A Review of Degraded Document Image Binarization Techniques

Jagroop Kaur[1], Dr.Rajiv Mahajan[2]

Dept of Computer Science & Engineering, GIMET

Abstract: Image binarization is the method of separation of pixel values into dual collections, black as foreground and white as background. Thresholding has found to be a well-known technique used for binarization of document images. Thresholding is further divide into the global and local thresholding technique. In document with uniform contrast delivery of background and foreground, global thresholding is has found to be best technique. In degraded documents, where extensive background noise or difference in contrast and brightness exists i.e. there exists many pixels that cannot be effortlessly categorized as foreground or background. In such cases, local thresholding has significant over available techniques. The main objective of this paper is to evaluate the different image binarization techniques to find the gaps in existing techniques.

Indexterms: Documents, Binarization, thresholding, binary image

1. INTRODUCTION

Image binarization is the process of separation of pixel values into dual collections, black as foreground and white as background. Thresholding has created to be a well-known technique used for binarization of document images. Thresholding is further divide into the global and local thresholding technique. In document with uniform contrast delivery of background and foreground, global thresholding is has found to be best technique. In degraded documents, where extensive background noise or difference in contrast and brightness exists i.e. there exists many pixels that cannot be effortlessly categorized as foreground or background. In such cases, local thresholding has significant over available techniques. The main objective of this chapter is to evaluate the different image binarization techniques to find the gaps in existing techniques.

A binary image [1] is a digital image that has just two feasible values meant for every pixel. Normally, two colors are used for a binary image i.e. black and white however any two colors can be used. The color used for the objects in the image is the foreground color while the rest of the image is the background color. Binary images [2] frequently occur in image processing as masks or as the outcome of some operations as segmentation and thresholding. Few input/output devices, for example, laser printers, bi-level computer displays, are able to just handle bi-level images. Binary images are formed from color images by segmentation.

Various approaches as well as techniques were developed to improve documents images quality. Binarization is one of the most important pre-processing steps which consist to separate foreground and background of documents images. It converts a gray-scale document image into a binary document image.
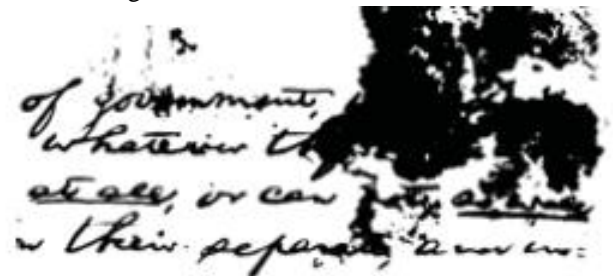

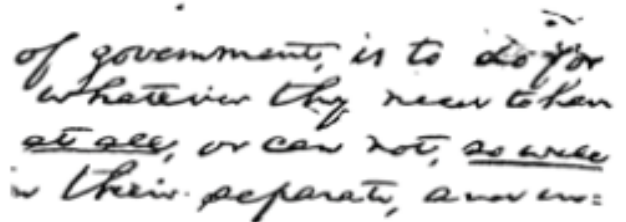Fig: 1: Input image (adapted from [3])

Fig: 2: Binarized image (adapted from [3])

Figure 1 has shown the input image for binarization and figure 2 has shown the binary image for the same .Document image binarization is generally performed in the pre-processing phase of distinctive archive picture handling related requisitions, for example, optical character

distinguishment (OCR) and report picture recovery. It changes over a light black scale record picture into a paired archive picture and likewise encourages the following assignments, for example, report skew estimation also report format examination. As more content records are checked, quick and exact report picture binarization is getting to be progressively critical. Despite the fact that archive picture binarization has been considered for a long time, the thresholding of debased record pictures is still an unsolved issue. This could be illustrated by the way that the displaying of the record foreground/background is extremely troublesome because of different sorts of report debasement, for example, uneven enlightenment, picture contrast variety, dying through, and smear. We attempt to create vigorous and productive report picture binarization methods which have the capacity to handle great effects for severely debased archive pictures.Generally, they can be classified into three major types: global binarization, local binarization and hybrid binarization methods.

A. The global thresholding technique computes an optimal threshold for the entire image; these techniques need few computations and can work well in simple cases. But fails in complex backgrounds, such as non-uniform color and poor illuminated backgrounds. These methods are usually not suitable for degraded document images, because they do not have a clear pattern that separates foreground text and background.

B. The local binarization techniques set different thresholds for different target pixels depending on their neighbourhood/local information. Generally, these techniques are sensitive to background noises due to large variance in case of a poor illuminated document or bleed-through degradation.

C. Hybrid binarization approach combines global and local thresholding. A first step consists in carrying out a global thresholding to classify a part of the background of the document image and keep only the part containing the foreground (graphics or text in our case). A second step aims to refine the image obtained by the previous step in order to obtain a sharper result by applying an adaptive thresholding technique.

D. Dynamic Threshold Binarization such as iteration method defines the threshold of a pixel with the grey-level values of its own and neighbouring pixels and the coordinate of the pixel. This binarization method is commonly used for the bad quality images, especially the images with single-peak histogram. However, owing to the dynamic threshold calculation, the method has high computation complexity and slow speed. Following Table shows a simple comparison of some common binarization algorithms. In the table, the dynamic threshold binarization method only has a "medium" evaluation due to its problems in the computation complexity. Therefore, there is a considerable need of improving the dynamic threshold binarization algorithm.

Table 1 is showing the comparative analysis of different binarization approaches.

Algorithm	Suitable condition	Shortage	Overall
Iteration method	Distinct double peak histogram	Non-uniform illumination	Average
Uniform gradient	Natural scene		Good
Multi-threshold gradient	Non-uniform illumination		Very good
Texture based	Bill, text and car license		Very good
Differential histogram	Single-peak histogram	Complex grey-level change	Average
Maximal variance	No histogram	Geometric structure	Good

Table 1: Binarization algorithms

2. DOCUMENTATION BINARIZATION TECHNIQUES

A. The global thresholding technique computes an optimal threshold for the entire image; these techniques need few computations and can work well in simple cases. But fails in complex backgrounds, such as non-uniform color and poor illuminated backgrounds. These methods are usually not suitable for degraded document images, because they do not have a clear pattern that separates foreground text and background.

(a) Input image

(b) Output image
Figure1: Global thresholding

### B. Image binarization using texture features

In this strategy for binarization of historical and corrupted document images, based on texture features. This technique is a versatile edge-based. This recent is processed by utilizing a descriptor focused around a co-event framework. The proposed technique is tested objectively, utilizing DIBCO dataset debased documents and subjectively, utilizing a set of old corrupted document gave by a national library.


Figure2: (a) Input   (b) Output (Texture Feature)

C. Adaptive binarization for degraded images

In this method utilize the dilation and erosion within light black-scale picture preparing; therefore get another picture in which the shadow levels and noise densities will be reduced. After that w plan the binarization method joined the system which enhanced Niblack and the neighborhood thresholding utilizing the little neighborhood which affected the mean value of the areas.
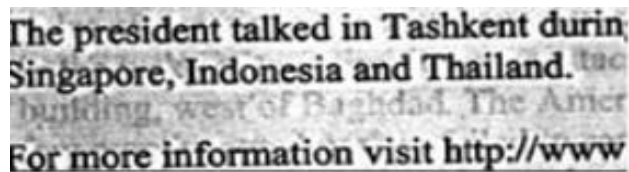

(a) Input image
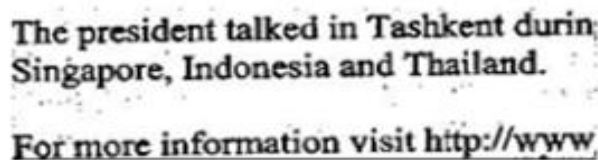
(b) Output image
Figure 3: Adaptive thresholding

D. Combination of Document Image Binarization Techniques

In this technique categorization structure to join different thresholding methods and generate enhanced performance for document image binarization. Given the binarization outcome of a number of reported methods, the proposed structure divides the document image pixels into three sets, namely, foreground pixels, background pixels and uncertain pixels.
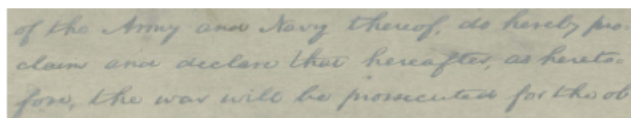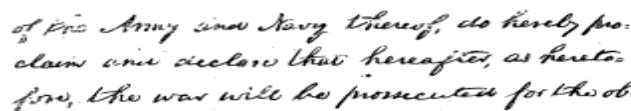

(a) One Handwritten Document Image Example
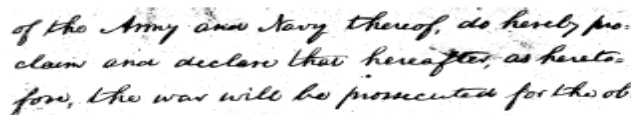
(b) Otsu's binarization result
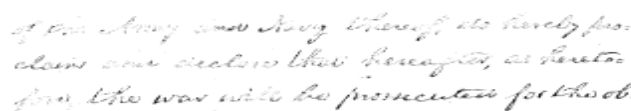
(c) Sauvola's binarization result

(d) Combined result
Figure 4: Combination technique

E. Dynamic Threshold Binarization such as iteration method defines the threshold of a pixel with the grey-level values of its own and neighbouring pixels and the coordinate of the pixel. This binarization method is commonly used for the bad quality images, especially the images with single-peak histogram. However, owing to the dynamic threshold calculation, the method has high computation complexity and slow speed.
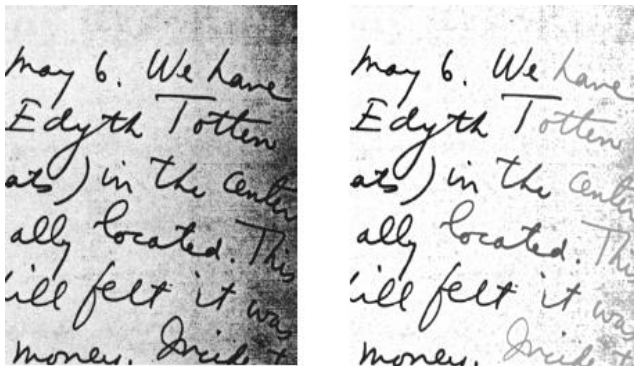
Figure 5: (a) Input (b) Output (dynamic thresholding binarization)

3. LITERATURE REVIEW

Ioannis Pratikakis1 et al. (2013) [4] has discussed a contest. The general target of the contest is to distinguish current developments in document image binarization for both machine-printed and manually written record images utilizing assessment execution measures that obey document image investigation and recognition. The contest details have been described incorporating the assessment measures used and also the execution of the 23 submitted routines as well as a short depiction of every strategy.

Abdenour Sehad et al.(2013) [5] has present a capable scheme for binarization of ancient and degraded document images, grounded on texture qualities. The suggested technique is an adaptive threshold-based. It has been calculated by using a descriptor centred on a co-occurrence matrix and the scheme is verified objectively, on DIBCO dataset degraded documents furthermore subjectively, utilizing a set of ancient degraded documents offered by a national library. The outcomes are acceptable and assuring, present an improvement to classical approaches.

Hossein Ziaei Nafchi et al.(2013) [6] has concluded that the pre-processing and post processing phases meaningfully advance the performance of binarization approaches, particularly in the situation of harshly degraded ancient documents. An unverified post processing technique is presented founded on the phase-preserved denoised image and also phase congruency features extracted from the input image. The central part of the technique comprises of two robust mask images that can be used to cross the false positive pixels on the production of the binarization technique. Firstly, a mask with an extreme recall value is attained from the denoised image with the help of morphological procedures. In parallel, a second cover is

acquired dependent upon stage congruency features. At that point, a median filter is utilized to evacuate noise on these two masks, which then are utilized to rectify the yield of any binarization strategy.

Jon Parker et al.(2013)[7] has studied that regularly documents of notable noteworthiness are ran across in a state of deterioration. Such archives are regularly examined to all the while history and announce a disclosure.Changing over the data found inside such reports to open information happens all the more rapidly and inexpensively if a programmed technique to upgrade these corrupted archives is utilized as opposed to improving each one document image by hand. A novel mechanized image upgrade approach that indulges no preparation information was introduced. The methodology was valid to images of typewritten text in addition to hand written text or both.

Konstantinos Ntirogiannis et al.(2013) [8] has analysed that document image binarization is of incredible value in the document image examination and recognition pipeline as it disturbs further phases of the recognition procedure. The assessment of a binarization technique helps in examining its algorithmic conduct, and also confirming its adequacy, by giving qualitative and quantitative sign of its execution. A pixel-based binarization assessment approach for recorded handwritten/machine-printed document image has been proposed. .In the proposed assessment procedure, the review and accuracy assessment measures are fittingly adjusted utilizing a weighting plan that decreases any potential assessment unfairness. Extra execution measurements of the proposed assessment plan comprise of the rate rates of broken and missed content, false alerts, foundation commotion, character amplification, and combining.

Vincent Rabeux et al.(2013)[9]has an approach to expect the outcome of binarization algorithms on a known document image according to its situation of degradation. Document shaving degradation which result in binarization errors.To characterize the degradation of a document image by using different features based on the strength, amount and position of the degradation. These characteristics allow us to build calculation models of binarization algorithms that are very accurate according to $R2$ values and p-values. The prediction models are used to select the best binarization algorithm for a given document image.

Djamel GACEB et al. (2013) [10] has studied a smart-binarization technique of the images. In this technique,

considered different degradations document images. The nature of every pixel is approximate using a hierarchical local thresholding in order to classify it as foreground, background or ambiguous pixel. The ambiguous pixels that represent the corrupted zones cannot be binarized with the same local thresholding. The global quality of the image is estimated from the density of theses degraded pixels. If image is degraded then apply a second separation on the ambiguous pixels to split them into background or foreground. Second process uses our improved relaxation method

Marian Wagdy et al. (2013) [11] has implemented a quick and proficient document image clean up and binarization technique depend on retinex hypothesis and global thresholding. This technique joins of local and global thresholding with concept of retinex theory which can efficiently improve the degraded and poor quality document image. Then, quick global threshold is utilized to change over the document image into binary form. The new method conquers the limitations of the related global threshold techniques.

Vassilis Papavassiliou et al.(2012) [12] has discussed an capable technique dependent upon mathematical morphology for extracting text regions from degraded document images. The fundamental stages of methodology area) top-hat-by-reconstruction to construct a filtered image with sensible background) region growing beginning from a set of seed points and attaching to each seed similar intensity neighbour pixels and c) conditional extension of the first detected text regions based on the values of the second derivative of the filtered image.

Bolan Su et al. (2012) [13] has studied a document image binarization structure that makes utilization of the Markov Random Field model. Structure isolates the document image pixels into three classes i.e. document background text, document foreground text, and uncertain pixels established binarization method. Uncertain pixels are belongto foreground and background categories by incorporating MRF model and boundary information.

C. Patvardhan et al. (2012) [14] has studied that images may contain difficult background i.e. shading or a denoising. Binarization method of document images creates them suitable for OCR using discrete curvelet transform. Curvelet transform is used for eliminate difficult image background, white Gaussian noise and gives improved binarized document image. The Curvelet transform also helps to enhanced in text shape still in the occurrence of noise. This method is capable to eliminate high frequency Gaussian noise and low frequency complex backgrounds and shows better performance.

4. GAPS IN LITERATURE

Many techniques have been proposed so far for document binarization as shown in literature survey. It has been concluded from the existing research is that no technique is perfect for every case. Therefore still some research is required in this field of image binarization. Following are the main limitations of this research work:-

1. Many researchers have used image filters to reduce the noise from the image but the use of the guided filter (best edge preserving filter) is not found. It may increase the accuracy of the available binarization methods

2. In the most of techniques the contrast enhancement is either done by tradition methods or not done. So, adaptive contrast enhancement is required.

3. Most of the methods have neglected the use of edge map which has the ability to map the exact character in efficient manner.

5. CONCLUSION

This paper has focused on the degraded document binarization technique. Document binarization is a key application of vision processing. The main objective of this paper is to evaluating the short comings of algorithms for degraded image binarization. It has been found that each technique has its own benefits and limitations; no technique is best for every case. The main limitation of existing work is found to be noisy and low intensity images. In near future we will propose a new algorithm which will use more reliable methodology to enhance the work. We will propose a new algorithm which will use nonlinear enhancement as a pre-processing technique to improve the results further.

REFRENCES

[1] Stathis, Pavlos, ErginaKavallieratou, and Nikos Papamarkos. "An evaluation survey of binarization algorithms on historical documents." Pattern Recognition, 2008.ICPR 2008.19th International Conference on.IEEE, 2008.

[2] Su, Bolan, Shijian Lu, and Chew Lim Tan. "Combination of document image binarization techniques." Document Analysis and Recognition (ICDAR), 2011 International Conference on.IEEE, 2011.

[3] Su, Bolan, Shijian Lu, and Chew Lim Tan. "Robust document image binarization technique for degraded document images." Image Processing, IEEE Transactions on 22.4 (2013): 1408-1417.

[4] Pratikakis, Ioannis, Basilis Gatos, and KonstantinosNtirogiannis. "ICDAR 2013 Document Image Binarization Contest (DIBCO 2013)." Document Analysis and Recognition (ICDAR), 2013 12th International Conference on.IEEE, 2013.

[5] Sehad, Abdenour, et al. "Ancient degraded document image binarization based on texture features." Image and Signal Processing and Analysis (ISPA), 2013 8th International Symposium on.IEEE, 2013.

[6] Nafchi, HosseinZiaei, Reza FarrahiMoghaddam, and Mohamed Cheriet. "Application of Phase-Based Features and Denoising in Postprocessing and Binarization of Historical Document Images." Document Analysis and Recognition (ICDAR), 2013 12th International Conference on.IEEE, 2013.

[7] Parker, Jon, OphirFrieder, and Gideon Frieder. "Automatic Enhancement and Binarization of Degraded Document Images." Document Analysis and Recognition (ICDAR), 2013 12th International Conference on.IEEE, 2013.

[8] Ntirogiannis, Konstantinos, Basilios Gatos, and IoannisPratikakis. "Performance Evaluation Methodology for Historical Document Image Binarization." Image Processing, IEEE Transactions on 22.2 (2013): 595-609.

[9] Rabeux, Vincent, et al. "Quality evaluation of ancient digitized documents for binarization prediction." Document Analysis and Recognition (ICDAR), 2013 12th International Conference on.IEEE, 2013.

[10] Gaceb, Djamel, Frank Lebourgeois, and Jean Duong. "Adaptative Smart-Binarization Method: For Images of Business Documents." Document Analysis and Recognition (ICDAR), 2013 12th International Conference on.IEEE, 2013.

[11] Wagdy, M., Ibrahima Faye, and DayangRohaya. "Fast and efficient document image clean up and binarization based on retinex theory." Signal Processing and its Applications (CSPA), 2013 IEEE 9th International Colloquium on.IEEE, 2013.

[12] Papavassiliou, Vassilis, et al. "A Morphology Based Approach for Binarization of Handwritten Documents." Frontiers in Handwriting Recognition (ICFHR), 2012 International Conference on.IEEE, 2012.

[13] Su, Bolan, Shijian Lu, and Chew Lim Tan. "A learning framework for degraded document image binarization using Markov random field." Pattern Recognition (ICPR), 2012 21st International Conference on.IEEE, 2012.

[14] Patvardhan, C., A. K. Verma, and C. Vasantha Lakshmi. "Document image denoising and binarization using Curvelet transform for OCR applications."Engineering (NUiCONE), 2012 Nirma University International Conference on. IEEE, 2012.