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Degraded Document Image Binarization

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Abstract—*Image Binarization is the basic preprocessing step performed in image processing related applications like optical character recognition (OCR). Degraded document image binarization is done to improve the quality of degraded document by removing degradations such as poor contrast, noise, uneven illumination, shadows, stains, bleed-through etc. Binarization basically converts the poor quality grayscale or colored images to binary images. This is done by using local binarization such as sauvola, midgray, niblack, bernsen etc in which different threshold values are selected for different parts of an image i.e. an image is divided into sub images or global binarization such as Otsu, isodata etc in which one threshold value is selected for full image. In this paper we have localized the region of interest and then applied local binarization only to that region followed by noise cleaning to yield better result. Region Localization is done by separating the textual region of the degraded document image from the background region. Edge detection and bounding box detection is done to separate the region of interest i.e. the textual region in document image. This approach yields more accurate result as compared to the already existing local binarization algorithm (sauvola). In this paper comparison has been made with the existing approach and basic evaluation parameters used for comparison are precision, recall, F-measure, mean square error (mse), signal to noise ratio (SNR) and peak signal to noise ratio (PSNR).*

Keywords: *Document image binarization; Binarization evaluation; Preprocessing*

1. INTRODUCTION

Binarization is one of the basic techniques used to improve the quality of an image. It converts the gray scale or coloured images to binary images. At present scenarios lot of research works are going on binarization as it is the basic pre-processing step in Image processing applications. There are many approaches and techniques to enhance document image quality and binarization is one of them.

Binarization is one of the most important pre-processing steps which separate foreground and background area of images. Foreground area is the main region of interest i.e. the textual region in the document. The extraction of this region from an image sometimes becomes more challenging because of the presence of some noises like ink bleed, variable background, non-uniform illuminations, shadow, stains, bleed through etc. Basic technique which separates an image into two meaningful regions: foreground and background is known as thresholding. In this a particular threshold value is selected and on the basis of that value, image is binarized. Generally, thresholding is of two types: Global Thresholding and Local Thresholding .This paper is organized in 4 sections. In Section 2 we present the proposed approach, section 3 describes about the Test results, section 4 describes some possible extensions and future works.

2. PROPOSED METHOD

In this section we present our approach of binarization which includes various modules. Fig. 1 shows an overview of the proposed binarization architecture.

2.1 Region Localization

Region localization is done after the conversion of an image into grayscale image. In this the textual region of the degraded document image is separated from the background region of the image. It is done by using Edge detection technique and bounding box detection. Edge detection is done by using canny's edge detection method in this the edges of the textual region are detected. After this the bounding boxes are made i.e. the textual region is surrounded by the bounding boxes hence providing us the main region of interest. As output of this module, we get the background region separated from the foreground region. This foreground region is the textual region of the document image and is the main region of interest and binarization will be applied on this region only.

2.2 Binarization

Binarization can be done in two ways-

Global thresholding- In this one threshold value is determined for whole image and binarization is done.

Local Thresholding- In this the original image is partitioned into smaller sub images and threshold is determined for each of the sub images.

In this approach we have applied local binarization to the region of interest which is detected by the bounding box. In local binarization we have applied sauvola algorithm. Sauvola has introduced a binarization technique where the local threshold is computed by standard deviation as explained in [3].

This method calculates pixel-wise threshold by sliding a rectangular window over the image.

2.3 Noise Removal

Degradations can be of many types. Degraded Images contain various types of noises like salt and pepper noise, Gaussian noise, Localvar noise etc. Noises can be removed by using many filters. In this approach different filters are used according to the type of noise present in the image. Filters include Median filter for salt and pepper noise, mean filter for Gaussian noise wiener filter for blurred images etc.

3. MEASURES FOR EXPERIMENTAL VERIFICATION

The following six parameters are used for the comparison of results of proposed approach and the existing approach. Those parameters are:

3.1 Mean Square Error (MSE)

Its Goal is to compare degree of similarity or level of error. Error is basically difference between the original and distorted image.

3.2 Peak Signal to Noise Ratio (PSNR)

The PSNR is most commonly used as a measure of how an image is close to another using the mean square error (MSE) and a constant C as measure for the difference between foreground and background pixel intensities.

$$PSNR= 10\log_{10}((C*C)/MSE)$$

3.3 Signal To Noise Ratio(SNR)

It is defined as the ratio of signal power to the noise power and is expressed in decibels.

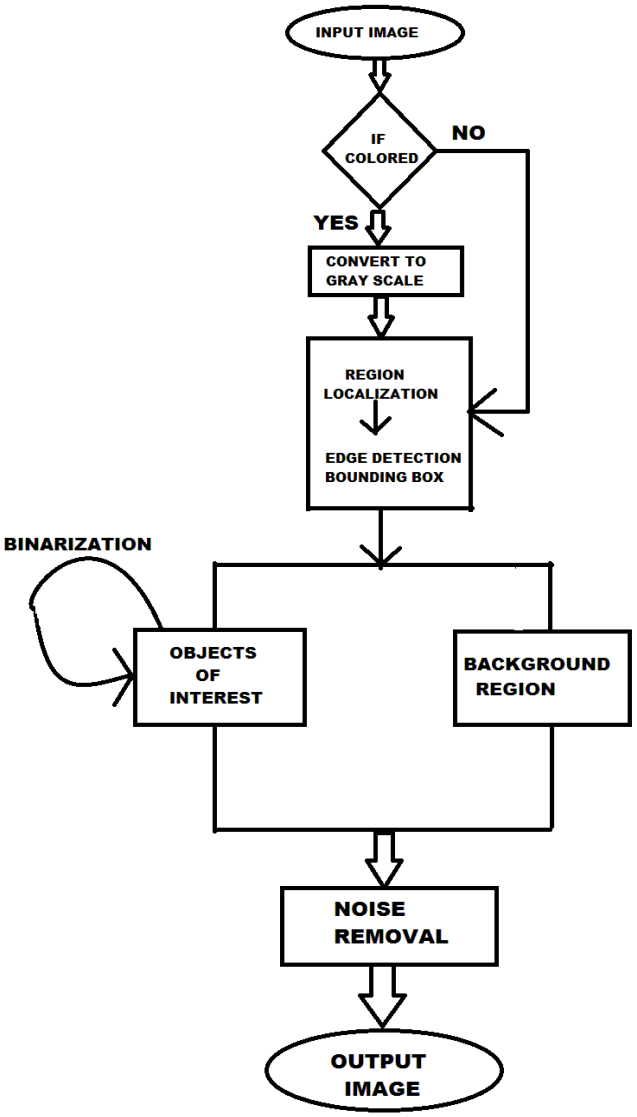


Fig. 1

3.4 Precision

Precision is defined as Relevant pixels retrieved divided by relevant and irrelevant pixels retrieved.

Precision=TP/TP+FP Where, TP (True Positives) is the number of pixels classified as foreground in the binarized image and which are really foreground in the ground truth image.

FP (False Positives) is the number of pixels classified as foreground in the binarized image and which are classified as background in the ground truth image.

3.5 Recall

Recall is defined as relevant pixels retrieved divided by relevant pixels in reference image.

Recall= TP/TP+FN

Where, TP (True Positives) is the number of pixels classified as foreground in the binarized image and which are really foreground in the ground truth image.

FN (False Negatives) is the number of pixels classified as background in the binarized image and which are foreground in the ground truth image.

3.6 F-Measure

F-measure is defined as harmonic mean of precision and recall.

F-Measure= (2*Precision*Recall)/ (Precision+Recall)

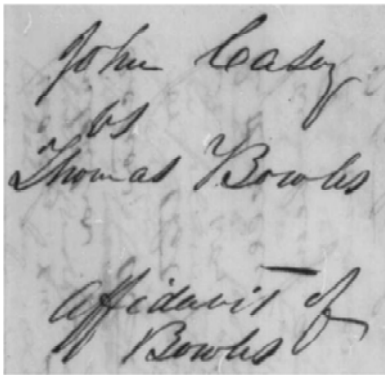
4. EXPERIMENTAL MEASURES

A number of document images have been tested. The experimental results show the effectiveness of the proposed approach. Comparison of the result from the proposed approach has been made with the existing local binarization (Sauvola Technique). The test images have been taken from DIBCO 2009, 2010 and 2013 database. Table 1 shows the comparison of existing and proposed approach. In this we have six rows representing the six parameters and two columns representing the results from existing and proposed approach.

Table 1: Comparison of images on the basis of average values of MSE, PSNR, SNR, PRECISION, RECALL and F-MEASURE value

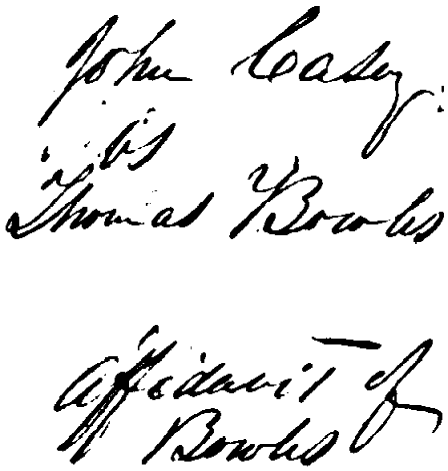
Parameters	Existing Approach	Proposed Approach
MSE	0.05213	0.02454
PSNR	60.95983	64.64324
SNR	11.94666	15.63007
PRECISION	0.72936	0.89814
RECALL	0.98262	0.99166
F-MEASURE	85.72%	92.24%

Fig. 2 shows the Sample of the test dataset images in which A1 is the degraded grayscale image and B1 is the binarized output image.



(A1)

Fig. 3 shows the comparison column chart for the parameter f-measure.



(B1)

Fig. 2: Samples of the test dataset resulted from binarization (A1) Degraded document (B1) Binarized document

5. CONCLUSION

This paper presents a simple and effective method for image binarization. The effectiveness of the proposed method has been proven by the experimental results on images from a standard image database. The comparison of this method with existing approach has also been made.

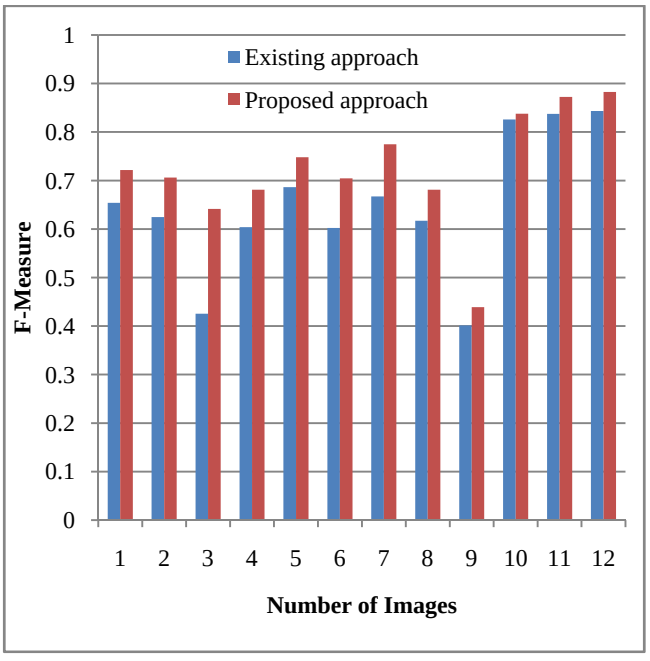


Fig. 3. shows the plot of F-measure value of sample of 12 images from the test dataset

In this new approach we have added region localization module which separates the image into two regions i.e. object of interest and background. The existing binarization technique will be applied on the object of interest region only and not on whole image thus improving the quality of image more and providing better result. The objective of our future work is to develop a technique that can detect the type of degradation in the image automatically, which will significantly improve the result of binarization.

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