



Various Skew Detection and Correction Techniques: A Survey

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Abstract— *The skew detection and correction plays an important role in text line extraction of any recognize system. Many researchers proposed various techniques for estimation of skew in Binary/grey images. This survey paper discuss about the various methods i.e. Hough transfer, nearest neighbour, projection profile, centre of gravity, Particle swarm optimization, Straight Line Fitting etc.*

Keywords— *Skew detection, Skew Correction, Centre of Gravity, Projection Profile, Particle Swarm Optimization, Straight Line Fitting, Linear Regression.*

I. INTRODUCTION

The computerization process include the document image analysis that related to automatic elucidation of document images, text etc. and OCR system which involve the process of transformation of human readable and optically sensed data to machine readable code. Optical character recognition is the most of the gripping and demanding area of character recognition. The high performance of any recognition system depends upon the detail analysis of pre-processing and segmentation operation for removing noise and extracting character component respectively from input document image [1].

- Online character recognition
- Offline character recognition

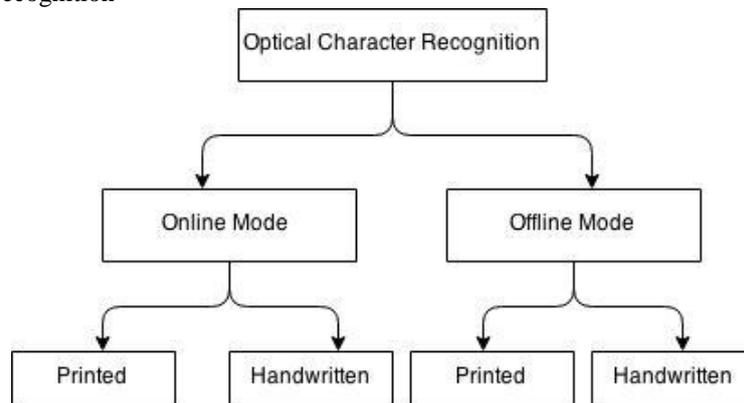


Fig 1 Classification of OCR System [2]

Online Character Recognition: - In this system, character is recognized based upon the direction of motion. This method is accessible on track pad, Smartphone etc.

Offline character recognition: - This system involves an automatic conversion of text into machine understandable code. The output obtained by the system is static representation of handwritten document. [3][4]

Skew angle estimation and correction of a handwritten document image is an important task of document analysis and OCR system. Skew angle is an angle between a text line and horizontal axis.

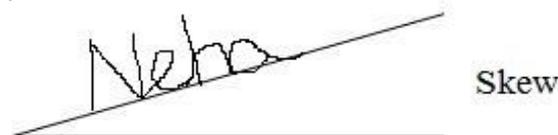


Fig 2 Example of a skewed image [5]

During computerization of document it happens that text page is not aligned properly [1]. There are various methods for detecting and correcting the skew angle i.e. Projection profile, Straight Line Fitting, Centre of gravity etc.

Projection Profile are mainly of two types i.e. Horizontal and Vertical projection profile. Horizontal projection profile is the histogram of ON or black pixels along every row of image and Vertical projection profile is the histogram of ON or black pixels along every column of image. Projection Profile is to find the skew angle of text.[6]

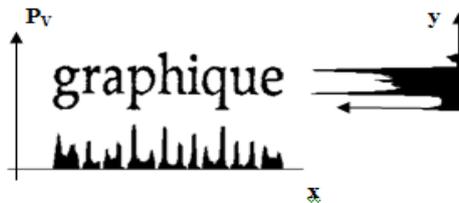


Fig 3 Horizontal and vertical histogram of text[7]

Particle swarm optimization is used for skew optimization technique in which projection profile is defined based upon local maxima and local minima. PSO is used to find the best angle that maximizes the difference between the value of local maxima and local minima.

Straight Line Fitting technique is used for detecting the skew that is based on Eigen point concept. Eigen-points on the baselines are selected as samples for the straight-line fitting which is used to find and correct the skew.

Centre of gravity is also known as centre of mass. COG is used to find and correct the skew by baseline identification and skew angle correction.

II. RELATED WORK

A. VARIOUS TECHNIQUES FOR SKEW DETECTION AND CORRECTION

1. Skew Detection and Correction technique by using Projection Profile-

[8] E.Kavallieratore et.al represent “skew angle estimation for printed and handwritten document using the winger–Ville distribution.” In this paper winger–Ville distribution for horizontal projection profile is used to correct the skew angle in between ± 89 . Winger-Ville Distribution represents for time varying or non-stationary signal whose attribute vary with respect to time. Time frequency distribution represents two classes i.e. Atomic decomposition and Energy distribution. It achieve success rate of 100% within range of $\pm 0.3^\circ$.

Bishankhajain [9] propose a “Comparison paper on skew detection of scanned document images based on horizontal and vertical projection analysis”. In this paper Assamese language paper image is used for skew detection and correction. Skew detection done with vertical projection profile analysis technique, the drafted line is scanned vertically and in the case of horizontal projection profile analysis technique, the drafted line is scanned horizontally, to find the maximum value of objective function. If noise is present, the result obtain from vertically projection profile analysis is not uniformly increase but horizontal profile analysis give accurate result with little noise images only and only if angle is less than $\pm 15^\circ$.

2. Skew Detection and Correction technique by using Centre of Gravity (COG) –

[10] Seyyed Y.H. Proposed a “Ultra high speed approach for document skew detection and correction based on centre of gravity”. For finding skew angle detection and correction for Arabic/Persian script uses Centre of gravity (COG) technique. It works on two stages. In first, Baseline identification the imaginary (baseline) line that course the lower part of particular line of words and Second stage is Skew angle correction, To find the angle exist between horizontal axis and imaginary line and correct them. In this paper follows these steps:-

- Identification of CC's
- Identify actual region of document (ARD)
- Detect Centre of gravity (COG)
- Identify the imaginary (Baseline) line
- Detecting and correction of skew.

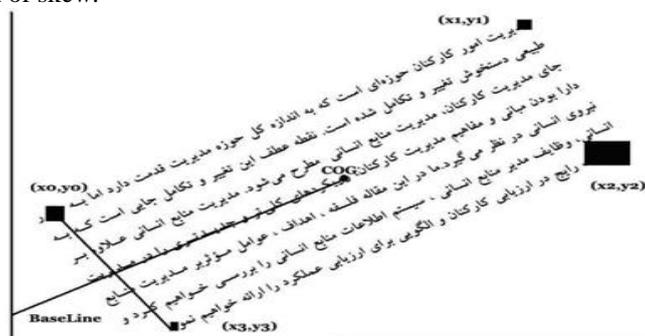


Fig: 4 calculate the amount of skew angle

The proposed method for English, Arabic/ Persian script and shows 93% accurate result with rate of error $< 1^\circ$.

3. Skew Detection and Correction technique by using Particle Swarm Optimization (PSO)

[11] Jauad.s el. al. proposed a “A new approach for skew correction of document based on PSO”. It consists of three steps: - In first step Modified projection profile measure function in projection profile. In second step best angle is detected by using PSO. In third step, after detection of global maximum function (skew angle) and rotate the document in

opposite direction by using this detected skew angle for removing the skew. PSO enables the best skew angle range greater than $\pm 10^\circ$ and this shows best result for these scripts such as Latin and Arabic.

4. Skew Detection and Correction technique by using Straight Line Fitting

[12] Yang cao, heng li represent "Skew detection and correction in document images based on straight line fitting". In Straight line approach, for detecting the skew by using Eigen point concept. Eigen point is the point at the center of the connected component at the bottom of the baseline.

For detecting the skew these steps are followed:-

- Selection of sub-regions and object
- Eigen point clustering
- Baseline fitting
- Skew detection algorithm.

This approach improves the speed, cost and accuracy.

5. Skew Detection and Correction technique by using Linear Regression

[12] Lipi shah el. al. proposed a paper based on linear Regression skew detection technique. Linear Regression make linear relationship between two variables to make a prediction about one variable related to knowledge of other variable. In result, it shows 59.63% accuracy for printed document and 45.58% accuracy for handwritten document and range of angle between 15° to 40° . But this paper has two disadvantages, first is correction coefficient should be statically significant and second is fail to handle minor variation of rotation angle.

Algorithm for skew angle estimation (detection and correction):

Step1: Get the skewed binary image

Step2: Apply the white space remove algorithm

Step3: Apply the Linear regression formula and compute the slope using the following formula

$$M = \frac{n \sum_{i=1}^n x_i y_i - (\sum_{i=1}^n x_i) (\sum_{i=1}^n y_i)}{n \sum_{i=1}^n x_i^2 - (\sum_{i=1}^n x_i)^2}$$

Where, (x, y) = co-ordinate value of the pixel and n = number of black pixels present in the text line

Step 4: Compute the skew angle using the formula

$$A = \tan^{-1} M$$

Step 5: Apply rotation of negative of angle (skew angle) to character image.

III. PARAMETER EVALUATION AND COMPARATIVE STUDY

I. Accuracy-Which means trueness with systematic errors. It defines the combination of clarity and trueness.

II. Success Rate - no of rate of success among no. of trials/ attempts.

III. Estimation angle of skew – It identify the divergence of its text lines from the horizontal axis. The skew of the document image can be a global (all document's blocks have the same alignment), multiple (document's blocks have a different alignment) or non-uniform (multiple alignment in a text line).

Table 1- Comparative study of Skew detection and correction Technique

Author, Year	Technique Used	Script	Advantage	Disadvantage	Result
S.Y. Hashemi	Centre of Gravity (COG)	Arabic/ Persian	1. Efficient and fast algorithm. 2. Works with different resolutions.	1. Show better results for English script rather than Arabic/ Persian.	93% with error rate less than 1°
L. Shah et. al.	Linear regression	Gujrati	Simple and fast algorithm	1. Fail to handle minor variations.	59.63% for printed & 45.58% for handwritten
E. kavallieratoo	Projection Profile	English	1.Reduce computation complexity	1. Unsuccessful for same orientation. 2. It can handle non parallel text line.	Success rate 100% within confidence range $\pm 0.3^\circ$
J. Sadri el. al.	Particle swarm optimization (PSO)	Latin/ Arabic	1.Better results for gray & binary scale images	1.Need to improve speed and performance for larger collection of documents	96.34% accuracy & error range less than $\pm 1^\circ$

Y. Cao et.al.	Straight Line fitting	English	1.Reduce computing cost 2. High accuracy and speed.	1. Size of the sub region should be carefully selected.	Correct angle b/w -3.8 to 4.2°.
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IV. CONCLUSIONS

Various method or techniques has been proposed for skew detection and correction. In this paper, different techniques are studied and analysed for detecting and correcting the skew of handwritten documents and we reviewed these different techniques i.e. Projection profile, centre of gravity, Particle swarm optimization, straight line fitting, linear regression etc. These all technique successfully handles the skew of handwritten documents.

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