



Skew Detection and Correction of Handwritten Document Images using Multiple Projection Profiles and Skew Angles

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Abstract: Numerous experimentations are performed in the area of optical character recognition. The overall process of optical character recognition can be assured successful only when there is skew free document input considered at the time of pre-processing. The automatic skew detection and correction of document images is one of the important operation to be focused in this regard, since it increases the chances of obtaining overall accuracy of entire optical character recognition system. In this paper we have devised a skew detection and correction methodology using multiple projection profiles and skew angles. The document is subjected to computation of vertical profiles and difference in black pixel density is used as parameter to identify the tie points of a particular text block and skew angle. The identified text block is then rotated in opposite direction to get a skew eliminated image. The algorithm has given an accuracy of over 90% in many documents experimented..

Keywords: Skew detection; skew correction; projection profiles; skew angle; Text documents;

I. Introduction

Image processing is a process of obtaining an image from a particular source which is subjected to processing in order to retrieve the features of the image. In order to get an enhanced image, the image is first converted to digital form and then subjected to processing using a particular algorithm. It is a type of signal exception where the input is an image and output is characteristics of that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods. It is one of the rapidly growing technology today, with its applications being used in various aspects with respect to business..

Image processing follows three different steps

1. Importing an Image from the optical scanner or by digital photography.
2. Analysing and manipulating the image which includes data compression, image enhancement and spotting patterns which are not visible to human eyes.
3. Output is a stage in which result obtained is the enhanced characteristics of the image.

The two types of methods used for Image Processing are Analog and Digital Image Processing. Analog techniques of image processing are mainly used for the hard copies like printouts. Image analysts use various methodologies of interpretation while using these visual techniques. The image processing does not only concentrates on the area that has to be studied but on knowledge of image analyst. Association is another important tool in image processing through visual techniques, so analysts apply a combination of personal knowledge and collateral data to image processing Digital Processing techniques help in manipulation of the digital images with the help of computers. As raw data from imaging sensors from satellite platform contains inadequacy. To overcome such flaws and to get original information, it has to undergo various phases of processing..

OCR (Optical Character Recognition) refers to a branch of image processing which involves reading text from the paper and translating images into a form that computer can manipulate. An OCR enables you to take a written document or a magazine article and feed it directly to the electronic computer file and then edit the file using word processor. Generally an OCR system involves a scanner to read the images and it also consists of other comprehensive software's to analyze the documents taken from the scanner. Advanced OCR systems are capable of reading variety of fonts but still it has difficulty with the handwritten scripts/hand written texts. The potential of OCR systems are enormous as they harness the power of computers to access the printed documents. Now a day's OCR systems are being used widely where searches which needed hours and days can now be accomplished in few seconds. There are several steps in the process of automation of documents. Skew detection and correction as one of the important step in pre-processing which defines the overall accuracy of system.

Skew Detection is process of identifying the angle between the straight horizontal axis to the textual direction present in the document. There are several methods for detecting skew in a page, some depends on detecting connected components and finding the average angles connecting their centroid. The method we employed was to project the page at several angles to determine the variance in the number of black pixels per projected line. The projection parallel to the true alignment of the lines will likely to have the maximum variance because when

parallel each given ray projected through the image will hit either almost no black pixels or many black pixels. Oblique projections will commonly pass through the lines of text and spaces that exist between the lines, the variance in the number of pixels hit by the individual rays will thus be smaller than in the parallel case. Skew Correction is process of correcting the skew in identified text block by the angular difference between the horizontal axis to the angular orientation of text block. After the skew angle of the page is determined, our recognition algorithm demands that the page must be rotated to correct this skew. Our rotation algorithm has to fast and accurate. We looked into two strategies for correcting slight skews existing in scanned images. This was a pure coordinate transformation, which takes extra time for large images, but gets the rotated exactly. The next was somewhat less accurate, but faster and works pretty well with slight skews that are common in scanned images. The second method uses two shears to achieve its result.

Hough transforms being one of the very popular methods for skew detection and correction in documents. Hough Transform is a feature extraction technique used in image analysis the purpose of the technique is to find the imperfect instances of object within a certain class of shapes by voting procedures. The voting procedure is carried out in a parameter space from which the object candidates is obtained as local maxima in a so called accumulator space that is explicitly constructed by the algorithm for computing the Hough Transform. The classical Hough Transform is mainly concerned with the identification of lines in the image but later the Hough transform has been extended to identifying positions of arbitrary shapes most commonly circles or ellipses. Advantages in the Hough Transform is-

1. The Hough Transform is tolerant of gaps in the edges.
2. It is relatively unaffected by noise.
3. It is also unaffected by occlusion in the image.

A Hough Transform for Straight Line Detection-

A straight line can be represented as $y = mx + c$, This representation fails in case of vertical lines.

Hough Transform technique is also an approach used for fitting lines and curves. This approach is preferred when the objective is to find lines or curves formed by groups of individual points on an image plane. The method involves a transformation from an image plane to a parameter space. Consider the case in which lines are the objects of interest. The line is expressed as $\rho = X \cos\theta + Y \sin\theta$.

There are two line parameters namely, the distance (ρ) and the angle (θ) which defines transformation space. Each coordinate (x, y) of ON pixel in the image plane is mapped onto the locations in the transformed plane for all possible straight lines. For all possible values of ρ and θ the transformations intersect at the same point on the transformed plane when multiple points are collinear. Therefore, the point (ρ, θ) , which has the greatest accumulation of mapped points, indicates lines with these parameters. In practice because of discretization error and noise, points mapped will not be collinear. Thus the points do not map on to exactly the same location on the transformed plane. For connected lines or positions of lines, computations can be reduced greatly by considering not all (ρ, θ) points but only those (ρ, θ) points that are in one orientation as indicated by the angle. The HT has a limitation that it does not give the coordinates of end points of the line, and further the long lines are favoured over short lines. For these reasons, spatial domain method is considered to be often faster and more effective for skew detection and estimation. Skew detection plays an indispensable role which affects the performance of the OCR system. To improve or to achieve cent percent accuracy it is important to perform skew correction in an efficient manner from an imbedded hand written script. With this motivation, the objectives of the proposed system are defined as follows:

1. To create a user friendly GUI interface that can load input images and converts it into skew free document images.
2. To develop efficient pre-processing techniques that can eliminate irrelevant contents from the image.
3. To analyze and detect the skew within the document as well as skew of overall document.

II. Literature Survey

OCR being one of the challenging areas of research, wide experimentations are performed towards the skew detection and correction systems. Some of the details are as outlined as follows.

K.R. Arvind *et. al.*, [1] has contributed an approach of skew correction by segmenting document into its constituent blocks. This is carried out similar to the block segmentation method. Then, the blocks are skew corrected based on their horizontal projection profiles and entropy. H.K. Chethan *et. al* [2] had proposed a method called Hough Transform to find out the skew and they proposed this algorithm. This method is applied on Graphics Separation and Skew Correction for Mobile Captured Documents. P Shivakumara *et. al.* [3] has proposed a projection profile method i.e., a series of projection profiles are obtained at a number of angles close to the expected orientation and the variation is calculated for each of the profiles. The profile which gives maximum variation corresponds to the projection with the best alignment to the text lines and that projection angle is the actual skew angle of the document. Ruby Singh *et. al* [4] had used an algorithm called Fast Fourier transform. The overall goal of this paper is to propose an algorithm which reduces the amount of time required to detect and correct the digital images. This also deals with the process to collect, analyze, and evaluate the digital

images to prove the effectiveness and efficiency of the proposed strategy. Mandip Kaur *et. al* [5] and experimented using similar documents that have been taken as input and compared the results obtained with the existing technique. In these both the tables the time taken, accuracy and detection angle calculated by proposed and existing techniques have been presented. The four quadrants of the Fourier spectrum of an image and output image rotated by -25.38degree using experimental technique. Zhixin Shi *et. al* [6] had tested a method using a set of USPS parcel images. We manually selected 813 of 1864 binary images with clear skews. These images are cropped and binarized from the original parcel address images automatically. The original scan resolution was 300dpi. For detecting skew angle, we don't need such high resolution. Mamatha Hosalli *et. al* [7] had proposed a methodology for skew detection, correction and segmentation of handwritten Kannada document into lines and words. Bounding box technique is used for the skew detection and correction. R. J. Ramteke *et. al* [8] had devised a simple, efficient and fast document image skew detection and alteration technique is presented. Centroid of image is calculated by determining four farthest points of image and skew angle is finding through base line. Further, the moments are evaluated up to second order to achieve the skewed angle. Ijonathan J *et al* [9] had experimented using the calculated projection profiles at different angles directly from image data, methods that calculated projection profiles from image features. This is applied for Hough Transform Analysis. Tal Steinhertz Nathan *et. al* [10] had proposed a method using Principal Components on each image twice: in its natural mode and when the negative was used instead. Our method and all the surrounding processing was implemented in MATLAB and tested on a Unix machine. We focus on the improvements in speed and the more accurate results achieved by using the negative image. Most of the experimentations in the literature had applied the Hough transform to perform the skew detection and correction. The present experimentation focuses on using projection profiles and block wise analysis to improve the performance of the OCR system.

III. Proposed Methodology

The proposed performs the skew detection and correction in several steps. Initially the input document image is imbibed through a imaging system. The image that is acquired through imaging system is basically a gray scale or colored image. The image is converted to a suitable format for further processing. i.e., image is transformed to a binary image using Otsu's thresholding algorithm [2]. The binary image is subjected to noise filtering process using the Gaussian filters. The filtered image is a well enhanced image that is good at appearance when compared to the original input image. The filtered image further processed using multiple projection profile to identify the tie points through which the skew angle of the image can be determined. The skew angle is determined by clipping a rectangle initially on the area of image where tie points are identified. Finally the image clipped with rectangle is rotated by skew angle towards the horizontal axis of the image. The algorithm 1 depicts the various steps in detail to perform the skew detection and correction of the document images.

Algorithm for skew detection and correction:

Step 1: *Input the Image I*

Step 2: *Obtain the binarized Image BI*

Step 3: *Perform the noise filtering on the image BI*

FI <= BI

Step 4: *For the image FI traverse to the last row of the image FI*

Step 5: *Count the number of black pixels in the last row r*

If black pixel count=0 then

Move to row r-1 and again the count the black pixels

Repeat with r-2, r-3 R-n if black pixel count is zero.

If black pixel count is not equal to zero at a particular row then mark the row as last line ending point. As well as one of the first coordinate for rectangle.

Step 6: *In the marked row (where black pixel count is not zero) check for the starting black pixel to get the first coordinate position of rectangle for line level skew.*

Step6: *Move to the last column of the marked row and count the black pixels vertically from last column till the column where black pixel count is not zero and mark the column as ending point of the line marked.*

Step 7: *from the marked column beginning check for starting black pixel and mark the pixel coordinate position as top right coordinate position of rectangle.*

Step 8: *Calculate distance between top right coordinate position of rectangle to marked row in the same column.*

Step 9: *calculate skew angle by forming a right angle triangle between three coordinate position of rectangle marked,*

Step 10: *clip a rectangle by identifying rectangle position of line/lines covered*

Rotate the rectangle by the skew angle detected. All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

A. Sample Input images:

Some of the samples considered as input to the proposed system is as presented in figure 1.

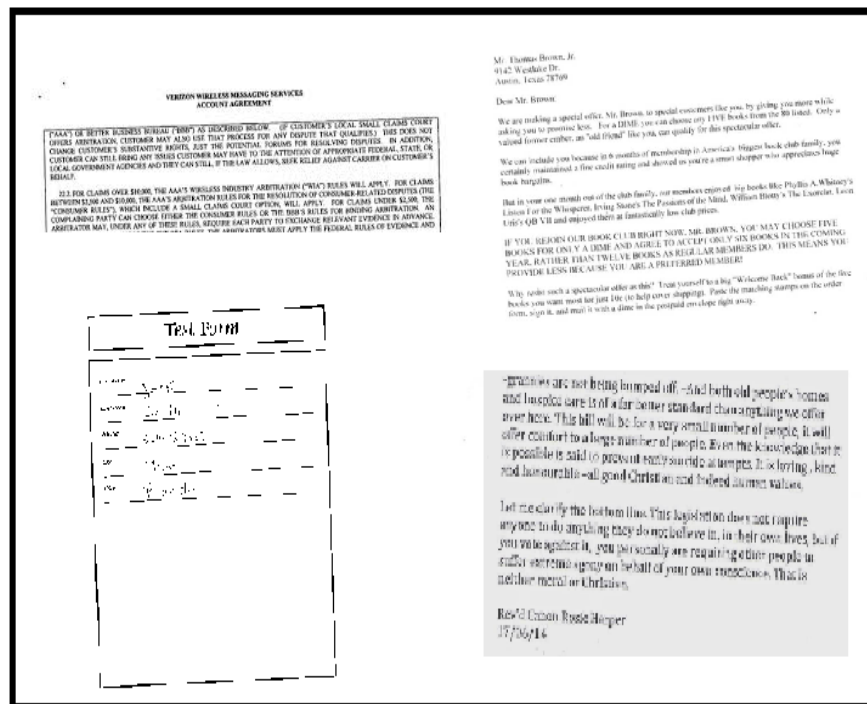


Figure 1: Sample datasets of the proposed system.

The proposed algorithm is implemented using MATLAB programming. The user interface is designed with various user friendly options to perform the skew detection and correction of document images. The figure 2 shows the user interface of the proposed system.

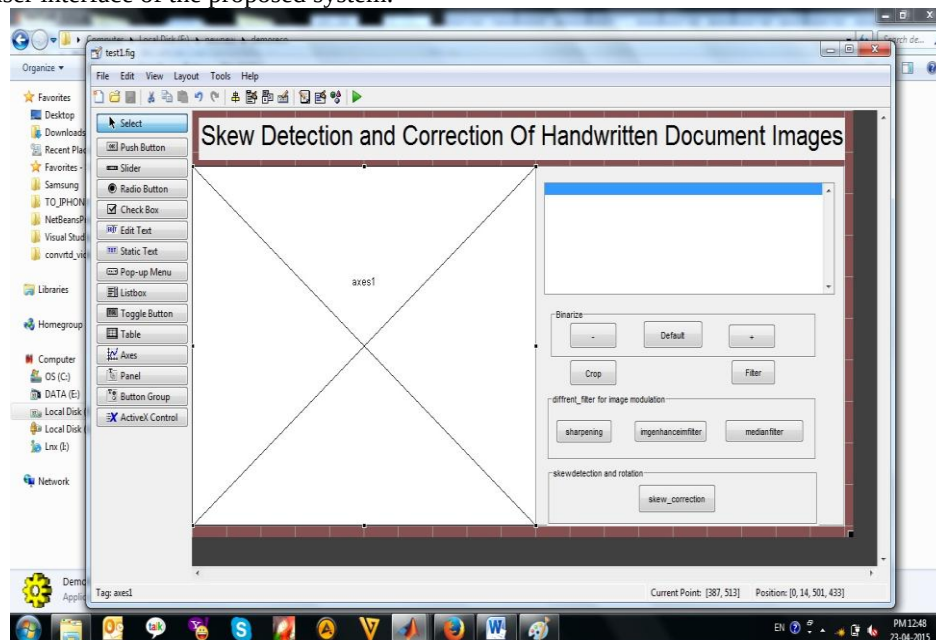


Figure 2: User Interface of Skew detection and correction.

The filtered binary image is traversed from the bottom of the image, i.e., from the last row of the image, every time counting the number of black pixel in each row till the black pixel count in particular row is not equal to zero. Once the row with black pixel count greater zero is obtained that is corresponded as the marked row where the one of the tie point in the image is present. Similarly the marked row from the top, left and right ends of the image are also traverse to determine the another marked row and two other marked columns. The two marked rows and two marked columns has the most probability for the presence of tie points which are again determined by identifying difference in number of rows and columns from one end of the marked to another end of marked column and vice-versa. The difference obtained is used for determination of the skew angle. The figure 3 and figure 4 represents the user interface snapshots after imbibing an input image and skew corrected images.

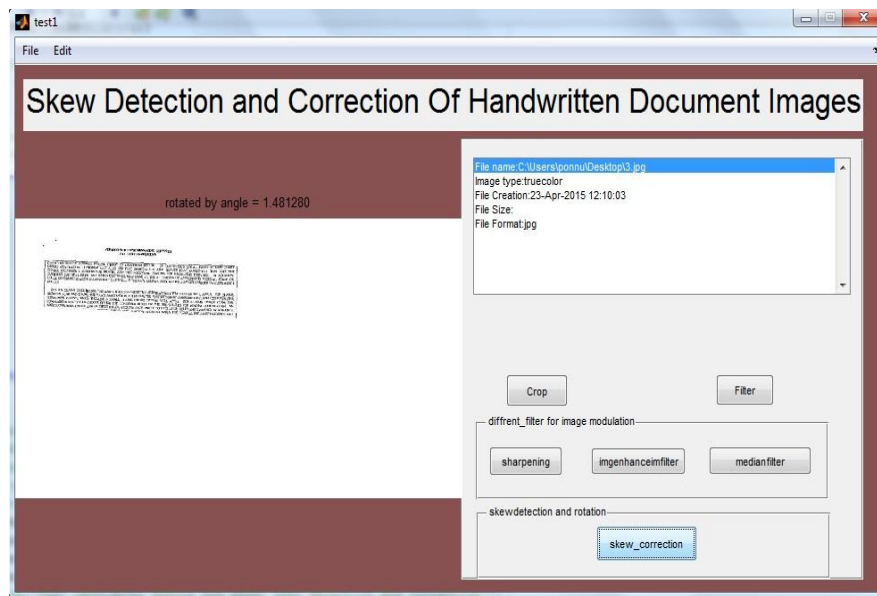


Figure 3: Input image read in user interface

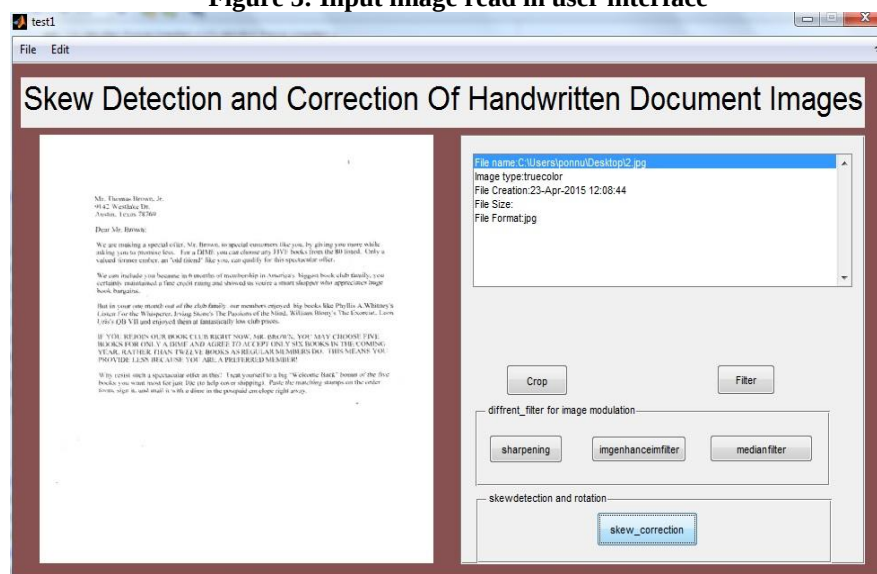


Figure 4: Results of skew correction

IV. Experimental Analysis

The proposed system is experimented with more than 25 images for testing. The algorithm has provided satisfactory results. The use of projection profile for determination of skew angle is really simple and efficient. The accuracy of the proposed system is defined as the difference in skew angle calculate to the original skew angle present in the document. The experimental results of proposed algorithm are presented in the above figures. The accuracy of algorithm is around 91%. The algorithm fails for detection of skew in text at line level.

V. Conclusion

Analysis of skew in documents is very important for the segmentation of document into text lines and its recognition. Thus skew detection and correction indeed is very prominent with respect to optical character recognition systems. The algorithm can be further extended in future for the skew correction of document images at line level.

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