An Elliptical Approximation Model For Removal Of Text Line Bending Deformations At Page Borders In A Machine Printed Documents

Sandeep Kaur Bains, Prof. Satmeet Kaur
Department of Computer Science & IT
Lyallpur Khalsa College, Jalandhar (India)

Abstract- The work presented in this paper, focuses on the problem of bending of text-lines observed in document images. A method is developed for 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 decision methodology is proposed to locate the side of deformation and the direction of deformation. A method 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*)*

Keywords- Deformation, Transformation, Skewness, De warping, noise)

I. INTRODUCTION

One of the major issue while preparing a document image for processing is to produce a quality document image for further image analysis. Some of normally performed pre processing activities on document images are noise removal and skew correction. Noise is a prevalent artefact 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 very difficult to proceed with the other sequence of activities in DIA. Generally, 'noise' components in a document image are referred as salt-and-pepper noise or impulse and speckle noise or just dirt. One more typical type of noise introduced while scanning a document image is due to (1) copying a page of a thick bound book because of non-planar surface created by the book on the flat copying surface (2) non -linearity in copying the contents at the start and finish ends of scanning. These result in 'bending of text-lines' at the page borders. Such bent text–lines are elliptical in shape. Samples of such bending of text -lines document images are shown in fig(1).

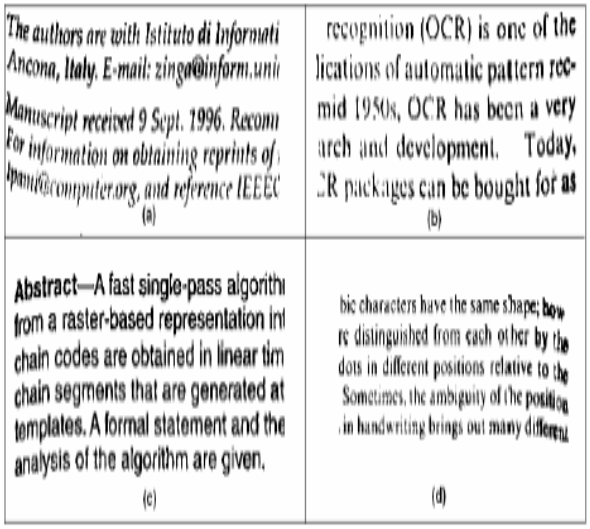

Fig.1: Sample of line bending in document images[6]

a) Left upward (b) Right upward (c) Left downward (d) Right downward

Bending of text-lines in document images may occur on left or right borders of the document image and deformation may be in either upwa document image viz., left upward or left downward or right upward or right downward to take further correction work. A decision process is adopted to locate the border and direction of deformation. Domain knowledge of printed document images and few assumptions are used in this process. The proposed method assumes that the document images considered are free from noise and skew and the decision process is explained in section 2. Once the side and direction of deformation is identified, subsequently estimation of bending of text-lines is made through elliptical

approximation model and the method is explained in section 3. Section 4 gives the explanation of correction of the deformed image through a transformation process based on the estimation of the deformation. An implementation for the method is given in section 5. Experimental results are explained in section 6. Finally, section 7 outlines the conclusion on the work.

II. DETECTION OF BORDER OF TEXT -LINES BENDING AND DIRECTION

Domain knowledge about the printed document image is the basis for detecting the edge and direction of bending of text-lines. The domain knowledge is that the lines in document are clearly separated, bending of lines occur only at the borders of the document, bending is either upward or downward in a line. It is evident from number of samples that bending of text-lines is towards borders and the mid region of any document image is always free from bending deformation. Deformation normally, occurs only in ¼th of left or right border of the document image. Using 1/4th through 3/4th region of the document image, uniform line separation area between two lines is determined as shown in fig (2).

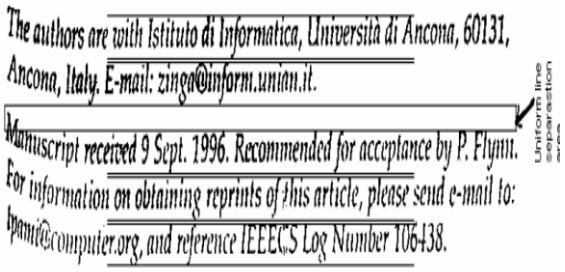

Fig.2:Area indicating uniform separation between two lines[2]

Two regions of 1/4th areas within the uniform lines separation region to the left is demarked as left zone and to the right as right zone.

III. ELLIPSE AND LINE DRAWING ALGORITHM

A digital differential analyzer (DDA) line drawing algorithm draws a line between any two specified points. A midpoint ellipse drawing algorithm draws an elliptical arc for given center, x-radius and y-radius. An imaginary elliptical arc and an imaginary line based on the side and direction of deformation from the position of deformation to edge of document helps in further processing. A series of elliptical arcs and lines are drawn until a suitable arc and a line are encountered such that the arc and line enclose the deformed region as shown in fig(3).

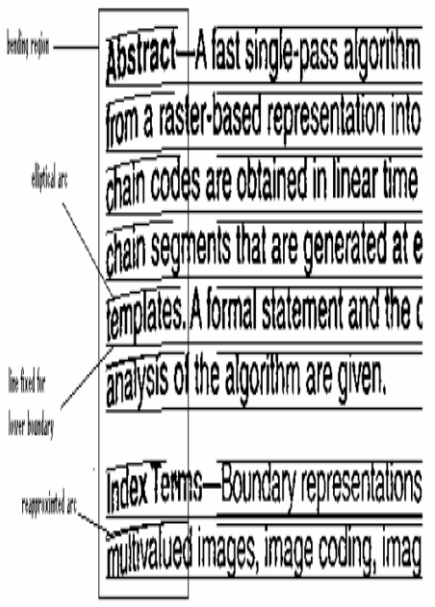

Fig.3: Enclosing the deformed area within an arc and a line[2]

Starting with smallest sized elliptical arc, a search process is performed to fit a suitable Within each uniform line separation region two sub regions each with 1/4th of the total area are marked towards left and right borders as left zone and right zone respectively. Leftsum and rightsum are two counters which keep the average count of number of points of the text entering the line separation region towards the left and right zones respectively.

An iterative search procedure is performed on the other side of the bent text- line to fit a line such that the bent portion of line is completely enclosed between the elliptical arc and line drawn. An algorithmic procedure for obtaining such line is given below.

x1 = x coordinate of deformation starting position
y1 = y coordinate of deformation starting position
x2 = x coordinate value at the edge of the document
y2 = y1
draw line(x1,y1,x2,y2)
while (line intersect the deformed text line) do
change y2 by 1 unit
draw line(x1,y1,x2,y2)
end while

ellipse that encompasses the deformation and the procedure is given as an algorithmic skeleton below.

x centre = x coordinate of deformation starting position

y centre = y coordinate of deformation starting position - 1
x radius = distance from edge to deformation st ellipse that encompasses the deformation and the procedure is given as an algorithmic skeleton below.
x centre = x coordinate of deformation starting position
y centre = y coordinate of deformation starting position - 1
x radius = distance from edge to deformation starting position
y radius = 1
draw ellipse(x centre ,y centre,x radius,y radius)
while (arc not touch deformed text) do
change y centre by 1 unit
increase y radius by 1 unit
draw ellipse(x centre ,y centre,x radius,y radius)
end while
The values of parameters are dependent on side and direction of deformation. Fig(4)demonstrates the position of arc and line based on deformation.

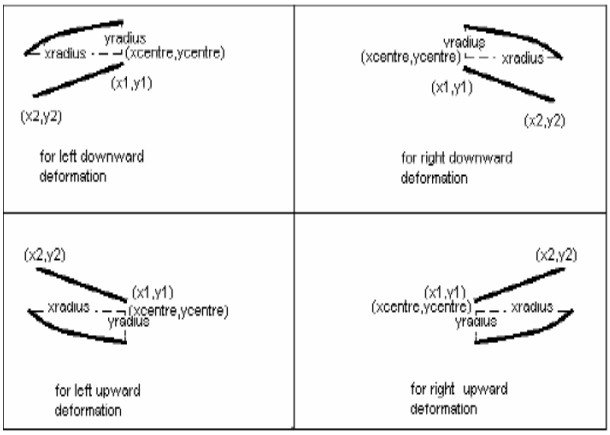

Fig.4: Drawing arc and line based on parameter value[3]

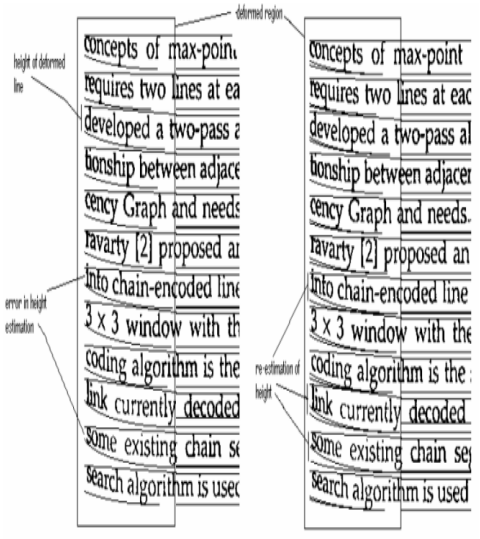

Fig.5: (a) Possibility of error in height Fig. 5: (b) Re-estimation of height estimation [5]

It is possible to estimate the height of the deformed text line erroneously due to text contents. The text contents may not have characters with upper and lower strokes like 'g', 'h', 'y', 't' etc. as shown in fig(5.a). Such deformed texts will lead to the situation of improper estimation to the deformation level and requires re-estimation. Re-estimation is made by drawing another arc with corrected parameters. The correction of error in estimation is done as follows:
h1 = height of deformed text line at edge
h2 = height of actual text line height
if h1 < h2 then
difference in height (dh) = h1 - h2
change y centre by dh units
increase y radius by dh units
draw ellipse(x centre ,y centre ,x radius ,y radius)
end if
Re-estimated level of deformation by another ellipse with different parameters may be noticed in fig (5.b). Once the estimation of deformation is completed, the correction process is done through transformation and is explained in the next section.

IV. TRANSFORMATION PROCESS

A spatial domain transformation is performed on image to remove the bending of text -line in the deformed region. The correction of estimated bending deformation adopts a point processing technique [] of shift in y-direction. In this transformation the deformed part of document is shifted in y-direction based on the estimation of bending of text-lines.
Transformation [] process can be represented as:

$$g'(x,y) = T[g(x,y)]$$

where is the original deformed image in spatial coordinates g' is the deformation corrected image in the same coordinate system and T is the point processing transformation function for deformation correction.

V. METHODOLOGY

The implementation of the proposed method is described in the form of skeleton algorithm below. Algorithm contains module only for the estimation and correction of left downward marginal deformation. Modules can be similarly incorporated for the other possible types of bending of text-lines viz., left upward, left downward, right upward and right downward.

1. Determine the side of deformation
2. Determine the direction of deformation
3. If (left down-deformation) then do left down-correction
4. if (left up-deformation) then do left up -correction
5. if(right down-deformation) then do right down-correction
6. if(right up -deformation) then do right up-correction
7. end Left down-correction module
1. for each line in the document image
a. fix up an imaginary arc and line as explained in section 3
b. for each point p(x ,y) on arc
i) d=distance between p(x, y) and q(x, y') on top text line
ii) shift all points between arc and line at x up by a value d
Similarly, modules for estimation and correction can be implemented to the other three possible types of bending of text-lines .

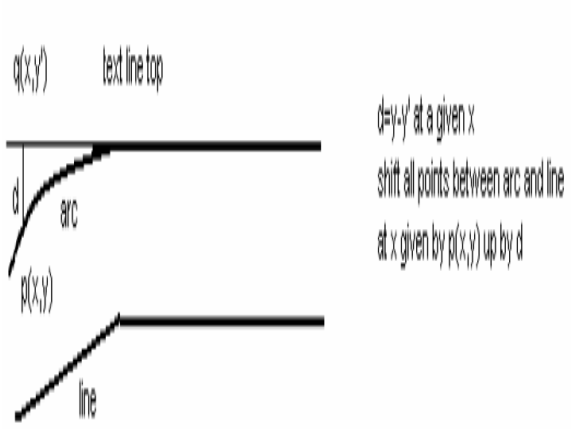

Fig.6: describes transformation process for left downward correction [5]

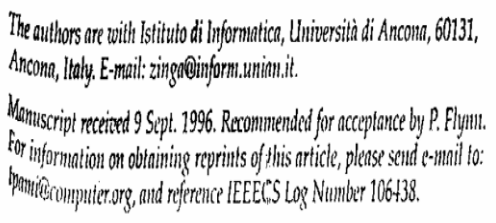

Fig.7: (a) Document image with left upward bending of text-lines[6]

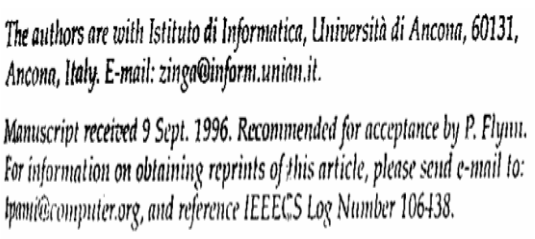

Fig.7: (b) Left upward text-line bending corrected[6]

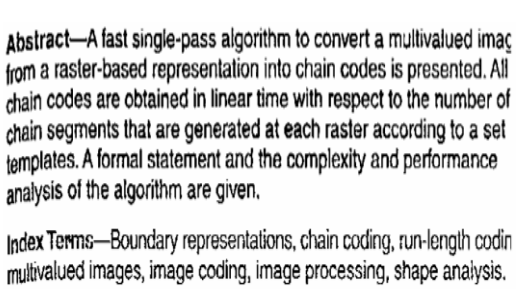

Fig.8: (a) Document image with left downward bending of text-lines[6]

VI. EXPERIMENTAL RESULTS

The proposed method is tested using more than 50 samples of English as well as on Gurmukhi document images containing text-lines bending deformations. The result of the experiments conducted is very much promising. Tests were conducted on all four types of text line bending deformed document images. The test samples were considered are with different font size and style, different line spacing and different scanning resolution. Fig(7) and Fig (8) shows the different input images and corrected output images as result.

TABLE 1: RESULT ANALYSIS

Efficiency range	Reason for efficiency	Characteristics
91%-95%	Elliptical arc matches more closer with the deformation	One or two edge characters in one or two lines remain insignificantly deformed
86%-90%	Over estimation is made by elliptical arc towards the edge	One or two edge characters in each lines are shifted slightly more
80%85%	Re-approximation of bending is improper due to absence of lower stroke characters	corrected portion still remains little lower than actual position
< 80%	Deformation is more circular than close to elliptical, and elliptical approximation assumes little bend at beginning, this causes little shift to beginning bend	Corrected portion forms a wave like structure

Fig.8: (b) Left downward text-line bending corrected[6]

VII. CONCLUSION

The developed method for estimation and removal of line bending deformation does not require any special arrangements to acquire the document image, the image obtained by flat -bed scanner is sufficient. The experimental results are fairly close to the results of the method proposed by Breuel and Zhang which requires set up for acquiring stereo vision image and Complex mathematical models for construction of 3D image vision and interpolation techniques. The developed model is very sensitive to noise and skew.

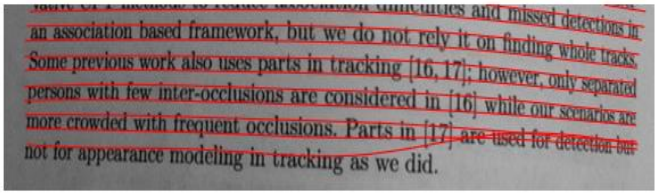

Fig.9: (a) right downward text-line bending of text lines[7]

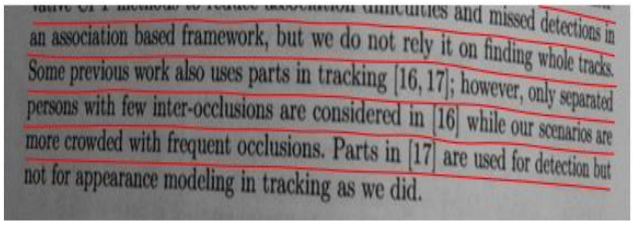

Fig. 9: (b) right downward text-line corrected[7]

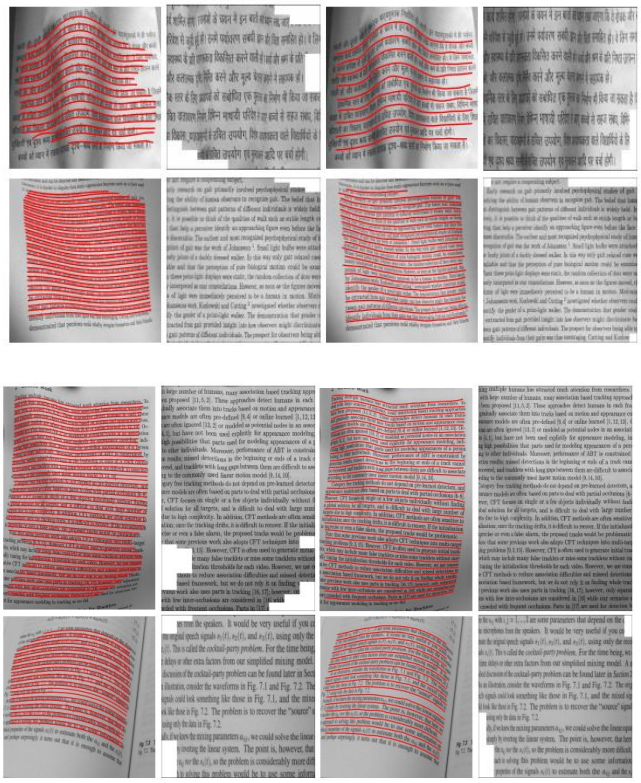

Fig.10: more examples on de warping

VIII. REFERENCES

[1]. Bin Fu, Minghui Wu, Rongfeng Li, Wenxin Li, ZhuoqunXu, Chunxu Yang, "A Model based Book Dewarping Method Using Text Line Detection", Proceedings of 2ndInternational Workshop on Camera based Document Analysis and recognition, 63-70.

[2]. A. Masalovitch and L. Mestetskiy, "Usage of continuous skeletal image representation for document images de-warping", Proceedings of 2nd Int. Workshop on Camera-Based Document Analysis and Recognition, Curitiba,Brazil, pp 45-52, Sep. 2007.

[3]. B. Gatos and K. Ntirogiannis, "Restoration of arbitrarily warped document images based on text line and word detection", Proceedings of Fourth IASTED Int. Conf. On Signal Processing, Pattern Recognition, and Applications, pages 203–208, Feb. 2007.

[4]. Adrian Ulges, Christoph H. Lampert, "Document Image Dewarping using Robust Estimation of Curled Text Lines", Proceedings of the 8th International Conference On Document Analysis and Recognition (ICDAR'05), 2005

[5]. Xu-Cheng Yin Jun Sun Satoshi Naoi, "Perspective rectification for mobile phone camera-based documents using a hybrid approach to vanishing point detection", Proceedings of the Second International Workshop on Camera Based Document analysis and rectification, 37-44, 2007.

[6]. Z. Zhang & C. L. Tan, "Warped image restoration with applications to digital libraries", International Conference on Document Analysis and Recognition, Seoul, Korea, 2005, pp. 192-196

[7]. A. Ulges, C.H. Lampert, and T.M. Breuel. Document image dewarping using robust estimation of curled text lines. In Proc. Eighth Int. Conf. on Document Analysis and Recognition, pages 1001–1005, Aug. 2005.

[8]. J. Liang, D.F. DeMenthon, and D. Doermann. Flattening curved documents in images. In Proc. Computer Vision and Pattern Recognition, pages 338–345, June 2005.

[9]. S. Lu and C.L. Tan. The restoration of camera documents through image segmentation. In 7th IAPR Workshop on Document Analysis Systems, pages 484– 495, Nelson, New Zealand, Feb. 2006.

[10]. S. Lu and C.L. Tan. Document flattening through grid modeling and regularization. In Proc. 18th Int. Conf. on Pattern Recognition, pages 971–974, Aug. 2006.

[11]. B. Gatos and K. Ntirogiannis. Restoration of arbitrarily warped document images based on text line and word detection. In Fourth IASTED Int. Conf. on Signal Processing, Pattern Recognition, and Applications, pages 203–208, Feb. 2007.