Skew Detection and Correction System for Ancient Kannada Document

Ravi P
SJB Institute of Technology and Vidyavardhaka College of Engineering
{ravipbympr@gmail.com}

Naveena C
SJB Institute of Technology
Bangalore, India
{naveena.cse@gmail.com}

Sharathkumar Y H
Maharaja Institute of Technology
Bangalore, India
{sharathyhk@gmail.com}

ABSTRACT**:** *In this work, the authors propose a skew correction method for ancient Kannada document. This method consists of four steps segmentation, clustering, skew estimation and correction. The Morphological process is applied for skew estimation and skew correction. Experimentation is carried on the seventeen ancient Kannada document. The ten human professionals are asked to acquire the orientation of each block present in the document and the same has been used to compare the results achieved by the proposed method for check the accuracy .We obtained encouraging the result in the proposed model.*

Keywords: Ancient Kannada, Skew Correction, Morphological Process, Clustering

Received: 12 April 2020, Revised 10 August 2020, Accepted 2 September 2020

© 2020 DLINE. All Rights Reserved

DOI: 10.6025/jcl/2020/11/4/128-134

1. Introduction

Ancient documents give us knowledge about the civilization and traditions of ancient people are practiced. Kannada is the ancient, heritage and formal language of the Indian state of Karnataka. Ancient records are in form of stone carvings, palm leaves, paper documents etc. In the modern era, archeology, libraries and museums have initiated to digitize ancient records that are of importance to a different kind of people, with the goal of preservative the content and creating the records available via electronic media with the help of image processing technique. Optical Character Recognition method is a way to convert document images into a scanned or photo-edited format that the computer can understand. Digitize ancient records is not direct procedure due to low quality of image, contrast of image and overlapping of characters and writing style. Text line extraction and skew finding and correction is a fundamental and critical step in OCR system for scanned document analysis and recognition and improving OCR system accuracy. There is a lot of work is presented for skew finding and correction in different languages of the world but there is less work available in Indian languages like Kannada. Skew finding and correction of ancient Kannada script is very challenging task when compared to any other language's script because of script style. In this research work, Morphological and clustering technique used to skew finding and correction in the image.

2. Related Work

In [1], the authors proposed a method to detect skew angle precisely for different types of documents by using thinning and Hough transform. Papandreou et al. [2] presented new approach that is based on vertical projection profile for detecting skew areas in printed historical documents.

The bagging technique to find and correct the skew in noisy images has been reported in [3]. In [4] the authors used method called Hough transform for skew correction of Devanagari records, Which is belongs to Indo-Aryan languages. The skew detection and correction in Arabic script by the method of Randomized Hough Transform [5].The authors reported [6] Principle-axis farthest pairs quadrilateral for skew recognition of different types of Telugu document. The local skew and global skew rectification in complex color documents using by using new rectification approach has been reported in [7]. The authors presented [8] a technique called Centre of Gravity and Sub-Pixel Shifting to detection and correction the skew in different size of alphabets in English language. The authors used Euclidean Distance for text line extraction followed by single and multi-skew correction in handwritten documents [9].The Piece-wise Painting method is presented [10] to estimate the skew in scanned documents. Hence in this study we proposed line segmentation and skew system for huge and complicate ancient Kannada datasets. In [11], the authors proposed a method to increase the rate at which the visually and blind impaired persons use the portable headset to find the oblique position of digitized documents in use.A sub-region based method for calculate approximately the skew position and finding lines in printed documents is presented [12] method is robust to different skew guidelines and suggestively increases OCR performance. Text Line Segmentation system is proposed [13] for unconstrained Hoysala Kannada script using Sauvolas algorithm, morphological thinning, connected component and projection profile. The authors presented [14] a new robust method for skew position finding and rectification in ancient and existing documents by the help of morphological skeleton, progressive probabilistic and Standard Hough Transform. A novel method for skew angle finding and rectification is presented [15], in this method the authors combine the probability, Q test, and projection profile approach to succeed a decent balance between computational difficulty and correctness. The authors presented a system for skew finding and correction for printed English, Devanagari and Arabic languages using connected components and morphological method and have reached significant performance [16].

3. Proposed Method

3.1. Skew Estimation and Correction

In this division, we contemporary the model which has mostly 4 stages: segmentation, clustering, skew estimation and correction. The 4 stages of the presented method is given in figure 1.

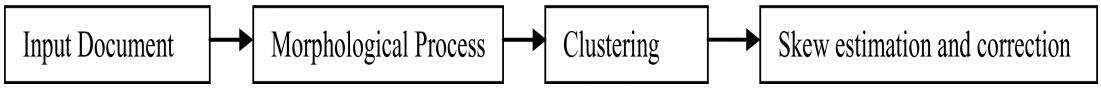

Figure 1. Steps in presented method

3.1. Morphological Process

In this work, we prescribe smearing dilation, a morphological task on the whole document, so that, every one of the characters in the archive are totally filled with no brokenness. When every one of the characters is filled, words are distinguished effectively. It will be seen that as space between words is more than space between characters, all characters of a solitary word get associated with the goal that each word seems, by all accounts, to be one single associated segment. Along these lines, we utilize associated part investigation and recognize information indicates on each word fit a base encompassing circle. The slant of the significant pivot of the circle of the word is taken as the slant edge of the particular word. When this division of each word is done, the words have been spoken to by their significant pivot as clarified in the following area. After morphological operations are applied on the document image the resultant image is given in figure 2. Here we applied erosion and dilation for processing of the documents and plotted a bounding box through connected component analysis.

3.2. Representation

To speak to a sectioned word for further preparing, we recom-retouch removing the slant edge of the real hub of the oval surrounding the word and furthermore to extricate the spatial directions (X, Y) of the two end purposes of the significant pivot. Thusly, each sectioned word can be portrayed by a five dimensional vector, where initial two parts are the spatial directions of

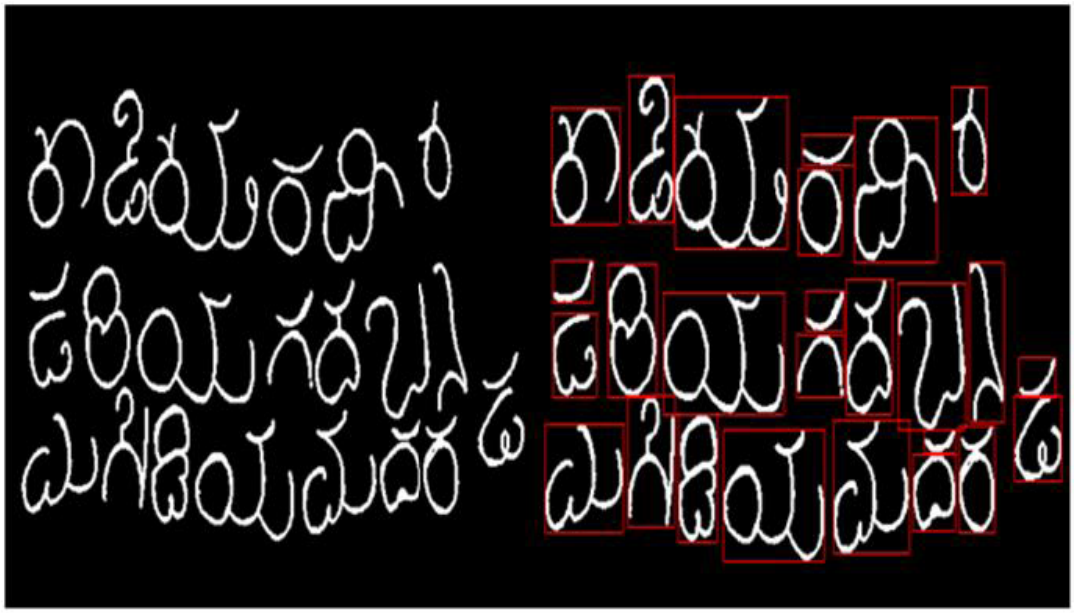

Figure 2. Shows the Morphological Process

one end point, the following two segments are the spatial directions of the opposite end purpose of the real pivot and the last segment is the slant edge of the real hub. Rather than keeping the incline edge in a persistent area, we prescribe digitizing the slant edge into various containers and the comparing canister worth is put away as the last part of the vector. On the off chance that there are n words in the archive picture, at that point a lattice of size n x 5 is made. Consequently in this lattice each column speaks to a word.

3.3. Clustering

As our enthusiasm for this paper is to recognize individual squares of content and evaluating their slants at square level, we suggest distinguishing just those words which have a place with a solitary square. The words which have a place with a solitary square should have right around an equivalent slant edge of their individual real pivot, notwithstanding being extremely near one another spatially. Along these lines, here in this stage, we propose to group every one of the words fragmented from a report picture dependent on spatial directions of the end purposes of the real hub and furthermore dependent on incline points. Along these lines, we utilize a partitional bunching calculation when all is said in done, k-implies grouping calculation in explicit on the network of size n x 5 created in the past subsection. The partitional k-means grouping calculation is explicitly picked due to its inborn points of interest. Consequently, as we don't have aprior learning on the quantity of squares, anticipating values for k is an unobtrusive one. Therefore, a variation of k-means calculation called versatile k-means is utilized. This versatile k-means calculation chooses naturally the quantity of squares of expressions of same directions. We will emphasize that since we use notwithstanding the incline edges of each word, likewise the spatial directions of the end purposes of the real hub, the bunching calculation bunches every one of those words which are not just like each other as for the slant points yet in addition physically near one another, subsequently delivering various squares of words existing in the record pictures.

3.4. Estimation of Skew Angle

Hence, averaging of all the words of skew angles in a block provides the skew angle of that block. In this way, the skew angle of separate block is computed.

Consider a document with skews which has k blocks (clusters). Let n_j be the number of words present in jth block B_j and let θ_i be the skew angle of the i^{th} word present in B_j. The overall skew angle $SA(B_j)$ for B_j is computed using the equation (1).

$$SA(B_j) = \frac{1}{n_j} \sum_{i=1}^{n_j} \theta_i \qquad \forall j = 1, 2, 3, \ldots k \qquad (1)$$

3.5. Skew Angle Correction

Predictable skew angle π is the found, to correct the skew document is switched in opposite direction of predictable skew angle by –π, is shown in figure 3.

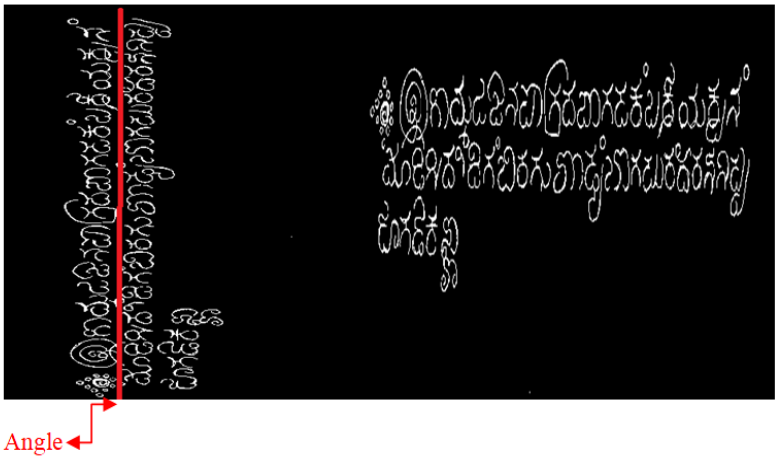

Figure 3. The skew Estimation and Skew Corrections

4. Experimental Results

In our experimentation, we formed our own dataset of skew textline documents, which containing 17 documents, the dataset have arbitrary words of interest in different orientations. To make most challenging datasets the documents are written in an unconstrained manner. To appraise the performance of the planned method the skew of each block is predictable manually by illustration a line on each paragraph in the document and the positioning of each line is stored. Additional to validate the efficacy of the planned method ten human experts are asked to acquire the orientation of each block present in the document and the same has been used to compare the results obtained by the planned method. The deposited orientation of the line of each paragraph is compared with the skew obtained by the proposed method. The average relative error in approximating the skew in multilingual handwritten documents with respect to human experts is shown figure 4 and also results obtained by the proposed model on our data set. Figure 5 shows the skew detection accuracy.

$$\textit{Average Relative Error} = | (\alpha_a - \alpha_o) / \alpha_a | \quad (2)$$

Where α_a = Actual skew and α_o = Achieved skew, Average Relative Error(ARE)

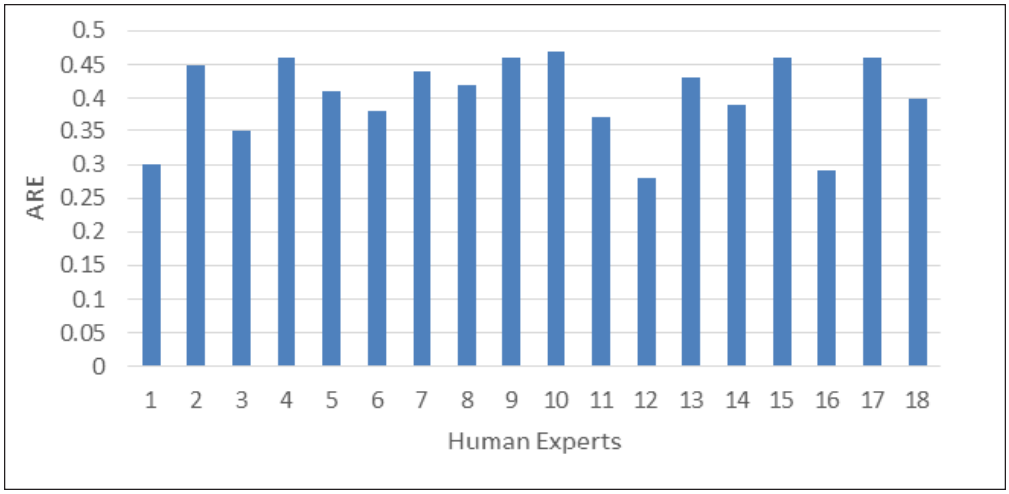

Figure 4. Average relative error rate of the proposed method with respect to human experts

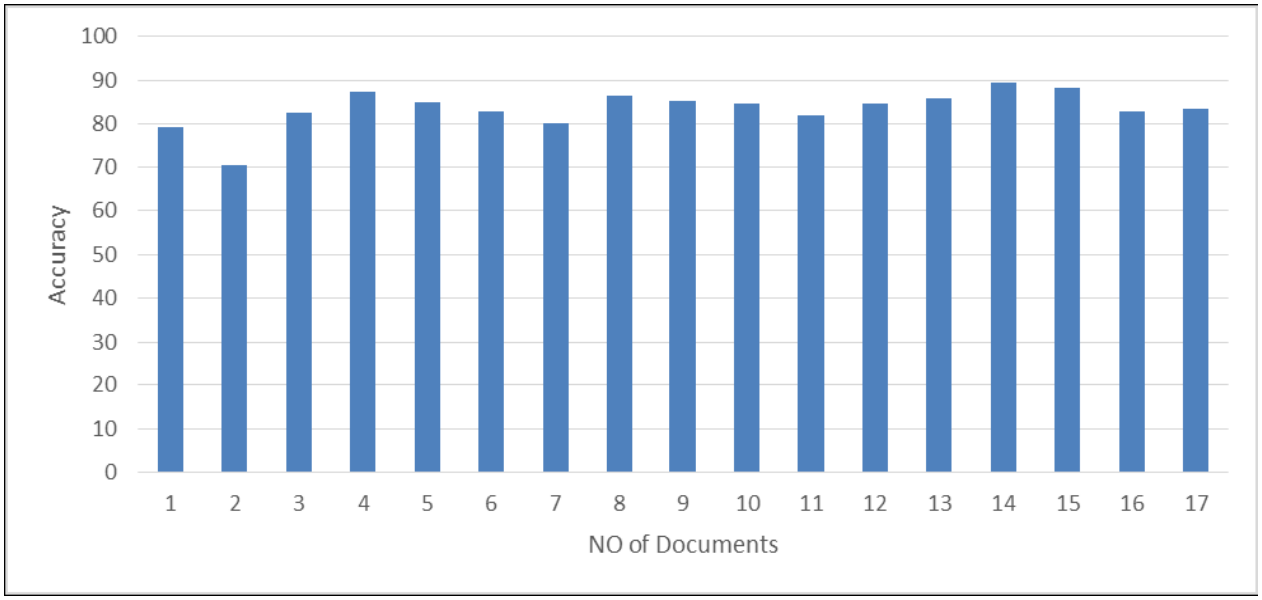

Figure 5. Shows the skew detection accuracy

Evaluation of Detection System

To evaluate the correctness of skew detection algorithms in videos, one should look into confusion matrix. A confusion matrix is a matrix plot of predicted versus actual classes of the samples.

Precision (P): Precision of the detected model is the ratio of the number samples correctly labeled and the total number of samples user labeled. The precision of the detection model is given by equation (3).

$$P_i = \frac{T_i}{c_i} \tag{3}$$

Recall (R): Recall of the Detection model is the ratio of the number samples cor-rectly labeled and the total number of sample user labeled. The recall of the detection model is given by equation (4).

$$R_i = \frac{T_i}{r_i} \tag{4}$$

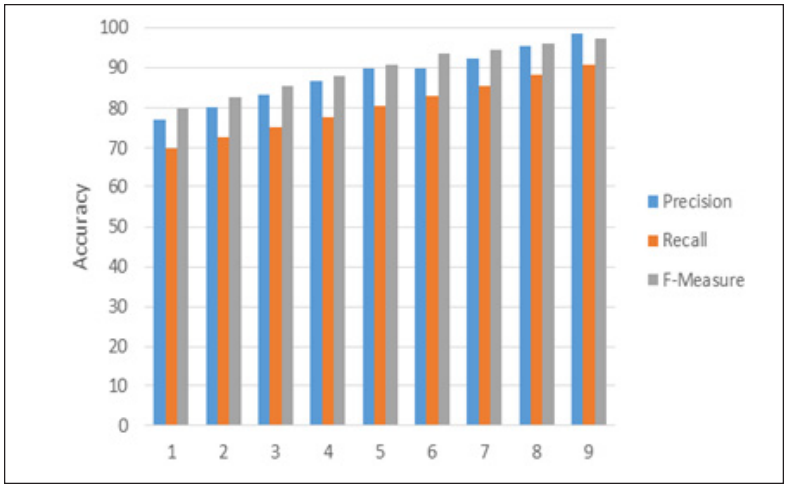

Figure 5. The Average Precision, Recall and F-measure

F-measure (F): F-measure is the harmonic mean of precision and recall and it is given by equation (5).

$$F = \frac{2 \times Precision \times Recall}{Precision + Recall} \quad (5)$$

5. Conclusion

The objective of our work is to estimate and correct the skew in the ancient Kannada manuscript. Initially, the image is pre-processed and converted to binary form to eliminate the noise in the image. Then Morphological and clustering method is applied to group the words. After clustering the skew is estimated. The performance is measured using precision, recall and f-measure. The proposed method gives better results for most image document in a dataset.

References

[1] Aradhya Manjunath V. N., Hemantha Kumar, G., Shivakumara, P. (2007). *Skew Detection Technique for Binary Document Images based on Hough Transform*, ISSRI, p 2401-2407.

[2] Papandreou, A., Gatos, B. A. (2011). *Novel Skew Detection Technique Based on Vertical Projections*, IEEE, p 384-388.

[3] Manomathi, M., Chitrakala, S. (2011). *Skew Angle Estimation and Correction for Noisy Document Images*, Springer, p 415-424.

[4] Trupti A Jundale., Ravindra S Hegadi. (2015). *Skew detection and correction of Devanagari script using Hough Transform*, Elsevier, *p* 305-311.

[5] Abdelhak, Boukharouba. (2016). *A new algorithm for skew correction and baseline detection based on the randomized Hough Transform*, Elsevier, p 29-38.

[6] Subrahmanyam, Vijaya Kumar, V., Eswara Reddy, B. (2018). A New Algorithm for Skew Detection of Telugu Language Document based on Principle-axis Farthest Pairs Quadrilateral (PFPQ), *International Journal of Modern Education and Computer Science*, p 47-58.

[7] Makridis Michael., Nikolaou, Nikos., Papamarkos, Nikos. (2010). *An adaptive technique for global and local skew correction in color documents*, Elsevier, p 6832–6843.

[8] Chinara, Chinmay., Nath, Nishant., Mishra, Subhajeet., Sahoo, Sangram K., Ali, Farida A. (2012). *A Novel Approach to Skew-Detection and Correction of English Alphabets for OCR*, *IEEE*, p 241-244.

[9] Neha1., Arora, Apoorva. (2015). Euclidean Distance Based Text Line Extraction and Skew Correction, *International Journal of Science and Research*, p 1617- 1620.

[10] Alaei, Alireza., Nagabhushan, P. (2016). Umapada Pal and Fumitaka Ki-mura,An Efficient Skew Estimation Technique for Scanned Documents,An Application of Piece-wise Painting Algorithm, *Journal of Pattern Recognition Research*, p 1- 14.

[11] Gari, A., Khaissidi, G., Mrabti, M., Chenouni, D., El Yacoubi, M. (2017). Skew detection and correction based on Hough transform and Harris corners, 2017 International Conference on Wireless Technologies, *Embedded and Intelligent Systems* (WITS), Fez.

[12] Li, W., Breier, M., Merhof, D. (2015). Skew correction and line extraction in bi-narized printed text images, 2015 IEEE International Conference on Image Processing (ICIP), Quebec City, QC, 2015, p 472-476.

[13] Vishwas, H. S., Thomas, B. A., Naveena, C. (2018). Text Line Segmentation of Uncon-strained Handwritten Kannada Historical Script Documents. In: Guru D., Vasudev T., Chethan H., Kumar Y. (eds) Proceedings of International Con-ference on Cognition and Recognition. *Lecture Notes in Networks and Systems*, vol 14. Springer, Singapore. https://doi.org/10.1007/978-981-10-5146-3_23.

[14] Boudraa, O., Hidouci, W. K., Michelucci, D. (2017). An improved skew angle detection and correction technique for historical scanned documents using morphological skeleton and progressive probabilistic hough transform, 2017 5th International Conference on Electrical Engineering - Boumerdes (ICEE-B), Boumerdes.

[15] Chen, Huang, K., Yu, Z., Yan, M., Yin. X. (2020). An Efficient Document Skew Detection Method Using Probability

Model and Q Test. Electronics 2020, 9, 55.

[16] Mohammed, S. W., Soora, N. R. (2018). Global Skew Detection and Correction Using Morphological and Statistical Methods. In: Hemanth D., Smys S. (eds) *Computational Vision and Bio Inspired Computing. Lecture Notes in Computational Vision and Biomechanics*, vol 28. Springer, Cham. https://doi.org/10.1007/978-3-319-71767-8_48.