Research Journal of Computer and Information Technology Sciences _____ISSN 2320 – 6527
Vol. **5(3),** 23-25, May **(2017)** *Res. J. Computer and IT Sci.*

Short Review Paper

Study of parameters in performing binarization of document images

Shankha De* **and Arpana Rawal**
Department of Computer Science and Engineering, Bhilai Institute of Technology, Durg, CG, India
shankhada2009@gmail.com

Available online at: www.isca.in
Received 10th April 2017, revised 1st May 2017, accepted 18th May 2017

Abstract

Now-a-days, all important paper documents flow within the transacting channels of real time working organisations are bound to perform document scans for their long term usage and gaining clarity during their frequent fetches. This paper discusses challenging issues undertaken in document image binarization. Upon resolving such binarization issues that are caused during printing, digitization and transmission process, image quality can be improved that helps in feature analysis.

Keywords: Document image, Degradation, Binarization, Noise, Global Threshold, Local Threshold.

Introduction

Document image processing begins with binarization. The performance of document image analysis directly depends on output of binarization. Binarization is the pre-processing step of document image processing. Binarization converts a gray scale document image to two color image. One color for background and another colour for foreground object. Many times documents are degraded due to uneven illumination. Text colors may be faded due to aging effects. Bleed-through and shadowing effects also make it difficult to classify foreground and background pixels[1,2]. Thus, selection a thresholding technique becomes a research challenge as it is sensitive to noise and gray level distribution of the images. Binarization can be done by global or local (adaptive) thresholding techniques. An exhaustive comparative survey of these is described in the subsequent section.

Literature survey: In global binarization, the most common parameters used features in binarization are intensity histograms, mean and standard deviation. Intensity histogram conveys the colour distribution information whereas mean and standard deviation represents the compact features. Local binarization techniques uses local features like contrast, maximum and minimum of intensity, mean, standard deviation of the subareas[3].

Global Thresholding: Using single pixel intensity "Threshold", all the pixels in the image are separated as foreground and background pixels. Global thresholding performed well if foreground and the background areas are well separated[4].

Local Thresholding: In local thresholding technique threshold value varies with pixel position or region. It is window based. To calculate threshold value T(x,y) for pixel (x,y), A window w x w is placed whose centre point is at (x,y) and neighbour pixels values under this window are considered.

Over timeline, some well known binarization algorithms viz. Otsu's, Niblack's, Sauvola's methods gained unanimous acceptance in the research community of document image processors.

They are mostly used as baseline to compare new spectrum of binarization techniques. These methods can be characterized with the help of attributes as outlined in Table-1.

Performance evaluation techniques

Binarization is found to separate background and foreground pixel in presence of any existing degradations. It removes various noise forms degradation like bleed-through, ink stains, uneven illumination and faint characters. Performance of a thresholding steps can be measured by one or many human evaluators or in terms of character or word accuracy detected in OCR or by comparing the ground truth image and binarization result image at pixel level or combination of human-oriented evaluation and OCR[13,14].

Once binarization is performed, performance is measured with the metrics like F-Measure, PSNR, Misclassification Penalty Metric (MPM), Negative Rate Metric (NRM), Distance Reciprocal Distortion Metric (DRD) and Pseudo (weighted) F-Measure[1,13,14].

Conclusion

There are various methods available for binarization but it is really difficult to select a singleton option that fit to the input set of all types of images.

Global thresholding methods are very fast and give good results for scanned documents with constant illumination and uniform background but may cause marginal noise along the page borders because of improper illumination over the documents.

Table-1: Comparative Summary of Binarization Techniques.

Types	Parameters used	Experimental Setting	Time Complexity *	Remarks	Ref.
Global Thresholding	Mean, standard deviation and variance	-	$O(n^2)$	Successful for bimodal document image.	5
Local Thresholding	Bias k, Local Mean and standard deviation	k=-0.2 w=15	$O(n^2 \times w^2)$	Window size must cover at least 1-2 characters. It's time complexity is high but easily parallelizable to reduce the required time. It fails in large variation of illumination.	6
Local Thresholding	Bias k, Dynamic range of standard deviation R, Local Mean and standard deviation	R=128 k=0.5	$O(n^2 \times w^2)$	It gives better result than Niblack's method for document image with stained and improper illumination. During noise removal sometimes it eliminates text region thus poor in document image.	7
Adaptive Local thresholding	Bias k, Integral Sub Image, Local mean and Local Sum.	0.5<k<0.6	$O(n^2)$	Time complexity is independent of window size. Need more suitable Integral Sum Image representation	8
Local Thresholding	Lacal contrast	w=31	$O(n^2 \times w^2)$	No bias to control threshold.	9-11
Local Thresholding	Bias K, Local mean and mean deviation	0<k<1	$O(n^2 \times w^2)$	Better in quality and speed as it also uses integral sum image.	10
Local Thresholding	Bias K, Local contrast and mean	0<k<1 (proposed k=0.95) w=5	$O(n^2 \times w^2)$	Threshold value depends on k. It works in smaller window also and comparatively gives better result.	6
Local thresholding	Winner filter for pre-processing, Local mean, variance, Estimated foreground region and Background surface		$O(n^2 \times w^2)$	No need of tuning parameters. Performs well even when the documents are very noisy and highly degraded with shadows, uneven illumination, low contrast, and noise. Need more research on low resolution image.	12

*Time complexity parameter {n,w}:Image size is n x n and window size is w x w.

However, it is supposed to be not a good option for documents having complex background and for images of low quality. Local thresholding techniques gives better results but proves to be an expensive computation in the order of time complexity O(m*n*p) for an image with size m x n with a window having p pixels. It may be noted that computed improper threshold value can misinterpret foreground pixel as background and vice versa.

Acknowledgement

The paper is a survey based literary work as an outcome of coursework carried out as a part of doctoral course curriculum, supported by research and development cell, Department of computer Science and Engineering, Bhilai Institute of Technology, Durg, Chhattisgarh, India.

References

1. Chauhan Shivani, Sharma Ekta and Doegar Amit (2016). Binarization Techniques for Degraded Document Images - A Review. in *5th international conference in reliability, infocom technologies and optimization(trends and future directions)*, 163-166.

2. Feng Meng-Ling and Tan Yap-Peng (2004). Contrast adaptive binarization of low quality document images *IEICE Electronics Express*, 1(16), 501-506.

3. Chamchong Rapeeporn and Fung Chun Che (2015). A Framework for the Selection of Binarization Techniques on Palm Leaf Manuscripts Using Support Vector Machine. *Advances in Decision Sciences*, 2015, 1-7. doi:10.1155/2015/925935.

4. Doermann David and Tombre Karl (2014). Handbook of Document Image Processing and Recognition. Springer Publishing Company, Incorporated.

5. Otsu Nobuyuki (1979). A Threshold Selection Method from Gray-Level Histograms. *IEEE*, 9(1), 62-66.

6. Singh Imocha O., Sinam Tejmani, James O. and Singh Romen T. (2012). Local Contrast and Mean Thresholding in Image Binarization. *International Jounal of Computer Applications (0975-8887)*, 51(6), 5-10.

7. Sauvola Jaakko and Pietikäinen Matti (2000). Adaptive Document Image Binarization. *Pattern Recognition*, 33(2), 225-236.

8. Singh Romen T., Roy Sudipta, and Singh Kh. Manglem (2012). Local Adaptive Automatic Binarisation (LAAB). *International Journal of Computer Applications*, 40(6), 27-30.

9. Bernsen J. (1986). Dynamic Thresholding of Gray Level Image. in *ICPR`86: Proceedings of International Conference on Pattern Recognition*, 2, 1251-1255.

10. Singh Romen T., Roy Sudipta, Sinam Tejmani, Singh O. Imocha and Singh Kh. (2011). A New Local Adaptive Thresholding Techniques in Binarization. *International Journal of Computer Science,* 8(6), 271-277.

11. Chaki Nabendu, Shaikh Soharab Hossain and Saeed K. (2014). A Comprehensive Survey on Image Binarization Techniques. in *Exploring Image Binarization Techniques*. New Delhi: Springer India, ch. 2, 5-15.

12. Gatos Basilios, Pratikakis Ioannis and Perantonis Stavros J. (2006). Adaptive Degraded Document Image Binarization. *Pattern recognition*, 39(3), 317-327.

13. Ntirogiannis K., Gatos B. and Pratikakis I. (2008). An Objective Evaluation Methodology for Document Image Binarization Techniques. in *The Eighth IAPR International Workshop on Document Analysis Systems*, Nara, Japan, 217-224.

14. Ntirogiannis K., Gatos B. and Pratikakis I. (2013). A Performance Evaluation Methodology for Historical Document Image Binarization. *IEEE Trans. on Image Proc.*, 22(2), 595-609.