

An Enhanced Model for Removal of Text-line Bending Deformations at Page Borders in Document Images for Better Readability by OCRs

Vijayashree C S^a, Shruthi C V^b, Vasudev T^b

^aP E T Research Foundation, P E S College of Engineering, Mandya-571 401, India.
Contact:cs.vijayashree@gmail.com

^bMaharaja Research Foundation, Maharaja Institution of Technology, Mysore 571 438, India.

Existing Optical Character Readers (OCRs) are capable of reading linear text from document images. Images obtained from scanning bound books result in bending of text lines at the page borders of binding. The bent-text area in document images cannot be processed by OCRs. The work presented in this paper, focuses on developing a modified method for better estimation and removal of line bending deformations introduced in document images during the process of scanning. The method consists of three stages. In the first stage, a macro level decision is proposed to locate the site and the direction of deformation. An enhanced elliptical approximation model is derived to estimate the amount of deformation in the second stage. Finally, a transformation process brings out the correction. The method has been tested on varieties of printed document images containing the bent text-lines at page borders. The readability analysis of corrected images is performed through an OCR.

Keywords : Deformation Estimation and Removal, Elliptical Approximation, OCR, Text-Line Bending Deformation. .

1. INTRODUCTION

The emerging technology for accomplishing automation in document reading, extracting contents from documents has lead into many vibrating research problems in the discipline of Document Image Processing and Analysis (DIA) [1]. Many researchers are working on different problems on document images starting from image acquisition to image understanding [1-3]. Considerable research work is being carried out on the specific sub areas in DIA viz., preprocessing, segmentation, classification, recognition, document layout analysis etc. The result of these researches is converging to provide generic solutions to major issues in DIA [1][2].

One of the major issue while preparing a document image for processing is to produce a quality document image for further analysis [1,2,4,5-9]. Essential preprocessing activities

required for document images are noise removal and skew correction [2,4,5]. Noise is a prevalent artifact [2,4,5] introduced in document images by image acquisition device or due to poor quality of document media. Skew is the orientation introduced while placing the document into scanning device. Unless these two problems are handled properly in the document images, it is quite difficult to proceed with the other sequence of activities in DIA. Considerable amount of research is reported in literature on these two problems [6-8, 10-12].

Generally, noise components in a document image are referred as salt-and-pepper noise or impulse and speckle noise or just dirt [2,4,5]. One more typical type of noise introduced while scanning a document image is due to (i) copying a page of a thick bound book because of non-planar surface created by the book on the flat copying surface (ii) non-linearity in copying the contents at the start and finish ends

Optical character recognition (OCR) is one of the most successful applications of automatic pattern recognition. Since the mid 1950s, OCR has been a very active field for research and development. An Today, reasonably good OCR packages can be bought for as little as \$100. However, these are only able to recognize high quality printed text documents or neatly written hand-printed text. The current research in OCR is now

(a)

Optical character recognition (OCR) is one of the most successful applications of automatic pattern recognition. Since the mid 1950s, OCR has been a very active field for research and development. An Today, reasonably good OCR packages can be bought for as little as \$100. However, these are only able to recognize high quality printed text documents or neatly written hand-printed text. The current research in OCR is now

(b)

Figure 10. (a) Document Image with Right Upward Bending of Text-Lines, (b) Right Upward Text-Line Bending Corrected

of text lines without bending. The approach can be extended to correct bending deformations of few Indian language document images. The developed model is very sensitive to noise and skew. A method is under investigation of generic model to correct multiple types of bending deformations in a single document.

REFERENCES

1. Nagabhushan P. Document Image Processing, in *Proceedings National Pre-Conference Workshop on Document Processing, India*, pages 114-120, 2001.
2. Lawrence OGorman and Rangachar Kasturi. Executive Briefing: Document Image Analysis, *IEEE Computer Society Press*, 1998.
3. B N Chatterji. Feature Extraction Methods for Character Recognition, in *Proceedings National Pre-Conference Workshop on Document Processing, India*, pages 7-20, 2001.
4. R C Gonzales and R E Woods. Digital Image Processing, *Addison Wesley Publication*, 1987.
5. A K Jain. Fundamentals of Digital Image Pro-

ಭೂತಿಯಿಂದ ಅರಿಯುತ್ತಾನೆ. "ಯಾವೂ ಕಾವ್ಯಾನುಶೀಲನವಿಲ್ಲದೆ ವಿಶದೀಭೂತೇ ಮನೋಮುಖಾರೇ ಪರ್ಣನೀಯ ತನ ಯೂ ಭವನಯೋಗ್ಯತಾ ತೇ ಹೃದಯ ಸಂವಾದಭಾಜು ಸಹೃದಯಾಃ" ಎಂದು ಅಭಿನವ ಗುಪ್ತನು ಸಹೃದಯನ ಬಗ್ಗೆ ಹೇಳಿದ್ದಾನೆ. ಅಂದರೆ ಕಾವ್ಯಗಳನ್ನು ಪರಿಶೀಲಿಸಿ ಮನಸ್ಸೆಂಬ ಕನ್ನಡಿ ನಿರ್ಮಲವಾದಿರುವುದರಿಂದ. ಪರ್ಣತ ವಿಷಯದಲ್ಲಿ ತನ್ಮಯವಾಗುವ ಯೋಗ್ಯತೆ ಯಾರಿಗುಂಟೋ ಅವರೇ ಸಹೃದಯರು. ಕವಿಯ ಹೃದಯವೂ ರಸಿಕನ ಹೃದಯವೂ ಸಮಶ್ರುತಿಯನ್ನುಳ್ಳ ಎರಡು ಮಣಿಗಳಂತೆ ಬಂದವು ನುಡಿಸಿದಾಗ ಇನ್ನೊಂದು ಅದಕ್ಕೆ ಸಮಕಾವ್ಯವಾಗ ರೋಂಕರಿಸುತ್ತದೆ. ಸಂಸ್ಕೃತದಲ್ಲಿ 'ಅನುಕಂಪಾ' ಎಂಬ ಶಬ್ದವಿದೆ. ಇದರ

(a)

ಭೂತಿಯಿಂದ ಅರಿಯುತ್ತಾನೆ. "ಯಾವೂ ಕಾವ್ಯಾನುಶೀಲನವಿಲ್ಲದೆ ವಿಶದೀಭೂತೇ ಮನೋಮುಖಾರೇ ಪರ್ಣನೀಯ ತನ ಯೂ ಭವನಯೋಗ್ಯತಾ ತೇ ಹೃದಯ ಸಂವಾದಭಾಜು ಸಹೃದಯಾಃ" ಎಂದು ಅಭಿನವ ಗುಪ್ತನು ಸಹೃದಯನ ಬಗ್ಗೆ ಹೇಳಿದ್ದಾನೆ. ಅಂದರೆ ಕಾವ್ಯಗಳನ್ನು ಪರಿಶೀಲಿಸಿ ಮನಸ್ಸೆಂಬ ಕನ್ನಡಿ ನಿರ್ಮಲವಾದಿರುವುದರಿಂದ. ಪರ್ಣತ ವಿಷಯದಲ್ಲಿ ತನ್ಮಯವಾಗುವ ಯೋಗ್ಯತೆ ಯಾರಿಗುಂಟೋ ಅವರೇ ಸಹೃದಯರು. ಕವಿಯ ಹೃದಯವೂ ರಸಿಕನ ಹೃದಯವೂ ಸಮಶ್ರುತಿಯನ್ನುಳ್ಳ ಎರಡು ಮಣಿಗಳಂತೆ ಬಂದವು ನುಡಿಸಿದಾಗ ಇನ್ನೊಂದು ಅದಕ್ಕೆ ಸಮಕಾವ್ಯವಾಗ ರೋಂಕರಿಸುತ್ತದೆ. ಸಂಸ್ಕೃತದಲ್ಲಿ 'ಅನುಕಂಪಾ' ಎಂಬ ಶಬ್ದವಿದೆ. ಇದರ

(b)

Figure 11. (a) Right Downward Text-line Bending in Kannada Document, (b) Right Downward Text-Line Bending Corrected in Kannada Document

- cessing, *Prentice Hall, Englewood Cliffs, NJ*, 1989.
6. L M Kennedy and M Basu. Image Enhancement using a Human Visual System Model, *Pattern Recognition*, 30(12):2001-2014, 1997.
7. A Amin and S Fischer. A Document Skew Detection Method Using the Hough Transform, *Journal of Pattern Analysis and Applications*, 3:243-253, 2000.
8. Yue Lu and Chew Lim Tan. A Nearest-Neighbor Chain Based Approach to Skew Estimation in Document Images, *Pattern Recognition Letters*, 24:2315-2323, 2003.
9. E Kavallieratou, N Fakotakis and G Kokkinakis. Skew Angle Estimation for Printed and Handwritten Documents using the Wigner-Ville Distribution, *Journal of Image and Vision Computing*, 20:813-824, 2002.
10. Lakhwinder Kaur, Savita Gupta and R C Chauhan. Image Denoising using Wavelet Thresholding, in *Proceedings of 3rd ICVGIP*, Ahmedabad, India, 2002.
11. Kuo-Chin Fan, Yuan-Kai Wang and Tsann-Ran Lay. Marginal Noise Removal of Docu-

- ment Images, *Pattern Recognition*, 35:2593–2611, 2002.
12. Claudio Rosita Jang and Jacob Scharcanski. Adaptive Image Denoising and Edge Enhancement in Scale-space using the Wavelet Transformation, *Pattern Recognition Letters*, 24:965–971, 2003.
 13. T Vasudev, G Hemanthakumar and P Nagabhushan. Transformation of Arc-form-text to Linear-form-text Suitable for OCR, *Pattern Recognition Letters*, 28:2343–2351, 2008.
 14. C S Vijayashree, C K Vishwanath and T Vasudev. Transformation of Artistic Text to Linear Form Text for OCR System, in Proceedings of International Conference on Advances in Intelligent System and Computing, Springer India, vol. 174, Pages 1135–1143, 2012.
 15. C S Vijayashree, C K Vishwanath, T Vasudev. Estimation of Tilt in Characters and Correction for Better Readability by OCR System, in International Journal of Computer Applications, 90(13):0975–8887, 2014.
 16. T Breuel. The Future of Document Imaging in the Era of Electronic Documents, in *Proceedings of International Workshop on Document analysis*, India, pages 275–296, 2005.
 17. Zheng Zhang. Restoration of Curved Document Images Through 3D Shape Modeling, in *Proceeding of International Conference on Computer Vision and Pattern Recognition (CVPR2004)*, June 2004.
 18. T Vasudev, G Hemanthakumar and P Nagabhushan. An Elliptical Approximation Model for Removal of Text-line bending Deformations at Page Borders in a Document Image, in Proceedings Of Internal Conference on Cognition and Recognition ICCR-2005, 2005.
 19. Donald Hearn, M P Baker. Computer Graphics, *Pearson Education, 2nd Edition*, 2003.
 20. Website link for Readiris pro URL://www.

neuratron.com/readiris.htm



Vasudev T is currently Professor in the Department of Computer Applications, at Maharaja Institute of Technology, Mysore. He obtained his Bachelor of Science and Post-Graduate Diploma in Computer Programming and has two Masters Degrees, one in Computer Applications and the other in Computer Science and Technology. He has a Ph.D degree in Computer Science from University of Mysore. He has 30 years of experience in academics and has published over 30 articles in reputed journals and conferences. His area of research is Digital Image Processing, specifically Document Image Processing.



Vijayashree C S obtained her B.E. Degree in Computer Science from B.I.T, Bangalore and M.E. Degree in Computer Science from U.V.C.E, Bangalore. She is pursuing research towards her Ph.D in Computer Science under University of Mysore at P.E.T. Research Center, PESCE, Mandya.



Shruthi C.V obtained her B.E. Degree from VTU, Belgaum. Currently she is pursuing her M.Tech degree in Computer Science and Engineering at Maharaja Institute of Technology, Mysore.