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Efficient RDIB Technique for Degraded Document Images

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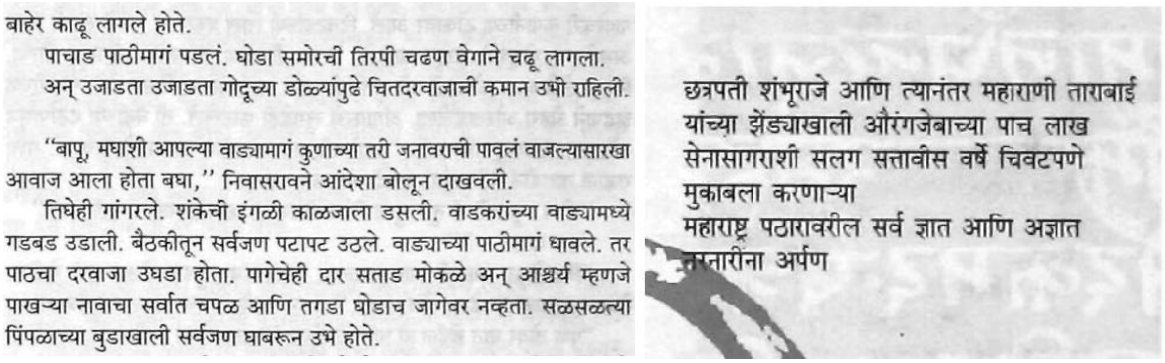
Abstract: *In this digital world, our entire data is available in the form of soft copies of documents. With this, we can update, store, backup and preserve the soft copies of our documents. This is the case with the latest data, but going towards our old traditional data, which is available only on hard copies of the paper, we come across a lot of problems while preserving such rad copies of data. Most of the papers containing our data get degraded due to lack of attention and improper handling and preservation. Most commonly seen degradation of such papers is interference of the text written on the front and back of the papers. In order to make this interfered front end data separate from rear page data many researchers have been proposed binarized documentation methodology. Here we study and analyze various binarization techniques proposed previously and then propose the new and innovative technique for the same. We create the binarized image of the degraded image through some intermediate steps. Ultimately, the binarized image will be next processed by the post processing module. The final output of entire process will generate a clear and binarized image with foreground text clearly seen without interference.*

Keywords – *Adaptive contrast, binarization, image gradient, local image contrast, local threshold*

I. Introduction

In this digital world, various image and document processing techniques emerged in a wider scope for data extraction or text extraction. The images are widely used in various domains of the researches such as geography, tomography, etc. Most of the novels written few of the years ago on the papers are of utmost use in our day to day life, but due to improper maintenance of such novels, the data is degraded and becomes unreadable for users and thus leads to loss of useful data. Such images become degraded after a particular span of time, and we can't use them in spite of them being very useful for us. Sometimes some documents get degraded due to low quality papers or inks used to type or write on the papers, thus making such useful image of no use for further use.



(a) (b)

(c)

Fig1. Sample Degraded Images taken from DIBCO Series of images

The degraded document images either scanned or captured are in the form unreadable text in foreground format. We need to differentiate between the foreground and background text. The techniques for image binarization are therefore emerged as useful ways for obtaining text from degraded documents. The degraded images are then passed through various intermediate methods which will produce the output image in a foreground text readable format. This survey will first analyze various techniques and then make compare the existing techniques to the proposed one. Although document or image binarization issue still prevails, threshold consideration of degraded and interfered document images have been resolved. It's because of the high inter/intra-variation between the foreground text stroke and the unnecessary document background across different documents and images.

II. Literature Survey

There are many thresholding techniques that are used for document image binarization. Because of the unclear bimodal pattern of degraded document images, global thresholding is not an appropriate solution for the degraded document binarization. So the adaptive thresholding method which calculates a local threshold for each pixel in the image, is a better solution to deal with different variations of degraded document images. For example, the formerly used window-based adaptive thresholding technique calculates the local threshold with the help of mean and the standard variation of image pixels in a local neighborhood window. The important drawback of the window-based thresholding technique is that the performance mainly depends on the window size and hence on the character stroke width.

Also there are many other approaches such as background subtraction texture analysis, recursive decomposition method, contour completion, Markov Random Field, matched wavelet cross section sequence graph analysis, self-learning, Laplacian energy user assistance and combination of binarization techniques. To segment the text from the document background, local image contrast and the local image gradient are very important components due to the certain image contrast of test stroke to the background of the neighborhood. Because their effectiveness many binarization techniques uses these components [5], [6], [7], [8]. The definition of local contrast is as follows [6]:

$$C(i,j) = Imax(i,j) - Imin(i,j) \qquad (1)$$

where C(i, j) indicates the contrast of an image pixel (i, j) and Imax(i, j) and Imin(i , j) indicates the maximum and minimum intensities respectively in a local neighborhood window of pixel (i, j). When the value of local contrast C (i, j) is smaller than a threshold value, the pixel is considered as background. Otherwise it is considered as text pixel. Bernsen's method is a simple method for calculating local threshold, but it does not give effective results for degraded document images with a complex document background.

III. Detailed Design and Architecture

In this paper we have introduced a post processing technique that is used to remove degradations in the images that are generated by the background text in the documents. The degradations that are generated due to sipping of ink through the document, spots generated by the spreading of ink are removed using this technique. This technique is used to enhance the result of recovering techniques of degraded document images. It works to get the clear image of foreground text without sipping of background text strokes.

The block diagram shows the architecture of the system. The architecture shows the five modules of the system. These modules combine gives the output. The modules are: contrast image, edge detection using gray scale method, threshold estimation, binarization and post processing. The output of contrast image is generated by inverting RGB values of pixels. The RGB values of pixels ranges from 0 to 255. Then output of contrast image is used by edge detection module to detect the edges of the text.

Edge detection is done by comparing the class of the pixel values. Only two classes are generated that are white and black using gray scale method. Then threshold estimation is done and the mean value is calculated. Local threshold method used in this system. Binarization technique is used to construct the binary map. The image is converted to binary format that is 0 and 1. The pixels on foreground that are not connected with other foreground pixels are filtered out to get the final result of the system. It gives the final filtered output of the degraded image of document.

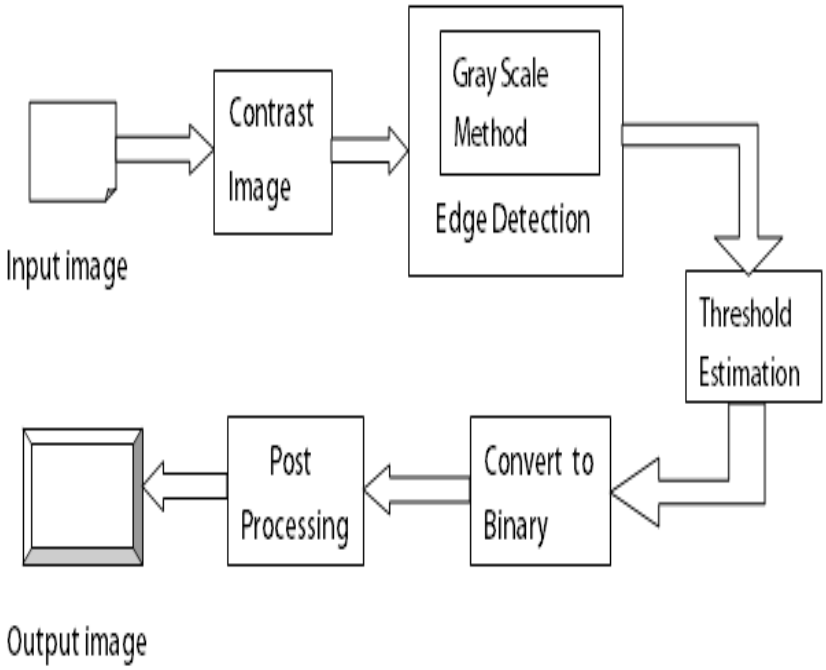


Fig2. Block diagram of system architecture

IV. Proposed System

Here the proposed system presenting an document image binarization technique that is based on adaptive image contrast which is tolerant to different types of degradation of documents such as uneven illumination and document smear. This is the simple and robust technique that involves only few parameters. It also works for different kinds of degraded document images. The local image contrast is used in this technique that is evaluated based on the local maximum and minimum values.

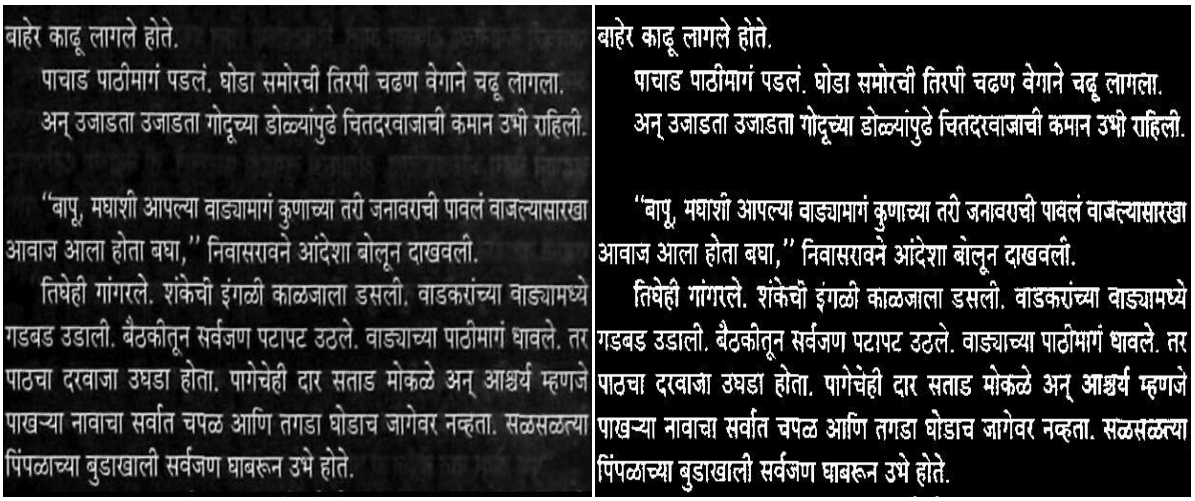
A. Contrast Image Construction:

In this module, local image gradient and local image contrast are combined to get the adaptive image contrast so that the adaptive combination of the local image contrast and the gradient can produce proper contrast maps for document images. For uniform background of document image gradient is the effective way to detect the text stroke edges of the document images. But it also detects the stroke edges from the background that may contains certain image variations due to noise, uneven lighting, bleed-through, etc. To extract only the text stroke edges properly and for compensation of the image variations of document background image gradient needs to be normalized. In earlier method [5], the local contrast is evaluated using the local image maximum and minimum and used to suppress the background variation as described in Equation 1.To overcome the problem of over-normalization, we combine the local image contrast with the local image gradient and derive an adaptive local image contrast as follows:

$$Ca(i,j) = \alpha C(i,j) + (1 - \alpha)(Imax(i,j) - Imin(i,j)) \quad (2)$$

where Ca(i, j) denotes the adaptive local image contrast, C(i, j) denotes the local contrast in Equation 2 and (Imax(i, j) − Imin(i, j)) refers to the local image gradient that is normalized to [0, 1]. The size of local windows is empirically set as 3. α denotes the weight between local contrast and local gradient which is controlled based on the statistical information of document image. When there is significant variation in intensity of image, the image gradient is assigned with the high weight i.e. large α.

Fig. 2 shows the contrast map of the sample document image in Fig. 1 (a) that is created by using local image gradient, local image contrast [5] and our proposed method in Equation 2, respectively. The use of the local image contrast produces a better result as shown in Fig. 2(b). As compared with variations within the text strokes, the use of the local image contrast removes many light text strokes in the contrast map as shown in Fig. 2(b) whereas the use of local image gradient is capable of preserving those light text strokes as shown in Fig. 2(a).



(a) (b)

Fig. 2. Contrast Images constructed using local image gradient

B. ***Text Stroke Edge Pixel Detection:***

In this module contrasted image is matched with gray scale edge detection graph. It produces the outline of the pixels around the foreground text. These pixels are divided into two groups : connected pixels and non-connected pixels. The area around text stroke is occupied by connected pixel. And the other noisy area present in the image is occupied by non-connected pixel. The binary map is further going to improve with the combination of the edges by Canny's edge detector because of the good localization property. It can mark the edges close to real edge location in the detecting image and can extracts a large amount of non-stroke edges by itself. From the contrast image construction we can get the stroke edge pixels of the document text properly. Constructed contrast image consist of a clear bi-modal pattern. The difference between the maximum and minimum intensity in a local window is used to evaluate the local image gradient. Pixels that are present at both the sides of the text stroke are selected as the high contrast pixels. After that the binary map is constructed. The pixels that are present in both the high contrast image pixel map and gray scale method, only those are placed in the combined map. Accurate extraction of the text stroke edge pixels is done with the help of this combination. Here we make use of Otsu's global thresholding method to detect the text stroke edge pixel. The binary map is further going to improve with the combination of the edges by Canny's edge detector because of the good localization property. It can mark the edges close to real edge location in the detecting image and can extracts a large amount of non-stroke edges by itself.

C. ***Local Threshold Estimation***

As soon as the detection of high contrast stroke edge pixels is done properly, the extraction of the text from the document background is carried out. From the different kinds of document images two characteristics can be noticed. First one is the text pixels are close to the detected text stroke edge pixels and second is the divergent intensity difference between the surrounding background pixels and the high contrast stroke edge pixels. Redrawing of the actual text can be done using edge detection method. In this module the mean value is calculated.

D. ***MODULE TO CONVERT INTO BINARY***

The edge detected image is then converted into binary format of 0's and 1's. 0 indicates that the image pixels are non-connected pixels and 1 indicate that image pixels are connected pixels and the represents the text strokes. The 0's are removed from the image because they are part of background image. From the contrast image construction we can get the stroke edge pixels of the document text properly. Constructed contrast image consist of a clear bi-modal pattern. The difference between the maximum and minimum intensity in a local window is used to evaluate the local image gradient. Pixels that are present at both the sides of the text stroke are selected as the high contrast pixels. After that the binary map is constructed. The pixels that are present in both the high contrast image pixel map and gray scale method, only those are placed in the combined map. Accurate extraction of the text stroke edge pixels is done with the help of this combination.

E. ***Post-Processing:***

Separation in the image is created by binarization method. So post processing is done to eliminate the non-strokes image from binary image. And it gives a clear image that consists of only text strokes. The comparison

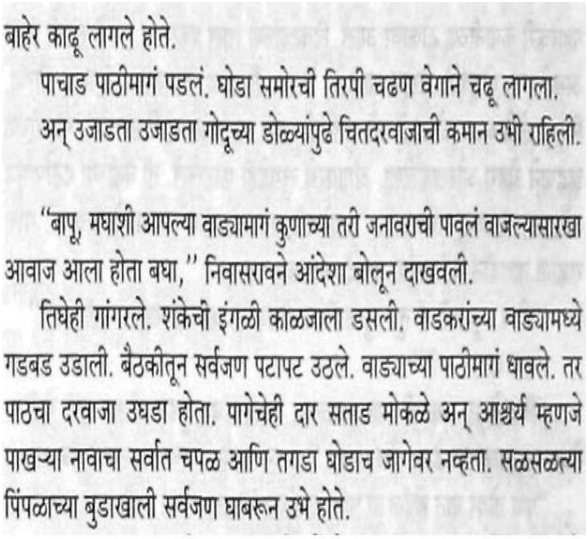
of output image with input image shows the significance of our system. Output image consists of clean and readable text. The binarization result from binarization method can further improved using post processing procedure algorithm. It requires: Input Document Image I, Binarization Result B and Corresponding Binary Text Stroke Edge Image Edge. First, the pixels that do not connect with other foreground pixels i.e. isolated foreground pixels are filtered out to precisely make the edge pixel set. Second, the neighbourhood pixel pair that lies on symmetric sides of a text stroke edge pixel should belong to different classes (i.e., either the document background or the foreground text). A single pixel out of the pixel pair is therefore labelled to the other category if both of the two pixels belong to the same class. At last, certain numbers of single-pixel artefacts along the text stroke boundaries are filtered out by using several logical operators[4].

V. Experimental Result

We have used our system on various on various type of images, like novel, books, and records, historical literature. The proposed system gives good improvement in recovery of images. The parameters such as peak signal to noise ration are increased. The accuracy is also increased compare to the previous techniques. Some of the results are stated as follow:

TABLE 1. Evaluation result

Methods	PSNR
OTSU’s method	11.58
Gatos’s method	13.44
Previous Binarization Technique	15.15
Proposed system	18.18



बाहेर काढू लागले होते.

पाचाड पाठीमागं पडलं. घोडा समोरची तिरपी चढण वेगाने चढू लागला. अन् उजाडता उजाडता गोदूच्या डोळ्यांपुढे चितदरवाजाची कमान उभी राहिली.

"बापू, मघाशी आपल्या वाड्यामागं कुणाच्या तरी जनावराची पावलं वाजल्यासारखा आवाज आला होता बघा," निवासरावने आंदेशा बोलून दाखवली.

तिघेही गांगरले. शंकेची इंगळी काळजाला डसली. वाडकरांच्या वाड्यामध्ये गडबड उडाली. बैठकीतून सर्वजण पटापट उठले. वाड्याच्या पाठीमागं धावले. तर पाठचा दरवाजा उघडा होता. पागेचेही दार सताड मोकळे अन् आश्चर्य म्हणजे पाखऱ्या नावाचा सर्वात चपळ आणि तगडा घोडाच जागेवर नव्हता. सळसळत्या पिंपळाच्या बुडाखाली सर्वजण घाबरून उभे होते.

Fig. 3: Input image for proposed system

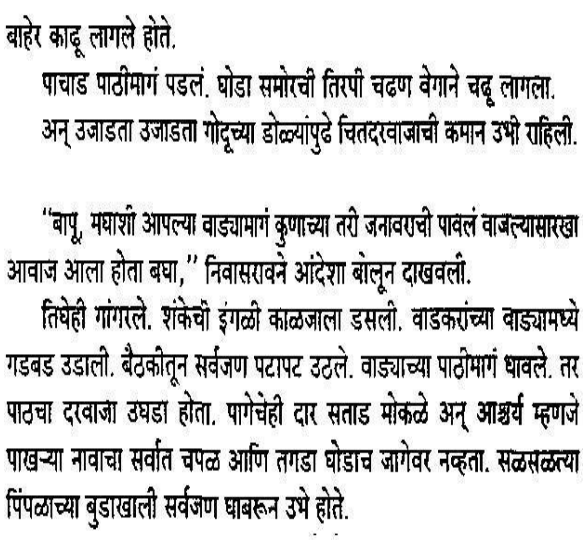


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Fig. 4: Final Output Of Project

VI. Conclusion

We introduced new post processing module in this paper which will remove the background degradations found in the binarized image. This technique uses contrast enhancement along with threshold estimation. This will help into create more clear and readable output. For that we have maintain the contrast level at minimum and maximum level. The output of this system produces separated foreground text from collided background degradation. It can live work on many degraded images. The proposed method is simple binarization method, which produces more clear output. In this technique we are going into used grey scale method through create outlined map around the text.

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