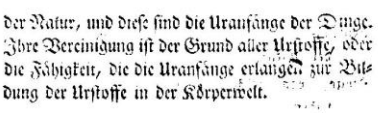


Fig 2.6 Resultant Image using Feng

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The PSNR value for set of seven images is evaluated and shown in fig 2.

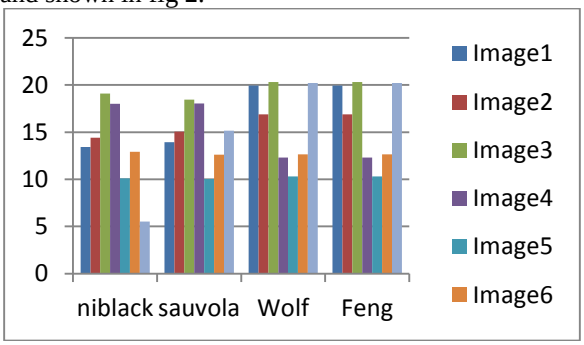

Fig 2 Similarity measures in PSNR

Correlation is a good measure to find how much similarity is occurred between original and result image. The result image is recovered from attack process such like blur,degradation. So its is good to measure its correlation. Correlation value will be between 0 to 1. Higher the value is a good measure. The correlation value for set of seven images is evaluated and shown in fig 3.

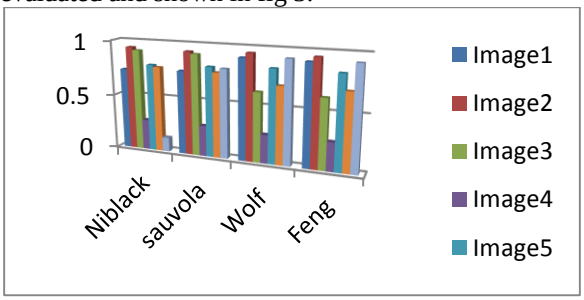

Fig 3 Correlation measure between Groundtruth and resultant image for all thresholding methods.

Conclusion

Restoration of degraded document was achieved without blur and noise even when the individual sources are largely correlated. This restoration is done successfully on text image by sauvola, wolf, feng threshold. It restore the foreground from background by calculating the local mean and standard deviation and minimum gray value. The potential of the applications of preliminary processing to document images, by adjusting the binarization method according to the category of the image, becomes reasonably estimated taking into account the improvement in the quality of the image as a whole and the increased readability of the texture. The estimated resultant image is further enhanced by an innovative image refinement technique. The image quality of the resultant image is then evaluated with the help of PSNR. It have shown improved image quality. Similarity is measured by use of correlation. It has turned out that feng performs better compared with niblack thresholding technique and it is robust for document images comparing with other thresholding methods based on connectivity and background analysis and might succeed in a wider range of applications.

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