ADV MATH SCI JOURNAL
Advances in Mathematics: Scientific Journal **9** (2020), no.6, 4095–4101
ISSN: 1857-8365 (printed); 1857-8438 (electronic)
https://doi.org/10.37418/amsj.9.6.91 Spec Issiue on ICAML-2020

A MODIFIED APPROACH FOR SKEW DETECTION OF GURMUKHI NATURAL SCENE TEXT WORDS

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ABSTRACT. Skew deformation in scene images has to be handled properly prior to any text and object recognition. Methods for text extraction in scene images are still in nascent stage in general and particularly for Indian scripts such as Gurmukhi. The proposed method uses the parallel lines in Sirorekha of Gurmukhi word to identify the skew. The method is able to identify the skew in most general situations including single character and severely skewed words. The results show that method performs much better with 78.6% accuracy as compared to existing methods.

1. INTRODUCTION

Text embedded in natural scene images contain useful information regarding content of the image. Extracting text from natural scene images has a number of useful applications [1, 2]. As the content is being captured through a non-stationary device such as mobile phone camera, there is more possibility of it to be affected by skew deformation. Skew correction is one of the pre-processing operation to correctly align the baseline/headline of text word along horizontal direction [3].

Scene text extraction system are generally used to recognize the small strings of text present in images, unlike optical character recognition (OCR) system.

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2010 *Mathematics Subject Classification.* 68U10.

Key words and phrases. Skew detection, Gurmukhi script, natural scene images, scene text.

The traditional approaches used in OCR may or may not be applicable on these systems. Few existing methods [4, 5] addressed the issue of skew detection for Indian scripts for scene images, but there are no attempts for Gurmukhi script.

The rest of the paper is organized as follows. Section 2 presents the details of the proposed research work and results are described in Section 3. Section 4 presents the conclusion and future scope of work.

2. METHODOLOGY

The proposed work has been implemented on self-captured Gurmukhi scene word images using MATLAB. Few sample source images used in experimentation are shown in Figure 1, whose details are available in a previous study [7]. It has been assumed that location of text within the image is known and cropped word image form as an input to the proposed system.

The approach has been modified based on work of [6] for skew detection of pre-segmented Devanagari scene word images. This modified method has been proposed for skew detection of Gurmukhi script, owing to problems encountered during implementation of previous technique [6, 7]. The proposed method is based on parallel upper and lower part of Gurmukhi *Sirorekha*. Algorithm 1 presents the steps of the proposed technique.

FIGURE 1. Sample Gurmukhi scene word images

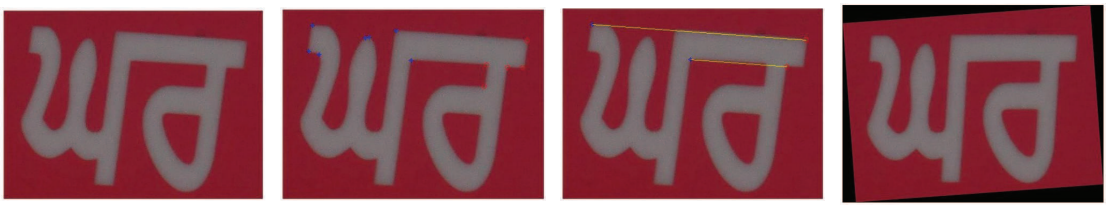
Algorithm 1: Skew detection of Gurmukhi scene text words

Result: Skew corrected words

1 In upper-half of input word image, salient points are detected using [8] and segregated for both left and right quarter.
2 Calculate the slope of all lines made by each salient point from left to right quarter.
3 Identify two parallel lines out of all lines with equal or nearly equal slope and calculate skew angle from slope of these parallel lines.
4 Apply traditional rotation transformation on word image using skew angle of identified parallel lines.

The steps of proposed skew correction approach are described in detail now.

(i) Salient points (sharp corners) are detected in original image as shown in Figure 2a, using [8] in upper-half portion of the word image. The salient points are segregated for both left and right quarter as shown in Figure 2b and marked as blue stars and red circles for left and right quarter respectively. The intent is to correctly identify the headline corners out of these salient points, as headline is always positioned in upper region of an upright Gurmukhi word (assuming skew$<10^{\circ}$).



(A) Original Image (B) Salient points (C) Parallel lines (D) Skew corrected

FIGURE 2. Steps of skew correction of Gurmukhi words

(ii) The slope of all lines made-up from all points in left and right quarter is calculated using following equation:

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1},$$

where (x_1, y_1) and (x_2, y_2) are co-ordinates of points in left and right quarter respectively.

(iii) Two lines with equal or nearly equal slopes are identified as shown in Figure 2c. The intent is to identify upper and lower lines of rectangular headline, which are parallel to each other. The skew angle has been calculated using following equation:

$$\theta = \tan^{-1}(slope).$$

(iv) Word image is rotated in appropriate (clockwise or anti-clockwise) direction as shown in Figure 2d with skew angle θ° calculated in previous step by applying following traditional rotation transformation:

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}.$$

3. Results & Discussion

The results of proposed techniques are shown in Figure 3. The proposed approach is better than existing method [6, 7] on four counts:

Figure 3. Skew correction of Gurmukhi words, from left to right: Original image, Salient points, Identified parallel lines and skew corrected image

(i) Firstly, this approach is able to correct the skew in case of single character words with upper-matra also (see Figure 4), which was not possible with previous method.

(ii) Secondly, approach used in [6] is biased to always select the opposite ends (corners) of rectangular headline, as it based on finding headline end-points located at faraway distance (longest line). Thus only approximate image skew could be calculated, but this approach always gives exact and accurate skew present in the image.

(iii) Thirdly, previous approach works correctly only if at-least two actual headline end-points of Gurmukhi word gets detected by [8]. In case of any failure to miss any headline endpoint, that approach did not work correctly. But the proposed technique works correctly, even if any headline endpoint did not get detected.

(iv) Fourthly, previous approach is unable to detect skew in words with severe skew ($>10^{\circ}$), but the present approach can detect and correct the skew of severely distorted words as shown in Figure 4. The proposed technique works well for even those words, where headline end-points are beyond the upper-half of word image. Sometimes the wrong parallel lines gets identified in place of intended lines (see Figure 5) resulting in incorrect skew correction.

FIGURE 4. skew correction of single character and severely skewed words

The percentage accuracy results of skew detection are 78.6% as shown in Table 1 as calculated by visual observation.The accuracy of the proposed approach is better as compared to existing method [6].

FIGURE 5. Results of wrongly skewed words

TABLE 1. Table showing %age accuracy of various methods

Technique	**Total Words**	**Skewed Words**	**Corrected**	**%age Accuracy**
Singh [7]	100	70	44	62.8
Murthy [6]	117	90	65	72.2
Proposed	100	70	55	78.6

4. CONCLUSION

In this paper, an improved and modified method as compared to [6] has been proposed for skew detection of Gurmukhi scene word images. The method give good results on self-captured dataset images without requiring any enhancement operation. The methods gives better accuracy of 78.6% and also works on single character and severely skewed images.

In future, the method may be further modified by identifying its limitations and suiting to all practical situations. The method may also be extended to other *Sirorekha* based Indian scripts.

ACKNOWLEDGMENT

The first author of paper would like to acknowledge financial assistance from the Punjabi University, Patiala in the form of study leave.

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