***Original Research Article***

# A hybrid approach for skew detection and correction in the multi-script scanned document


## ABSTRACT

Skew detection and correction of a scanned document is a very important step in Optical Character Recognition because skew of scanned document is reducing the accuracy of text line approach for skew detection and correction to calculate the skew angle on multi script scanned document using radon transform, Hough transform, harries corner, wiener filter and smearing algorithm. In this paper, a proposed approach is compared existing skew detection and correction techniques for printed documents having different scripts: English, Tamil, Sinhala and mixed script. A proposed hybrid method is tested on 160 documents. The overall testing results is 90.62% for skew detection and correction.



*Keywords:*
*OCR, Skew detection and correction, Radon Transform, Hough transform, Harris corner*


## 1. INTRODUCTION

Skew detection and correction are important steps of document layout analysis and optical character recognition, (OCR) because skew of scanned document is reducing the accuracy of text line and character segmentation. The skew angle of a scanned document is defined as the variation of the dominant orientation of the text lines from the y-axis. When a document is fed to the scanner either mechanically or by a human intervention, a few degrees of skew is unavoidable.

The skew angle in a scanned document is divided into two types: Clock wise skew angle and Anti-clock wise skew angle. There are three types of skew in the scanned document basis on number of skew angle and orientation: (1) Single Skew on scanned document, (2) multiple skew on scanned document, and (3) multiple skew in single text line

### A. Single Skew on scanned document

In this skew, the document is skewed to single angle. Fig. 1(a) shows the sample single skew document

### B. Multiple skew on scanned document

The document can have many sections; each may be skewed to different angles. Fig. 1(b) shows the sample multiple skew documents

### C. Multiple skew in single text line

When documents contain several orientations in the single line is called as multiple skew in single text line. In multiple skew in single text line, there are several orientations in each line of the document. Fig. 1(c) shows the sample multiple skew in single text lines

(a) (b) (c)

Fig. 1. skew on scanned document and (c) multi skew in single text line

Many techniques of skew detection can process text only, and good quality document images and single skew document successfully. But it is challenging problem to process documents with non-text document which consists of tables, charts, graphics, figures or different font sizes.

This study proposes a hybrid approach for skew detection and correction techniques using Radon transform, hough transform, Harris corner, smearing technique and Wiener filter; Following this introductory section, the rest of the paper is organised as follows. Section 2 summarize the related work in skew detection and correction technique, whereas section 3 describes the background of Hough transform and radon transform. The proposed methodology is presented in Section 4. Section 5 briefly describes the constructed dataset. Experimental setup and testing results are presented in section 6. Finally, section 7 concludes this paper with future extension.

## 2. RELATED WORK

In [1], Salem Saleh Bafjaish et al. proposed Skew Detection and Correction of Mushaf Al-Quran Script using Hough Transform. The proposed method involved in converting to grayscale image, binary image, foreground image detection, HT to detect lines, calculate skew angle and rotate image. The technique using Hough transform lines detection for calculating the skew angulations. It works for different version of Mushaf AlQuran image pages which has skewed text zones. Moreover, it can detect and correct the skew angle in the range between 20 degrees.

In [2], Abdelhak Boukharouba proposed a new algorithm for skew correction and baseline detection based on the randomized hough transform. The proposed algorithm involved lower edge determination and segmentation, small edge filtering, skew angle detection, baseline estimation with skew correction and baseline estimation without skew correction. Authors have collected a variety of printed Arabic documents consisting of magazines, books and newspaper. This algorithm can also contribute significantly for text line extraction from skewed document images for many languages.

In [3], Rubani and Jyoti Rani proposed the Skew Detection and Correction in Text Document Image using Projection Profile Technique. The proposed method works in two phases: calculate the skewed angle from the input text document ,and correct the sleekness in the given text document on line by line basis. The proposed algorithm involved the binarization, line extraction, Convert the extracted lines into independent block using RLSA algorithm, calculate the corner coordinate points, and calculate the skew angle. The proposed system is tested on 30 text documents which are written in various languages: Punjabi, Hindi and English. The overall recognition rate is around 97%.

In [4], Ramandeep Kaur et al. proposed a hybrid approach to detect and correct a skew in scanned document images using fast fourier transform and nearest neighbor algorithm. The proposed method for Skew Detection and correction involved Preprocessing, Apply Faster Fourier Transform, Apply nearest neighbor, Calculate the skewed angle. The overall recognition rate of proposed method is 96%.

In [5], MSLB. Subrahmanyam et al. proposed a new algorithm for Skew Detection of Telugu Language Document based on Principle-axis Farthest Pairs Quadrilateral (PFPQ). The proposed system consists of preprocessing, Derivation of PFPQ, Parameters estimation on PFPQ, Painting and Directional smearing, Final Estimation. The proposed technique is independent on Font size, line spacing between Text lines etc.

There are many methods: Hough transform [6]-[8], Discrete Fourier Algorithm [9], Fast Fourier transform [10]-[11], Fast frequency domain [12], Nearest neighbor [4], Interline cross-correlation [13], Projection Profile [14], Principal Component Analysis [15]-[16], Radon transform [17], Hough transform and Harris corners [18], radon transform and Wiener filter [19], and straight-line fitting [19] for skew estimation and correction.

## 3. BACKGROUND

### A Hough Transform

Standard Hough Transform (SHT) uses the parametric representation of a line (Fig. 2):
rho = x*cos(theta) + y*sin(theta)
The variable rho is the distance from the origin to the line along a vector perpendicular to the line. Theta is the angle of the perpendicular projection from the origin to the line measured in degrees clockwise from the positive x-axis. The range of theta is $-90° \leq \theta < 90°$. The angle of the line itself is $\theta+90°$, also measured clockwise with respect to the positive x-axis.

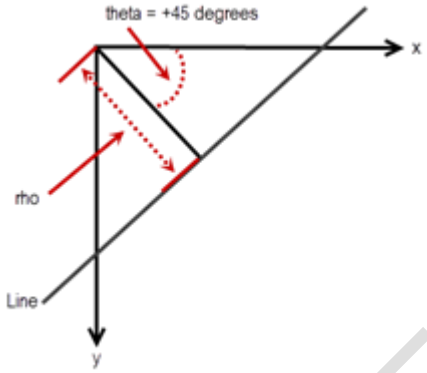


**Fig. 2. Parametric representation of Standard Hough Transform (SHT)**

The SHT is a parameter space matrix whose rows and columns correspond to rho and theta values respectively. The elements in the SHT represent accumulator cells. Initially, the value in each cell is zero. Then, for every non-background point in the image, rho is calculated for every theta. rho is rounded off to the nearest allowed row in SHT. That accumulator cell is incremented. At the end of this procedure, a value of Q in SHT(r,c) means that Q points in the xy-plane lie on the line specified by theta(c) and rho(r). Peak values in the SHT represent potential lines in the input image.

### B. Radon Transform

The Radon transform of an image is the sum of the Radon transforms of each individual pixel (Fig. 3). The algorithm first divides pixels in the image into four subpixels and projects each subpixel separately, as shown in the following figure.

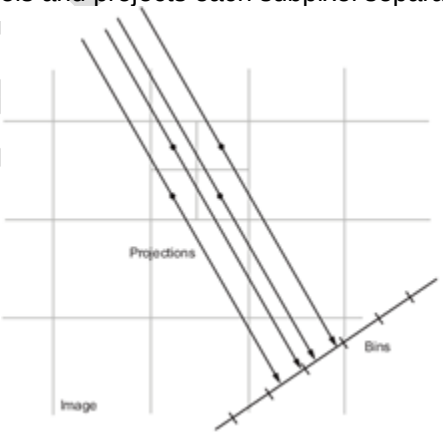


**Fig. 3. Parametric representation of Random Transform**

Each sub pixel's contribution is proportionally splits into the two nearest bins, according to the distance between the projected location and the bin centers. If the sub pixel projection hits the center point of a bin, the bin on the axes gets the full value of the sub pixel, or one-fourth the value of the pixel. If the sub pixel projection hits the border between two bins, the sub pixel value is split evenly between the bins.

## 4. METHODOLOGY

In this section, the proposed skew detection and correction technique is described in details. The block diagram of skew detection and correction technique consists of various steps as shown in Fig.3.

The following steps are applied to perform skew detection and correction:

**Step 1:** Input the printed scanned documents typed in single or multiple scripts.

**Step 2:** Convert the RGB image into Gray Scale Image.

**Step 3**: Convert the grayscale image into a Binary image- Binarization is the process of converting a gray scale image into binary image using Otsu's method.

**Step 4**: Detection of bounding box - Each binary image is enclosed in a tight fit rectangular boundary. The portion of the image outside this boundary is discarded using projection techniques.

**Step 5**: Divide an image into three blocks of equal size name as Block 1 (B1), Block 2 (B2) and Block 3 (B3) steps (see Fig.4.)

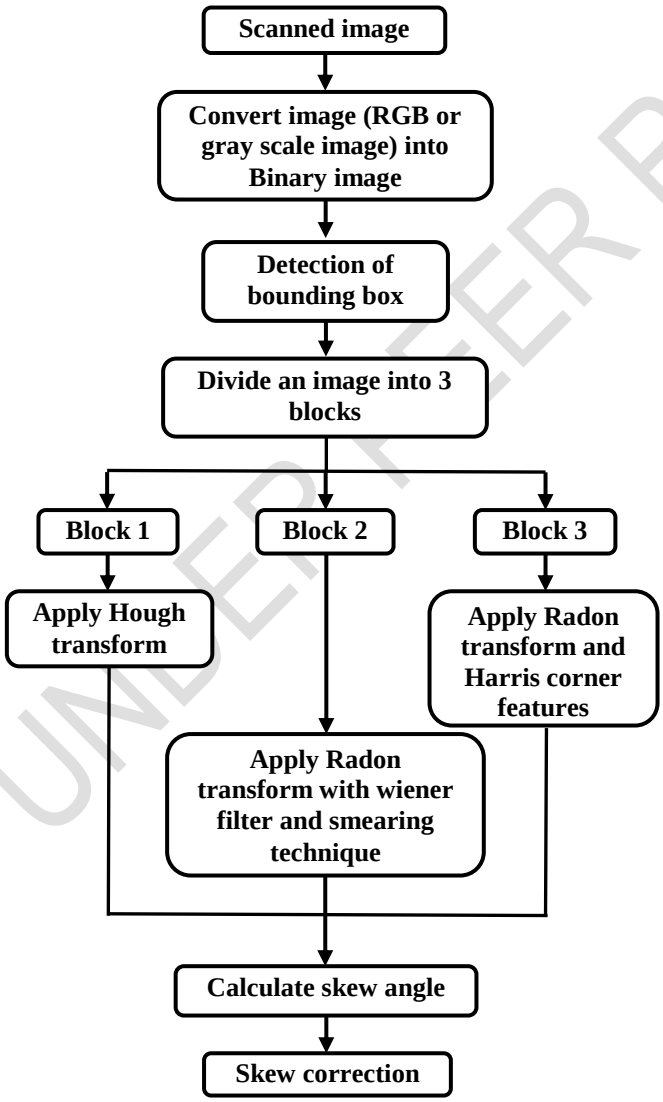


Fig.4.Block diagram of skew detection and correction technique

**Step 6:**

**Apply Radon transform** is the sum of each pixel of the edge map. The Radon function computes projections of Block 1 matrix along specified directions. The Radon transformation is applied to determine the largest line in the Block 1 (B1) and identifies most visible line on the Block 1 to estimate the angle of skewness (ΘB1).

**Apply Hough transform**: Hough transform is applied to either vertical or horizontal Block2 (B2). After that calculate the angle of skewness (ΘB2).

**Apply Radon transform with smearing and Wiener filter**

• Apply Wiener filter to the Block 3.

• Apply smearing algorithm

• The Radon transformation is applied to determine the largest line in the Block 3(B3) and identifies most visible line on the Block 1 to estimate the angle of skewness (ΘB3).

**Step 7:** Calculate skew angle

if (Θ B1== Θ B2== Θ B3)
skewangle= Θ B1;
elseif (Θ B1== Θ B2)
skewangle= Θ B2;
elseif (Θ B2== Θ B3)
skewangle= Θ B3;
elseif (Θ B1== Θ B3)
skew angle= Θ B1;
else
(Θi, Θj)=minimum (|ΘB1- ΘB2|, |ΘB2- ΘB3|, |ΘB1- ΘB3|)
where i, j=B1,B2,B3;
skew angle=average of (Θi, Θj)
end

**Step 8:** Skew correction - Is to rotate the original image with the calculated skew angle in the opposite direction.

**Step 9:** End of program

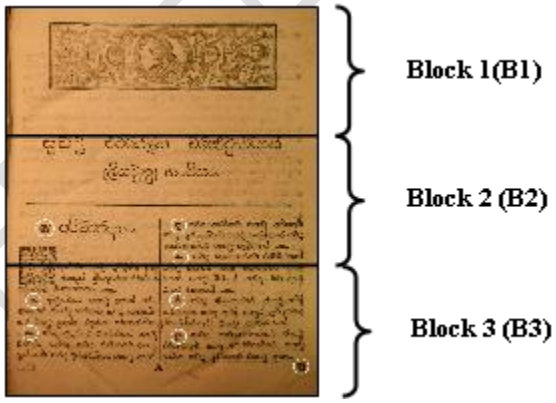


Fig. 5. Block segmentaion on Scanned image

## 5. DATASET

The Created database for the printed scanned documents consists of 160 samples collected from different old books, magazines, newspapers and pamphlets. This dataset include documents having different scripts: English, Tamil, Sinhala and mixed script (see Fig. 6.). This dataset contains 4 different script consisting 40 images per script. The constructed dataset consists of multi-columns, text and non-text blocks, broken characters, different font size and formatting.

Fig. 6. Sample of various script document (a) Tamil (b) sinhala (c) English (d) Mixed

## 6. RESULTS

The recognition rate is evaluated using the following criteria:

$$\text{Recognition rate} = \frac{\#\text{correctly detected skew documents}}{\#\text{documents}}$$

In Table 1 and 2, presents the recognition rate evaluated on created dataset along with the testing times (in seconds). The best results in the proposed method were obtained by using the Hough transform, Radon transform, Harris corner, Wiener filter, and smearing technique.
The range of skew angle considered here is -20 to +20 degrees.

**Table 1: A comparison text only for printed scanned document**

| | **Script** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **English** | | **Tamil** | | **Sinhala** | | **Mixed script** | |
| **Method** | **rate (%)** | **time (s)** | **rate (%)** | **time (s)** | **rate (%)** | **time (s)** | **rate (%)** | **time (s)** |
| Shafii's method [21] | 75 | 1.85 | 75 | 1.90 | 85 | 2.01 | 70 | 2.32 |
| Radon method with harries corner | 80 | 4.20 | 80 | 3.57 | 90 | 3.28 | 80 | 3.85 |
| Radon method with smearing and Wiener filter [19] | 90 | 2.65 | 85 | 2.32 | 90 | 2.67 | 85 | 2.75 |
| Proposed method | **95** | 2.12 | **90** | 2.45 | **95** | 2.08 | **85** | 2.53 |

**Table 2: A comparison text and non-text for printed scanned document**

| | Script | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | English | | Tamil | | Sinhala | | Mixed script | |
| Method | rate (%) | time (s) | rate (%) | time (s) | rate (%) | time (s) | rate (%) | time (s) |
| Shafii's method [21] | 70 | 2.05 | 75 | 2.10 | 75 | 2.35 | 75 | 2.25 |
| Radon method with harries corner | 85 | 4.32 | 80 | 4.10 | 85 | 3.96 | 80 | 4.35 |
| Radon method with smearing and Wiener filter [19] | 85 | 3.95 | 85 | 3.35 | 85 | 3.24 | 80 | 3.60 |
| Proposed method | 95 | 3.70 | 90 | 3.30 | 90 | 3.10 | 85 | 3.23 |

The proposed approach is evaluated on the entire dataset (i.e, 160 images) by comparing with the Shafii's method, Radon method with Harries corner, and Radon method with smearing and Wiener filter. Shafii's method yields a recognition rate of 75%, Radon method with Harries corner yields 82.5%, Radon method with smearing and Wiener filter yields 85.62%, whereas my proposed approach yields 90.62%.

## 7. DISCUSSION AND CONCLUSION

In this paper, a method for skew angle detection and correction is proposed. The estimation of skew angle is performed using Radon transform, Hough transform, Harris corner, smearing technique and Wiener filter. The proposed technique is experimentally evaluated on two types of dataset that are based on text only, and text and non-text of printed various script documents. The skew detection method yields a recognition rate of 91.25% for text only of printed various script documents and yields a recognition rate of 90% for text and non-text of printed various script documents. The overall

recognition rate is around 90.62%. The recognition rates confirm that the proposed technique is effective for preprocessing step of Optical character recognition on multi- script printed document.

## REFERENCES


1. Salem Saleh Bafjaish, Mohd Sanusi Azmi, Hairulnizam Mahdin, (2018), "Skew Detection and Correction of Mushaf Al-Quran Script using Hough Transform", International Journal of Advanced Computer Science and Applications, Vol. 9, No. 8, pp. 402-409.
2. Abdelhak Boukharouba, (2017), "A new algorithm for skew correction and baseline detection based on the randomized hough transform", Journal of King Saud University – Computer and Information Sciences 29, pp. 29-38.
3. Rubani, Jyoti Rani, (2018), "Skew Detection and Correction in Text Document Image using Projection Profile Technique", International Journal of Computer Sciences and Engineering, Vol.-6, Issue-7, pp. 986-990.
4. Ramandeep Kaur, Seema, Sunil Kumar, (2016 ), "A hybrid approach to detect and correct a skew in scanned document images using fast Fourier transform and nearest neighbor algorithm", International Journal of Advances in Electronics and Computer Science, Volume-3, Issue-5, pp. 1-6.
5. MSLB. Subrahmanyam, V. Vijaya Kumar, B. Eswara Reddy, (2018), "A New Algorithm for Skew Detection of Telugu Language Document based on Principle-axis Farthest Pairs Quadrilateral (PFPQ)", I.J. Image, Graphics and Signal Processing, pp. 47-58
6. A. Papandreou and B. Gatos, (2013), "A coarse to fine skew estimation technique for handwritten documents", International conference on document analysis and recognition (IEEE),
7. B. Aditya, A. Kumar and B. M. Yadav, (2013), "Skew Detection in Handwritten Documents", International Journal of Computer Applications, vol. 69, pp. 0975-8887,
8. T. Jipeng, H. G. Kumar and H. K. Chethan, (2011), "A skew correction for Chinese character using hough transform", International journal of advanced computer Science and applications, pp. 45-48.
9. R. Singh and R. Kaur, (2013), "Improved skew detection and correction approach using discrete fourier algorithm", International journal of soft computing and engineering, vol. 3, issue 4, pp. 55-57.
10. L. Kaur, S. Jindal (2011), "Skew detection technique for various scripts", International journal of scientific & engineering research, vol. 2, issue 9.
11. Rao, K.R.; Kim, D. N. & Hwang, J.J. (2010). Fast Fourier Transform - Algorithms and Applications, Springer, Dordre ht, ISBN 978-1-4020-6629-0, London
12. Mehta, S.; Walia, E. & Dutta, M. (2015). "Fast frequency domain method to detect skew in a document image.", Proc. SPIE 9817, Seventh International Conference on Graphic and Image Processing, Dec. 2015, vol. 9817.
13. Yan, H. (1993). "Skew Correction of Document Images Using Interline Cross-Correlation.", CVGIP Graphical Models and Image Processing, Vol. 55, No. 6, pp. 538-543.
14. Li, S.T.; Shen, Q. H. & Sun, J. (2007). "Skew detection using wavelet decomposition and projection profile analysis.", Patter Recognition Letters, Vol. 28, No. 5, 2007, pp. 555-562.
15. Basavanna M, S. S. Gornale ,(2015), "Skew Detection and Skew Correction in scanned Document Image using Principal Component Analysis", International Journal of Scientific & Engineering Research, Volume 6, Issue 1, pp.1414-1417.
16. T. Steinherz, N. Intrator, E. Rivlin, (1999), "Skew detection via principal components analysis", Proceedings of the International Conference on Document Analysis and Recognition, pp. 153-156,
17. K. Aithal, G. Rajesh, D. Acharya and P. Siddalingaswary,(2013), "A fast and novel skew estimation approach using radon transform", International Journal of Computer Information Systems and Industrial Management Applications, vol. 5, pp. 337-344.
18. Ahmed Gari ; Ghizlane Khaissidi ; Mostafa Mrabti ; Driss Chenouni ; Mounim El Yacoubi, (2017), Skew detection and correction based on Hough transform and Harris corners, 2017 International Conference on Wireless Technologies, Embedded and Intelligent Systems (WITS)
19. M. Ramanan, A. Ramanan and E. Y.A. Charles, (2015), "A Preprocessing Method for Printed Tamil Documents: Skew Correction and Textual Classification", IEEE Seventh International Conference on Intelligent Computing and Information Systems (ICICIS, pp. 495-500.
20. Cao, Y.; Wang, S. & Li, H. (2003). "Skew detection and correction in document images based on straight-line fitting", Pattern Recognition Letters, Vol. 24, No. 12, pp. 1871-1879.
21. M. Shafii,(2014), "Optical Character Recognition of Printed Persian I ArabicDocuments", Electronic Thesis and Dissertations, 2014