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Modified Adaptive Contrast Based Degraded Document Image Binarization Technique

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Abstract: ***Segmentation of text from badly degraded document images is a very challenging task due to the high inter/intravariation between the document background and the fore- ground text of different document images. This paper, propose a novel document image binarization technique that addresses these issues by using modified adaptive image contrast. The modified adaptive image contrast is a combination of the local image contrast and the local image gradient that is tolerant to text and background variation caused by different types of document degradations. In the proposed technique, a modified adaptive contrast map is first constructed for an input degraded document image. The contrast map is then binarized and combined with sobel edge map to identify the text edge pixels. The document text is further segmented by a threshold that is estimated based on the intensities of detected text edge pixels with the mean and standard deviation. The proposed method is simple, robust, and involves minimum parameter tuning.***

Keywords: Segmentation, Binarization, Sobel edge, Threshold, Parameter Tuning

1. Introduction

Document image binarization is performed in the preprocessing stage for document analysis and it aims to segment the foreground text from the document background. A fast and accurate document image binarization technique is important for the ensuing document image processing tasks such as optical character recognition (OCR).

Though document image binarization has been studied for many years, the thresholding of degraded document images is still an unsolved problem due to the high inter/intravariation between the text stroke and the document background across different document images. The handwritten text within the degraded documents often shows a certain amount of variation in terms of the stroke width, stroke brightness, stroke connection, and document background. In addition, historical documents are often degraded by the bleed through. In addition, historical documents are often degraded by different types of imaging artifacts. These different types of document degradations tend to induce the document thresholding error and make degraded document image binarization a big challenge to most state-of-the-art techniques.

The document binarization technique that extends previous method [1].The proposed method is simple, robust and capable of handling different types of degraded document images with minimum parameter tuning. It makes use of the adaptive image contrast that combines the local image contrast and the local image gradient adaptively and therefore is tolerant to the text and background variation caused by different types of document degradations. In particular, the proposed technique execution time can be reduced.

This paper proposes a novel document image binarization technique that addresses these issues by using modified adaptive image contrast. The modified adaptive image contrast is a combination of the local image contrast and the local image gradient that is tolerant to text and background variation caused by different types of document degradations. In the proposed technique, an adaptive contrast map is first constructed for an input degraded document image. An average filter and wiener filter is applied to remove lightening artifact and noise. The contrast map is then binarized and combined with sobel edge map to identify the text edge pixels. The document text is further segmented by a local threshold that is estimated based on the intensities of detected text edge pixels with the mean and standard deviation. Morphological operations can be used to detect and rectify the edge distortions. The proposed method is simple, robust, and involves minimum parameter tuning.

In the proposed document image binarization techniques. Given a degraded document image, first a preprocessing stage is applied, an average filter and wiener filter is used to remove lighting artifacts and noise respectively. A modified adaptive contrast map is then constructed and the text edges are then detected through the combination of the binarized modified adaptive contrast map and the sobel edge map. The text is then segmented based on the local threshold that is estimated from the detected text edge pixels. Some morphological operation such as closing ie, dialation followed by erosion is applied to detect and restore most of the edge distortions.

A modified adaptive contrast based degraded document image binarization technique has been adopted. In this method, from a degraded document image, a modified adaptive contrast map is first constructed. The edge pixel are detected through the combination of binarized modified adaptive contrast map and sobel edge map. The text is then segmented based on thresholding and stroke width is made constant. An average filter and wiener filter is applied in this method. Morphological operations are also performed.

A. Preprocessing

In the preprocessing stage an average filter and wiener filter is applied to the degraded document image. An

average filter is windowed filter of linear class, that smoothes image. Its also called as mean filter. The basic idea behind filter is for any element of the image takes an average across its neighborhood. Mean filtering is a simple, intuitive and easy to implement method of smoothing images, i.e. reducing the amount of intensity variation between one pixel and the next. The filter works as low-pass one and therefore, reduces the spatial intensity derivatives present in the image. Low pass filtering, otherwise known as "smoothing", is employed to remove high spatial frequency noise from image. This filter is used to avoid the lighting artifacts.

The Wiener filter is a filter used to produce an estimate of a desired or target random process by linear time-invariant filtering of an observed noisy process, assuming known stationary signal and noise spectra, and additive noise. The Wiener filter minimizes the mean square error between the estimated random process and the desired process. The goal of the Wiener filter is to compute a statistical estimate of an unknown signal using a related signal as an input and filtering that known signal to produce the estimate as an output. The Wiener filter can be used to filter out the noise from the corrupted signal to provide an estimate of the underlying signal of interest. The Wiener filter is based on a statistical approach, and a more statistical account of the theory is given in the minimum.

B. Modified Contrast Image Construction

The image gradient has been widely used for edge detection and it can be used to detect the text edges of the document images effectively that have a uniform document back- ground. On the other hand, it often detects many nonstroke edges from the background of degraded document that often contains certain image variations due to noise, uneven lighting, bleed-through, etc. To extract only the edges properly, the image gradient needs to be normalized to compensate the image variation within the document background. A modified contrast image is constructed by changing the equation. From the previous work ,combine the local image contrast and local image gradient and an adaptive contrast map is generated.

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

where C(i, j) denotes the local contrast and (Imax(i, j) Imin(i, j)) refers to the local image gradient that is normalized to [0, 1]. _ is the weight between local contrast and local gradient that is controlled based on the document image statistical information. Ideally, the image contrast will be assigned with a high weight (i.e. large _) when the document image has significant intensity variation. So that the proposed binarization technique depends more on the local image contrast that can capture the intensity variation well and hence produce good results. Otherwise, the local image gradient will be assigned with a high weight. The proposed binarization technique relies more on image gradient and avoid the over normalization problem. The mapping from document image intensity variation to ∝ by a power function as follows

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

Where Std denotes the document image intensity standard deviation, and γ is a predefined parameter. The power function has a nice property in that it monotonically and smoothly increases from 0 to 1 and its shape can be easily controlled by different γ can be selected from [0,α], where the power function becomes a linear function when γ = 1. Therefore, the local image gradient will play the major role when is large and the local image contrast will play the major role when is small. The equation is modified by finding the standard deviation of Ca(i; j) and it is denoted as Cs. Then the new equation is as follows

$$C_s = C_a * (0.1)^{C_s}$$

Where Cs is the modified contrast map .Using this the execution time is reduced and gives a better result compared to existing system.

C. Edge Pixel Detection

Edge pixels can be detected through the combination of modified adaptive contrast map and sobel edge map. Here binarization is done using modified adaptive contrast map. sobel edge detection method can detect the edges of degraded document images more accurately, because of its two main advantages: it has some smoothing effect to the random noise of the image. In sobel the element on the edges has been enhanced, so that the edge seems thick and bright, it is because sobel is the differential of two rows or two columns.

Modified adaptive contrast map


sobel edge map

Combination

The purpose of the modified contrast image construction is to detect the edge pixels of the document text properly. As the local image contrast and the local image gradient are evaluated by the difference between the maximum and minimum intensity in a local window, the pixels at both sides of the text stroke will be selected as the high contrast pixels. In the edge function, the sobel method uses the derivative approximation to find the edges. It produces a clean edge map by extracting principal edge features of the image. It is the differential separated by two rows or two columns, so that the edge elements on both sides have been enhanced and make the edges seems to be thick and

bright. Sobel operator is a kind of orthogonal gradient operator. It has been researched for parallelism.

D. Threshold Estimation

The text is then segmented based on the thresholding that is estimated from the detected texts edge pixels. The threshold for binarization is calculated by taking mean and standard deviation of contrast map. The document image text can thus be extracted based on the detected edge pixels as follows:

$$B = I \leq Emean + \frac{Estd}{5}$$

Where Emean and Estd are the mean and standard deviation of the intensity of the detected edge pixels. Here the edge width is constant. In the previous work, edge width is varying and an algorithm is used to find the edge width. The edge width is not accurate because of its variation. so that in this method, the width is fixed. Manually the edge width values can be given depend on the input. It gives better result than the previous threshold estimation.

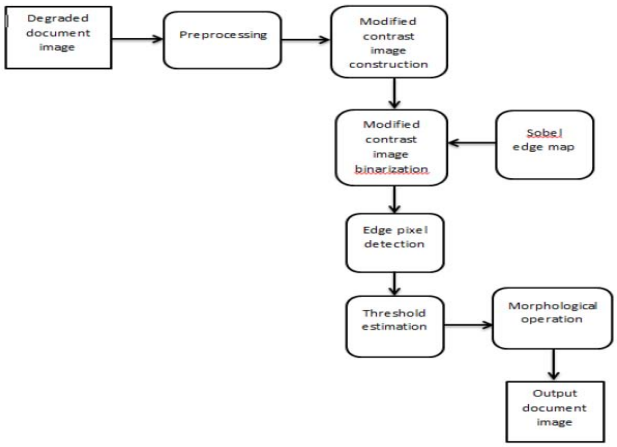
Another modification applied is:

Most of the edge distortions are detected and resolved using morphological operations. Binary images may contain numerous imperfections. In particular, the binary regions produced by simple thresholding are distorted by noise and texture. Morphological image processing pursues the goals of removing these imperfections by accounting for the form and structure of the image. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. By choosing the size and shape of the neighborhood, you can construct a morphological operation that is sensitive to specific shapes in the input image. The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image depends on the size and shape of the structuring element used to process the image. In the morphological dilation and erosion operations, the state of any given pixel in the output image is determined by applying a rule to the corresponding pixel and its neighbors in the input image. The rule used to process the pixels defines the operation as dilation or erosion.

Dilation and erosion are often used in combination to implement image processing operations. For example, the definition of a morphological opening of an image is erosion followed by dilation, using the same structuring element for both operations. The related operation, morphological closing of an image, is the reverse: it consists of dilation followed by erosion with the same structuring element. Here use closing operation.

2. System Design

A. Steps of Proposed Method



It combines the local image contrast and the local image gradient that help to suppress the background variation and avoid the over-normalization of document images with less variation and execution time can also be reduced. Second, the combination with edge map helps to produce a precise text edge map. Third, the proposed method makes use of the text stroke edges that help to extract the foreground text from the document background accurately.

3. Implementation and Results

A. Results

Existing threshold estimation

Proposed threshold estimation

B. Performance Evaluation

The performance of the proposed system is evaluated by finding the elapsed time and precision of both the existing and proposed system.

Figure 1

Figure 2

Table 1: Performance of proposed system

Dataset	Elapsed time	Precision
Fig 1	1.2553	0.83882
Fig 2	0.58037	0.90375

Elapsed time is the measured duration of an event. It is the time that elapses while some event is occurring. It is the amount of time that has passed since a particular process started, especially compared with the amount of time that was calculated for it in a plan. It is also the actual time taken for a process to complete. By comparing with the above tables of existing and proposed systems, the elapsed time less to proposed system as compared with the existing system; ie, the execution time of proposed system is less compared to existing system. The proposed systems which modify its equation reduce the execution time.

Precision is the measurement deviation from true value and its scatter. The number of significant digits to which a value has been reliably measured. Precision is defined in terms of random errors. The precision of a measurement system is the degree to which repeated measurements under unchanged conditions show the same results. Precision is defined by the number of decimal or binary digits.

$$Precision = \frac{tp}{(tp + fb)}$$

where tp is the number of true positive pixels, fb is the number of false positive pixels and (tp+fb) is the total number of true and false positive pixels. By comparing with the above tables of existing and proposed systems, the precision to proposed system is more as compared with the existing system; ie, the proposed system gives better result. Hence conclude that, the proposed system reduces the execution time and gives better result.

4. Conclusion

This paper presents a modified adaptive image contrast based document image binarization technique that is tolerant to different types of document degradation such as uneven illumination and document smear. The proposed technique is simple and robust, only few parameters are involved. Moreover, it works for different kinds of degraded document images. The proposed technique makes use of the local image contrast and local image gradient. The proposed method has been tested on the various datasets.

The proposed method involves several parameters, most of which can be automatically estimated based on the statistics of the input document image. This makes proposed technique more stable and easy-to-use for document images with different kinds of degradation. The superior performance of proposed method can be explained by several factors. First in the proposed technique, an adaptive contrast map is first constructed for an in- put degraded document image. An average filter and wiener filter is applied to remove lightening artifacts and noise. The proposed method combines the local image contrast and the local image gradient that help to suppress the background variation. Also the modified equation reduces the execution time. Second, the contrast map is then binarized and combined with sobel edge map to identify the text edge pixels. The document text is further segmented by a local threshold that is estimated based on the intensities of detected text edge pixels with the mean and standard deviation. The proposed method makes use of the text edges that help to extract the foreground text from the document background accurately. Morphological operations can be used to detect and rectify the edge distortions. The proposed method gives better result compared to existing method. The execution time is reduced by this method.

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