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Skew Detection Techniques for Printed Documents of Various Scripts: A Survey

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Abstract

Various problems may get introduced during document scanning, which may decrease the overall accuracy of optical character recognition system. These problems are skewness, noise, unequal intensity etc. Skewness is frequently occurring phenomenon due to non-alignment of image border with scanner. Various techniques have been developed to detect and correct the skew in different type of documents. The commonly used techniques are based on identification of baseline, projection profile, Hough transformation, nearest neighbor, morphological, cross correlation. Each technique has its own pros and cons. In this paper, literature survey of skew detection methods for printed document of various scripts has been carried out.

Keywords: Skew, OCR, document images, Hough transform, projection profile

Introduction

Optical character recognition (OCR) is used to transform a scanned document image to machine readable format. The main purpose of document image analysis is to read the intended contents from the document image. Pre-processing operations are performed to enhance the image properties and to improve the output of OCR system. Image pre-processing involves noise removal, binarization, thinning and skew correction [1]. The features are extracted from document image after application of required pre-processing operations. The OCR is able to classify the characters into various classes using extracted features. Skew detection and correction is an important pre-processing step in OCR system. Skew is deviation or tilt of baseline/headline of text line with horizontal axis [2]. The image must be de-skewed properly by detected skew angle. Various techniques has been used previously to detect the skew in document images such as projection profile analysis, baseline identification, Hough transform, nearest neighbor and cross correlation [3]. In projection profile technique, horizontal and vertical histogram has been computed and skew is estimated by identifying angle which has maximum peaks and valleys. In Hough transform, the skew angle is calculated by identifying straight lines from the document image. Nearest neighbor technique uses clustering to identify the skew of baseline formed at bottom of detected connected components. Cross-correlation technique estimate skew of document image by comparing projection profile of adjacent vertical segments of image. The paper is organized as follows. Section 2 discusses the various existing skew detection techniques. Section 3 present the conclusion and future scope.

Literature Survey

Boukharouba proposed a technique for skew detection of Arabic text documents by using randomized hough transform and locating text baseline [4]. The skew angle is calculated from slope of baseline at various locations and selecting the best threshold. The image is rotated in appropriate direction with calculated skew angle. The method works well for handwritten as well as printed Arabic text.

Al-Shatnawi and Omar presented a skew detection technique by identifying the slope of line joining origin and centroid of polygon made from enclosing the text within it. The technique has been tested on 150 Arabic language documents with 87% accuracy [5].

Jundale and Hegadi presented a skew detection technique for Devanagari documents at word level using Hough transform [6]. The image has been de-skewed using rotational transformation with estimated angle of skew. The technique has been tested on 1050 handwritten and Devanagari words and reported skew correction accuracy of 92.88%. In similar work, same authors proposed another technique for skew correction of handwritten Devanagari words [7]. Firstly, area of axes parallel rectangle has been calculated and skew angle has been estimated using regression analysis. The skew has been corrected by applying rotation transformation. The method has been able to correct the skew of words with 89% accuracy and text-line with 93% accuracy.

Sun and Si presented a skew correction technique for document images by utilizing gradient data [8]. Skew angle has been detected by locating highest point in histogram of gradient. A rotation transformation has been applied to correct the skew. Same technique has been used to detect the slant and corrected with shear transformation.

Kapoor et.al proposed a method for skew detection and correction for handwritten words using projection profile calculated from Radon transform [9]. The results obtained has been compared with Hough transform. The method works well for words having proper Shirorekha and for any skew angle. The skew correction is also based on Radon transform and nearest neighbor interpolation method.

Ghosh and Mandal presented a skew detection technique for online Bangla words by estimating the slope of line connecting the center of gravity of left and right parts of the word. The authors have reported an accuracy of 92.22% for skew correction of Bangla handwritten words [10].

Banumathi and Chandra presented a line and word segmentation technique for historical and handwritten Kannada script using projection profile [11]. Skew has been detected using Hough transformation and skew correction has been performed by rotating the image.

Singh et.al. Presented a fast method for both skew detection and correction after complexity analysis of various phases in the process [12]. Fast algorithms has been proposed for all three stage of skew detection and correction process: A block adjacency graph based method for pre-processing, skew detection based on voting procedure using Hough and de-skew method based on integer calculations. The results demonstrate that the method is very effective for Roman script, but unsuitable for header-line based Indian scripts like Gurmukhi.

Chaudhary & Pal proposed a skew detection method based on common header-line property of Indian scripts such as Devanagari, Bangla and Gurmukhi [13]. The straight header-line in upper-portion of words has been identified by first labelling the components. The upper envelope has been identified by scanning vertically from top and parts which satisfy the straight line property has been designated as header-line. Skew angle has been estimated by averaging the skew of various individual clustered portions. The skew of header-line gives the tilt of whole document image.

Das & Chanda presented a fast technique for skew detection using Morphological operations [14]. Closing and opening has been applied with line and square structuring element respectively. Text baseline has been identified with vertically scanning of all changeover from 1 to 0. All lines with length greater than some threshold has been identified using component labeling and skew angle of document

image has been estimated from median of slope of all lines found after pruning end-points of different identified lines. Method has been compared with many existing technique and turn out to be faster and working for various scripts.

Lehal & Dhir proposed a technique based on calculation of horizontal and vertical projection profiles [15]. Firstly, image is rotated at different angles to estimate rough skew angle by locating highest peaks and deepest valleys in image. Then exact skew angle is found using the structural properties of Gurmukhi script. The technique works on various skew angles irrespective of page orientation.

Sharma & Wadhwa presented a technique to estimate and eliminate line bending introduced during scanning as a result of bounding in documents [16]. The place, direction and estimate and correction of distortion has been carried out and results are presented for Gurmukhi documents. The results shows that methods works well in case of even spread of pixels.

Conclusion

Skew detection and correction is an important pre-processing operation in OCR system. Various techniques has been proposed for skew detection of many scripts such as Roman, Devanagari, Gurumukhi and Arabic. Some techniques are script specific while others work on different kind of scripts. The paper discusses the various techniques for different scripts.

Skew detection has been widely studied for many scripts, but only few studies are available for Gurmukhi script. In future, we will try to formulate a method for skew detection of Gurmukhi script keeping in mind flaws in existing techniques.

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