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CONTENTS

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STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESES

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

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- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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SKEW DETECTION AND CORRECTION OF INDIAN SCRIPT DOCUMENTS

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ABSTRACT

An optical character recognition (OCR) is the process of converting scanned images of machine printed documents into computer readable codes. Recognition of characters of Devnagari and Gurumukhi scripts have been an area of research for many peoples and large number of research papers and reports have been published in this area. The generalized way for developing OCR system of any script involves preprocessing, segmentation, feature extraction & classification and Post processing. To develop OCR for any language, the input document to be scanned may have some skew ness and needs to be tackled properly. This paper discuss in detail about skew angle detection and correction which is the main operation performed during Preprocessing phase of an OCR system. A fast and robust method for detecting and correcting skew angle is described which is based on head line which is inherent properties of Indian languages like Hindi and Punjabi. For estimation of skew angle, the proper headline of the digitized image is detected and its skew angle is estimated with horizontal direction. The proposed skew detection and correction method has accuracy about 89%.

KEYWORDS

Devnagari script, Preprocessing, Segmentation, Feature extraction, Classification, Post processing, skeletonizing, skew ness, Horizontal projection, Vertical projection.

INTRODUCTION

OCR is the acronym for Optical Character Recognition. A human eye can read the characters of any language written correctly by person or when it is printed. Making the computer do the same is called the problem of character recognition. OCR (optical character recognition) is the process of converting scanned images of machine printed or handwritten text or hand printed text into computer readable codes. Character recognition systems can contribute tremendously to the advancement of the automation process and can improve the interaction between man and machine in many applications including post offices, defense organizations, office automation, cheque verification and a large variety of banking, business, data entry applications and commercial data processing applications [1]. The main goal of OCR is to imitate the human ability to read in a very fast rate.

The process of recognizing characters of any script is usually performed through several phases which are as follows:

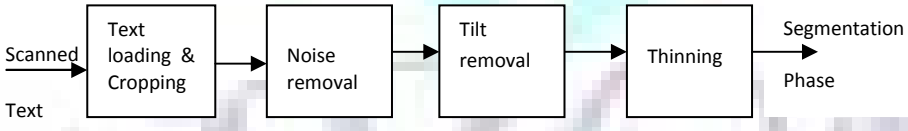
1. Pre-processing
2. Segmentation
3. Feature Extraction
4. Classification
5. Post processing

PREPROCESSING OF MACHINE PRINTED SCRIPT

In a typical OCR system, input document is read and digitized by an optical scanner. The Preprocessing phase of OCR takes digitized image as input, reduce noise and distortion, remove skew ness perform skeletonizing or thinning of the image and hence simplify the processing of remaining stages. The main advantage of preprocessing a text is to organize the information so as to make the task of character recognition simpler. Skew detection and correction of Indian script documents is a crucial part of preprocessing phase of OCR as it affects the subsequent understanding of the document.

The preprocessing starts with data acquisition in which documents to be processed are first scanned and digitized, and ends up with output to segmentation phase of character recognition system as shown in fig. 1. In this Figure, the various processes involved in preprocessing stage of OCR are shown. First the digitized text is loaded and cropped. Then the noise if any in the digitized text is removed. After this, skewness of the digitized text is corrected and then thinning is performed.

FIG. 1: FLOW DIAGRAM OF PRE-PROCESSING PHASE OF OCR



SKEW DETECTION AND CORRECTION

Skew ness in the digitized image is unavoidable because of casual use of scanner by human operator. Whenever a document is fed in to a scanner because of hand placement or automatic document feeder mechanisms, a few degree of skew (tilt) is always there. The skew angle is the angle that the text lines of the digitized image make with the horizontal direction. Hand placement or automatic document feeder mechanisms normally create $1 - 3^{\circ}$ of skew, due to the document's incorrect placement, or to a slight variation in roller speed. In some cases, the skew can reach as much as 10°. When the skew angle is $2 - 3^{\circ}$, the accuracy of document analysis and OCR is reduced; when it is more than 5, however, the result becomes unreliable. As a result, the skew estimation of document images to be carried out before segmentation and Feature extraction and classification phase of OCR [2, 3, 4].

Skew detection and correction are important for a successful OCR. Skew detection and correction can be achieved in two steps

(a) Estimation of skew angle
(b) Rotation of the image by skew angle in opposite direction.

Image of Gurumukhi document with some skew ness is shown in figure 2 and figure 3 shows the same document after correcting skew ness from it.

FIG. 2-SKEW NESS IN THE DOCUMENT

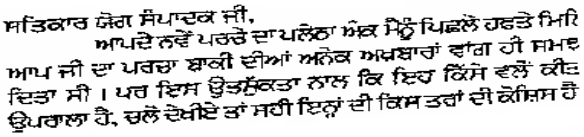
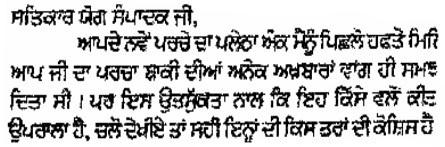


FIG. 3-SCRIPT WITHOUT SKEW NESS



REVIEW OF LITERATURE

In the past years many techniques have been applied to skew detection. One of the techniques is based on the projection profile of documents [5, 6]. For a document with horizontal text lines, the horizontal projection profile will have peaks at text line positions and troughs at positions in between successive text lines. To determine the skew of a document, the projection profile is computed at a number of angles and for each angle, a measure of difference of peak and trough height is made. The maximum difference corresponds to the best alignment with the text line direction which in turn, determines the skew angle. A nearest neighbor clustering based approach to estimate skew angle of the document is described by hashizume, yeh, Rasenfield [7]. In their methodology, all the connected components in the document were extracted and for each component, the direction angle of its nearest neighbor is estimated. A histogram of the direction angle is computed and the peak of which indicates the document skew angle. A heuristic approach has been applied by Lehal and Singh to detect and correct skew ness in Gurumukhi script [8].

PROPOSED METHOD FOR SKEW DETECTION AND CORRECTION

To detect and correct skew angle, a fast and robust method is based on head line which is inherent properties of Indian languages like Hindi and Punjabi. For estimation of skew angle, the proper headline of the digitized image is detected and its skew angle is estimated with horizontal direction. The detection of head line is necessary for script zone and character and word segmentation which will be used in later stages of OCR. So headline based skew detection and correction helps in saving computation during zone detection and character and word segmentation, which is main benefit of this approach. Head line is very useful for character segmentation from words and to divide a text line in different zones for the OCR of script like Devnagari and Bangla [9].

This method of detecting and correcting skew angle follows the following steps.

a) Check whether digitized document has skew ness or not
b) If yes then skew angle is detected with horizontal direction
c) Correct skewness

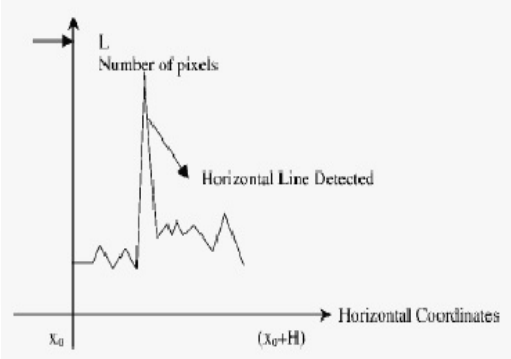
a) ***DETECTING DOCUMENT WITHOUT SKEW***

Scan the whole image horizontally and count the number of pixels in each row. Prepare a table with two columns of row number and number of pixels. We find out from the table whether some consecutive lines fulfill the constraint mentioned below. Based on this, we define a feature which once extracted will prove that the character image has a tilt or not. That feature has been named as 'line' which means that a feature 'line' has been detected when scanned row gives the number of information pixels that are at least 90% of the total number of pixels possible horizontally in an image frame as shown in figure 4.

H_{LINE} >= 0.9 * L (number of pixels)

where H_{LINE} is the number of pixels in a row while scanning horizontally.

FIG. 4: HORIZONTAL PROJECTION

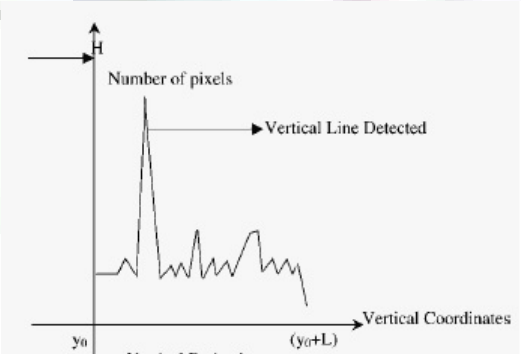


The X-axis in the graph shows the row number and the Y-axis shows the number of pixels. The graph showing the peak meeting of the constraint mentioned above will be termed as 'line detection' and once detected has to be confirmed through vertical scanning. Even if the line has been detected after horizontal scanning, it still has to be confirmed through vertical scan and no further processing is needed if the same result is obtained. Vertical projection and finding the line feature will also require the same effort as in the horizontal process. The same has been demonstrated in Figure 5.

V_{LINE} >= 0.9 * H (number of pixels)

where V_{LINE} is the number of pixels in a row while scanning vertically.

FIG. 5: VERTICAL PROJECTION



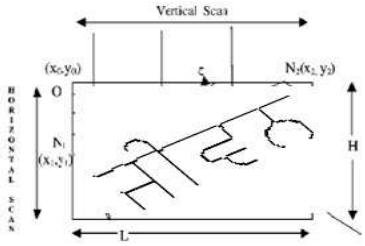
Once the 'line' has been detected, there is no further need to process the image to find the tilt. This means that the image is either exactly horizontally straight, i.e. at 0^o, 180^o or it is exactly vertical at 90^o or 270^o. The distinction between the 0^o and 180^o images will depend on the direction of the scan (top-left or top-right) and the detection of the line feature. Similar process is applied to have distinction between 90^o and 270^o. If the 'line' is not confirmed during the vertical scan then that means the image is tilted and we need to find the tilt angle and remove it.

b) SKEW ANGLE DETECTION

Characters in Hindi or Punjabi languages are formed in a structured manner. Whereas most of the language scripts are written with reference to the central axis, the Gurumukhi script is written w.r.t. the central axis along with an axis parallel to the central axis. This is the inherent property of writing Gurumukhi script. Once the angle of the axis w.r.t. the reference axis has been detected, thereafter the word can be rotated perfectly horizontally. This dominating feature of Indian script has been used for detecting the tilt angle. This can be better explained with an example (Fig. 6). Scannable area is nothing but the cover of the word

when it is viewed from four directions. But the informative scan area is the projected view ON1 from left side of the character image and ON2 is the projected view from topside of the image. If the word image is enclosed in a rectangular frame then, we easily get the length and the height of the image, which has been represented by L and H, respectively. Tilt angle has been represented by ζ. Figure 6 shows the skewed document being used to demonstrate the skew detection process.

FIG. 6: WORD SAMPLE



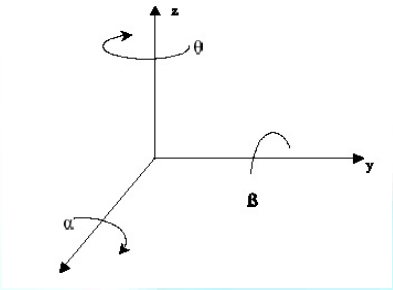
***c)* SKEW REMOVAL PROCESS AFTER SKEW DETECTION**

Once skew angle has been detected and finalized then a simple transformation technique works perfectly fine to straighten the tilted word of Devnagari or Gurumukhi script.

The transformation technique [4] mentioned below is applicable for rotating a point about the coordinate axes. To rotate a point about another arbitrary point in space requires three transformations. The first translates the arbitrary point to the origin, the second performs the rotation and the third translates the point back to its original position.

Referring to fig. 7, the rotation of a point about the *z* coordinate axis by an angle θ is achieved by using the transformation.

FIG. 7: TILT ANGLES



$$R_\theta = \begin{bmatrix} \cos\theta & \sin\theta & 0 & 0 \\ -\sin\theta & \cos\theta & 0 & 0 \\ 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$R\alpha = \begin{bmatrix} 0 & \cos\alpha & \sin\alpha & 0 \\ 0 & -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

where α= ζ

$$R\beta = \begin{bmatrix} \cos\beta & 0 & -\sin\beta & 0 \\ 0 & 1 & 0 & 0 \\ \sin\beta & 0 & \cos\beta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

where β = ζ

CONCLUSION AND LIMITATION

A fast and robust method for detecting and correcting skew ness is described in this paper which is the main operation performed during preprocessing phase of character recognition. The method is based on head line which is inherent properties of Indian languages like Hindi and Punjabi. So headline based skew detection and correction helps in saving computation during zone detection and character and word segmentation, which is main benefit of this method. The proposed skew detection and correction method has accuracy about 89%. The limitation of this skew detection and correction method is that it will not work

well if the skew angle is very large. However, it has been observed that such skew angles are relatively uncommon. Another limitation is that this method of skew detection and correction does not provide desired results if the document is multi-skewed.

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