An approach for Skew Detection using Hough Transform

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ABSTRACT
Detecting skew of any document image and correcting that are important issues in the preprocessing stage of OCR system. The Hough Transform is a technique that performs skew detection in the document images. In the present work, voting is done on the basis of angle from 0 to less than 90°. Moving from one angle say Θ1 to Θ2 , five partitioned are considered i.e. there would be 450 classes. Voting is the process to find the belongingness of a pixel to a particular class. Finally, each pixel present in skewed image is found to which class it belongs. The class which has maximum count of the pixels is taken as skewed angle class.Performance of our algorithm is analysed. It gives increasing results.

Keywords
Skew detection, Hough Transform, OCR

1. INTRODUCTION
Optical character recognition (OCR) system is very useful in many offices. It automatically reads a printed or handwritten documents and converts into editable text format. Government records, automatic reading of postal addresses, forms, postal mails, credit card imprints etc. are other application of OCR. OCR converts the images of scanned documents into the editable text format. Editable text format means characters are in ASCII or UNICODE form whereas images are in the bitmap form. Convert images into text and reduced storage space which is very useful for storing more data and transmission of documents is the primary goal of OCR system. These conversion processes are challenging task and involve various steps. The performance of OCR system depends on the speed and accuracy of all these steps. Scanning, pre-processing, segmentation and post-processing are the steps of any OCR system. Skew detection and correction is done in the preprocessing part which affects the performance of OCR systems because segmentation cannot be done in proper manner without removing the skew of document (C. Singh, N. Bhatia and A. Kaur, 2008). In the document image processing first step is to find a digitized image of document using a proper scanning system. Then page layout analysis and thereafter character recognition is done. A testing is done to check that given image is skewed or not before the structure of text is obtained. Fig. 1. shows the steps of the skew detection and correction.

2. PREVIOUS WORK
Over the past three decades, many people have given different methods to solve the problem of skew in document images. Hough Transform is a popular approach which determines the straight lines

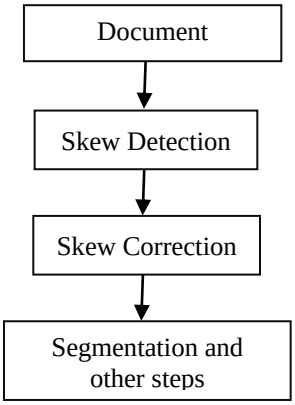


Fig 1: Steps of skew detection and correction

with the help of a set of points in images. A. Amin and S. Fischer (2000) uses Hough transform to determine the skew. Hough transform's complexity is directly proportional to no. of image points. So it performs some preprocessing to reduce the number of points to be used in the hough transform. This algorithm find the angle of skew in the entire document by identifying text blocks such as pictures, paragraph and calculate the skew angle of each block. Preprocessing, Connected component analysis Grouping, Skew Estimation, Skew Calculation, Skew Correction are the basic steps of this algorithm. N.V.A. Manjunath, G.H. Hemantha , and P. Shivakumara (2004) also work on the skew detection technique which is based on the Hough Transform. In this algorithm, thinning is used as preprocessing step. It has two stages and then Hough Transform. Selecting the characters from document image are first stage and perform thinning on that characters are second stage. H. S. Baird (1992) has worked on connected component analysis and develops a projection profile which uses single point for representing each connected component. S.C. Hinds, J.L. Fisher and D.P. D'Amato (1990) apply horizontal and vertical run length computations to reduce the data. S. N. Srihari and V. Govindaraju (1989) use the Hough Transform method on all black pixels. D. S. Le, G. R. Thoma and H. Wechsler (1994) uses this transform only for the bottom pixels of connected components. Skew angle is the angle at which cost function is maximized. Y. Ishitani (1993) maximize the deviation from mean of pixel counting in projection profiles to detect the angle of skew. A. Hashizume, P-S Yeh and A. Rosenfeld (1986) propose an algorithm that computes the nearest neighbor of every character and then creates a histogram of those values to find the skew angle.

3. BASICS OF HOUGH TRANSFORM
Hough transform is a feature extraction method used in image analysis, digital image processing and computer vision.

Hough transform is designed to detect the lines, using parametric representation of a line. Hough parametric space is described in (a, b) form in the Cartesian coordinate system (C. Singh, N. Bhatia and A. Kaur, 2008). Where, a and b are intercepts of line passing through point(x1, y1). It is 2-D space. Transform is

$$b=-ax_1+ y_1 \quad (1)$$

Hough transform in the Cartesian system is shown in Fig. 2. Since dynamic range of parameters a and b is [−∞, ∞], but range of a is splitted in two parts: -1≤a≤1 and -∞≤a< -1 and 1<a≤ -∞, which is given by following equations:

$$b = \begin{cases} -ax1 + y1, & -1 \le a \le 1 \\ -ay1 + x1, & otherwise \end{cases} \quad (2)$$

The parametric space $b = f(a)$.

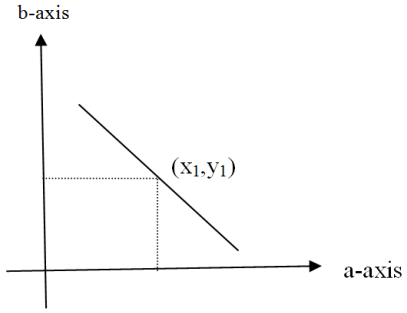


Fig 2: The Hough transform in slope–intercept form for the line, $b=-ax_1+ y_1$

Paul Hough introduced Hough Transform in 1962. Basically Hough Transform is feature descriptor which is used to identify lines and finding any shape position in a image and is used in the field of image processing and computer vision. Basically Hough transform is a feature extraction method which is used to detect lines and to find arbitrary shapes in the given input image. Hough transform is invented by R. Duda and P. E. Hart (1972) which is used today and known as "generalized Hough transform". Equation of a line is

y = mx+c.

Fig. 3 shows the basic the idea of Hough transform. A Straight lines passes from any point (x, y), satisfies the equation where c is intercept value and m is slope and values of c and m may vary. Now instead of taking point(x, y), parameters (m, c) is taken to describe the line's characteristics. These all things are basics of Hough Transform. Value of m will be infinity in the case of vertical line. So we use the parameter (r, θ). Where r is the distance between origin and line, θ is angle of the vector from this point to origin.So new re-arranged equation becomes

$$r = x\cos\theta + y\sin\theta$$

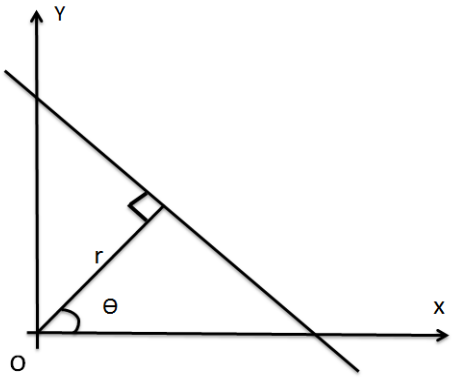


Fig 3: Line showing parameters r and θ

Lines that go through from any arbitrary point in the image plane coordinates, e.g. (x1, y1) are

$$r(\theta) = x1\cos\theta + y1\sin\theta$$

This makes a curve in the plane (r, θ), which is unique for the particular point. Now, generally a set of points which belongs to a straight line will produce curves which will be cross at the (r, θ). Result given by Hough transform is stored in a matrix which is known as accumulator. One dimension of matrix shows the values of θ(angles) and other dimension shows values of r (distances), and each element has a value telling how many pixels/points that lie on the line with parameters (r, θ). So the element with the highest value tells what line that is most represented in the input image. Main advantage of Hough Transform, which is that point need not all be continuous. If any line is broken because of noise then it will be helphul. Efficiency is also a factor which depends on the quality of input data. It also has an importance in the skew correction of documents and characters, finding shapes such as ellipse, circle, rectangle etc. in the image.

Hough transform is a famous skew detection method. It has capability for locating fragmented lines in a binary image. So, a group of black pixels is given, imaginary line or lines can be find which will be going through maximum number of these pixels. Given a binary image with a effective text area, the detected lines will most probably go forward the entire middle zone of textual lines. So these lines' skew shows the skew angle of whole page. In the case of Hough transform, there is always a tradeoff between the accuracy and speed. More computation is needed to find accurate angles of detected lines. Computation time totally depends on number of pixels present in the image. Skewed image is shown in Fig. 4.

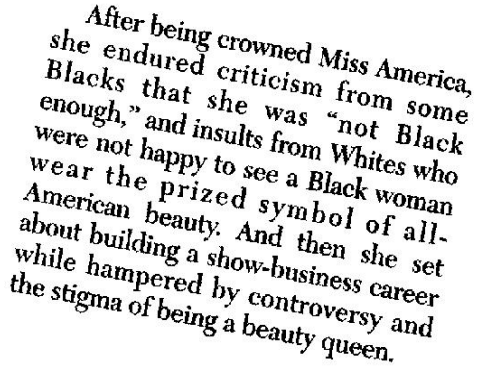

After being crowned Miss America, she endured criticism from some Blacks that she was "not Black enough," and insults from Whites who were not happy to see a Black woman wear the prized symbol of all-American beauty. And then she set about building a show-business career while hampered by controversy and the stigma of being a beauty queen.

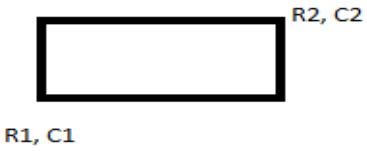
Fig 4: Skewed image

4. ALGORITHM AND RESULTS

An algorithm is implemented to find skewed angle and authors assume that skewed angle is less than 90° means an acute angle(AA). Implemented algorithm using Hough Transform is as follow:

Algorithm

1. Input: Take a binary image file



// Initial point of image is (R1, C1) and ending point is (R2,C2).

2. Distance variable is D where

$$0 \le D \le D_{max} = \sqrt{{R_2}^2 + {C_2}^2}$$

3. Make voting matrix T [D, Θ]
4. For D= 0 to D_{max}
   For Θ = 0 to AA
   T[D, Θ]=0
   Θ=Θ+0.2
   End for
   D = D+0.1
   End for
5. For each pixel of image, calculate Dfor different values of angle Θ and increment corresponding voting matrix accordingly.

```
For x=R1 to R2
    For y= C1 to C2
      If image(x,y)==0 then
        For Θ = 0 to AA
          D=y * Sin(Θ)+x * cos(Θ)
          T[D,Θ]=T[D,Θ]+1;
          Θ=Θ + 0.2
        End for
      End if
      Next y
    End for
    Next x
End for
```

6. Find the angle Θ of voting matrix T, which has the maximum voting value.

$Vote_{max}$ = 0

For D = 0 to D_{max}
  For Θ = 0 to AA
    If T[D,Θ] ≥ $Vote_{max}$
      $Vote_{max}$ = T[D,Θ]
      Θ_1=Θ
    End if
    Next Θ
  End for
  Next D
End for

7. Skewed angle = Θ_1

Table 1. Voting matrix(T) after voting

Angle Θ →

Distance D1 / D2	**0.0**	**0.2**	**0.4…**		**10.0**	**…**	**….**	**89.6**	**AA**
								7	
	69		19				101	86	
		24	23		**123**	92	80	48	
			54			87			
				14					
					49				

Now maximum value in the voting matrix is 123, which is corresponding to angle 10.0 degrees. So value of skewed angle given by Hough transform is 10.0 and then correct the skew of image which are shown in Fig 5.

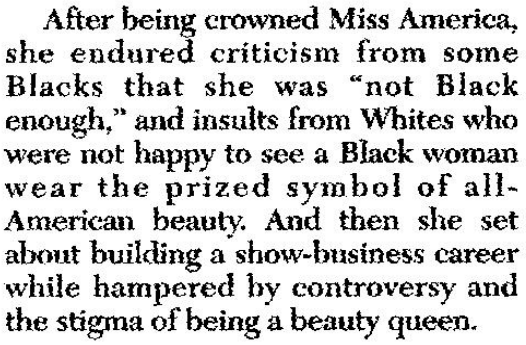

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Fig 5: Image after removing skew

5. CONCLUSION

The proposed algorithm is tested on number of documents. In most of the cases result were correct i.e. skewed documents were de-skewed. The range of angles considered in the present work is from 0 to less than 90°. Therefore it gives an ample scope for covering all the pixels in one quadrant and extended to all quadrant. So it provides a basis for the improvement of results. Spacewise also the present work is more efficient.

6. REFERENCES

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