An Integrated Skew Detection And Correction Using Fast Fourier Transform And DCT

Mandip Kaur, Simpel Jindal

Abstract: Skew detection and correction is very important task before pre-processing of an image and it is a major problem in scanned documents, if it not detected correctly it will lead wrong result in future during image analysis. During the scanning of the document, skew is being often introduced in the document image. To measure the processed time and speed taken by skew detection algorithm, the Fast Fourier Transform (FFT) technique is applied as it is fast approach for finding the angle of skewed document. This technique is used by firstly applying DCT compression and thresholding on image to reduce timing computation and after that Fourier spectrum is obtained. Further this spectrum is divided into four quadrants and detected skewed angle of each quadrant is measured. And finally Input image is rotated by using bilinear interpolation method.

Keywords: Skew correction, Skew detection, Skew angle, Fast Fourier Transform, DCT, Thresholding, Spectrum

1 INTRODUCTION

Skew angle estimation and correction of a scanned document is very important task for document analysis. During digitization of documents, it often happens that the document is not aligned correctly and it may lead to skewed image. Therefore, due to skew it can cause further performance degradation of segmentation and recognition stage of any text processing system [1]. Skew in scanned document can be of two types and shown in figure 1 [2].

1. Clock -wise skew (Positive skew)
2. Anti-clock wise skew (Negative skew)

(a)

(b)

Figure 1: (a) clock -wise skew (Positive skew) and (b) Anti-clock -wise skew (Negative skew).

Several techniques have been used to do the analysis of skewed images such as Projection Profile [4], Centre of Gravity [5], Fourier Transform [6], Hough Transform [7] and Geometric Text-line Modeling [9] but the Fourier Transformation is the fastest and easiest to implement in comparison to all other existing techniques. The working of Fast Fourier technique is explained bellow.

Fast Fourier Transform

When the image was converted from its Spatial Domain f(x, y) to its frequency domain f(u, v), then by using Fast Fourier Transform technique it is easy to process the image and its further calculations such as skew angle, speed, time etc. because the frequency at each point of the image can be easily calculated. This technique based upon removal of certain range of frequencies from a processed image. This technique mainly contains the following steps:

- Computes the Fourier Transform of an Image f(x,y).
- Computes a new transform f(u,v) by setting some values to zeros

The FFT of 2D image having spatial domain f(x, y) of size M x N is given by following Fourier equation [3].

$$f(u,v) = \frac{1}{MN}\sum_{x=0}^{M}\sum_{y=0}^{N} f(x,y)e^{-j2\pi(ux/M+vy/N)}$$

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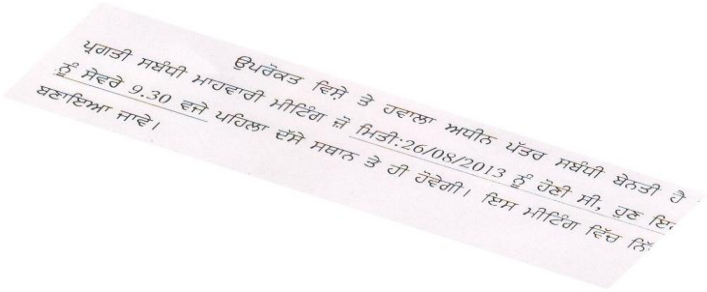
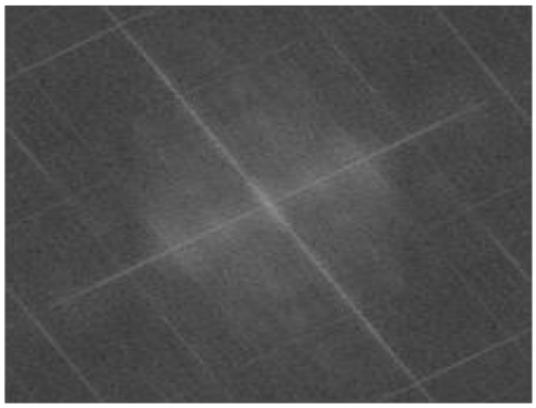
FFT as described by above formula calculates the frequency spectrum of the spatial coordinate function f(x, y). The Fourier function f (u, v) may have complex values but for better accuracy, only absolute values of the frequency spectrum have been taken. As the image is rotated, its frequency spectrum also rotates and shifts the energy of the image to the Centre of the image. Here is the example of the input (skewed) and output (De-skewed) images frequency spectrums shown in figures 2 and figure 3.

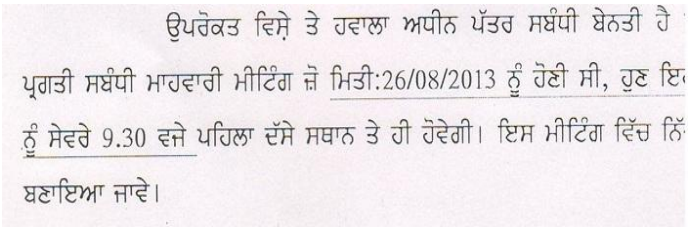


(a)

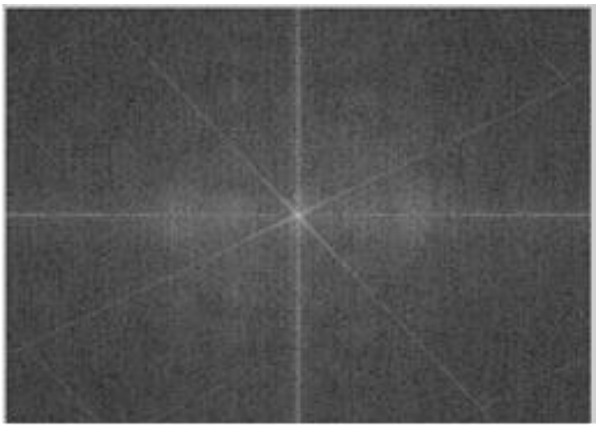


(b)

Figure 2: (a) Original input and (b) Fourier Spectrum of input skewed Image.



(a)



(b)

Figure 3: (a) Output-De-skewed Image and (b) Output Spectrum of the De-skew Image.

From the above frequency spectrum it concludes that when image rotates to some angle then its frequency spectrum also rotates, this is the basic mantra of finding the skew angle detection with frequency spectrum. In this paper, we used the Fast Fourier technique to calculate the skewed angle of various images by keeping the similar input parameters as used by Manjunath et al [7] for better performance comparison with Hough transform.

2. LITERATURE SURVEY

In 2012 Kumar et al. has introduced a new method which reduces the time complexity without compromising with the accuracy of Hough transform. The main advantage of Hough transform [1] is due to its better accuracy and simplicity. In 2002 Lowether et al. [6] has presented a new Averaged Block Directional Spectrum (ABDS) technique for determining the skew angle of digitized documents. It is based on calculating the average 2D Fourier Transform of blocks in a document image and using the Radon transform to find the peak in the directional spectrum. In 2007 Aradhya et al. [7] has proposed a novel skew detection method for binary document images. This method considered some selected characters of the text which may be subjected to thinning and after applying Hough transform skew angle of the documents are estimated. On the other hand, several experiments have been conducted on various types of documents such as English documents, Journals, Text-Books, different languages, documents with different fonts and resolutions etc. to reveal the robustness of the proposed method. The experimental results reveal that the proposed method is accurate in comparison to the results of well-known existing methods.

3 RESEARCH METHODOLOGY

Figure 4 shows the pictorial representation of various steps to be taken in proposed technique to implement for detecting skew of the images.

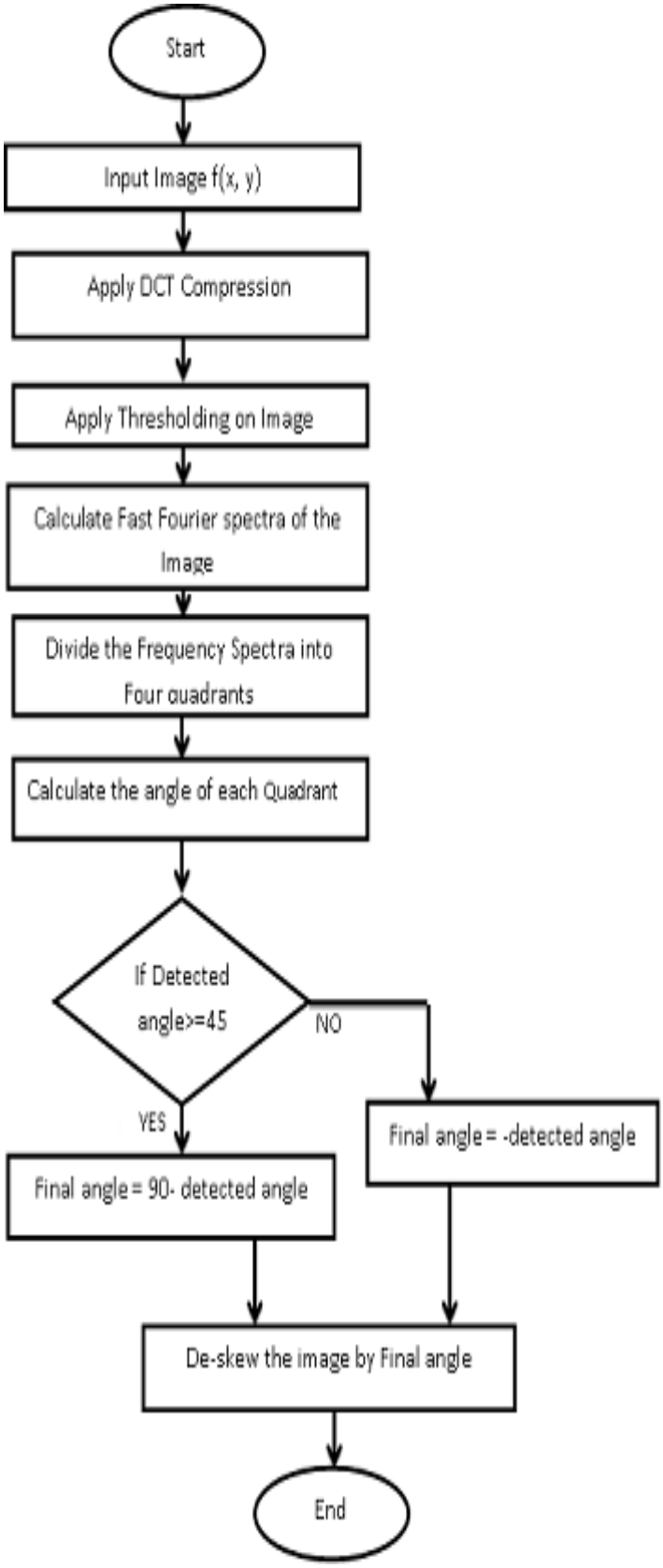


Figure 4: Data Flow Diagram of the proposed technique.

3.1 Proposed Algorithm

Step 1.Start.

Step 2.Input the Image and read the image using imread() function of the MatLab.

Step3.Perform the DCT lossy Compression on the image to reduce the timing calculations during processing of the image.

Step 4.Apply thresholding on the input image to get grey-scale image because grey-scale image having improved intensity values and then convert it into binary image.

Step 5.Convert the image into its Frequency Domain Spectrum and now frequency value Matrix of the image is stored in size [M N] matrix.

Step 6.Divide the Fourier spectrum into Four quadrant.

Step7. Calculate the angle of tilt of each quadrant corresponding highest transform intensity of each quadrant say angle degree (1), angle degree(2), angle degree(3), angle degree(4) and Sum up the four angles and find average angle to find the Detected angle.

Step 8. If Detected_ angle>=45
Then final angle=90- Detected_angle.
Else
final angle = -Detected_angle.

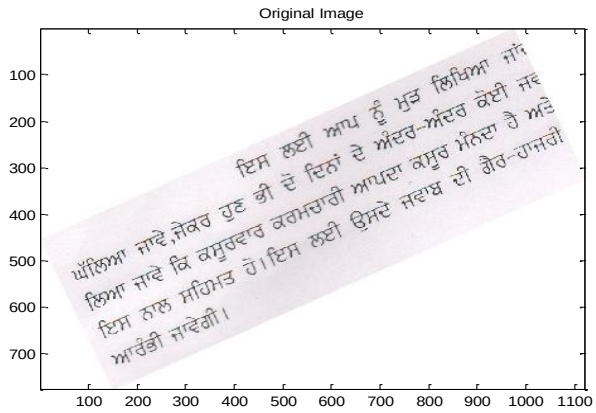
Step 9.Rotate the image through its centre by angle final angle using bilinear interpolation method.

Step 10. Display the De-Skew image.

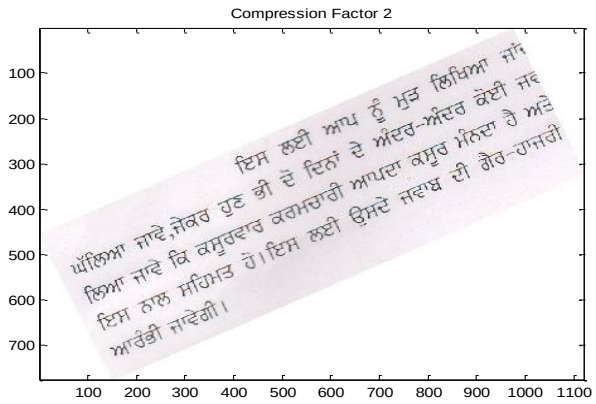
Step 11.End

4 EXPERIMENTAL RESULTS

Figure 5(a) and 5(b) shows the rotation angle of -25 degree and the compressed image.



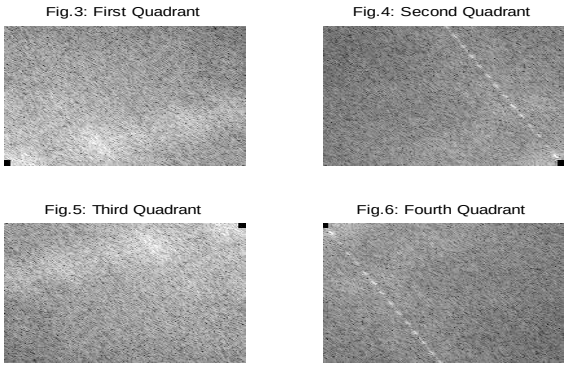
(a)



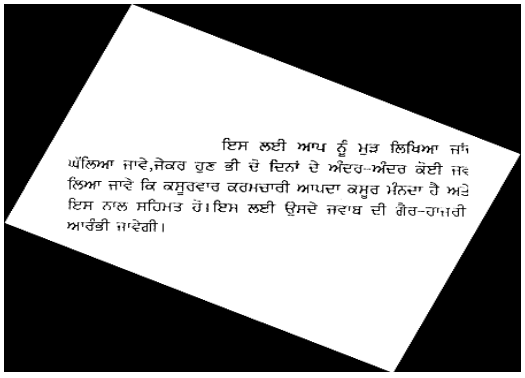
(b)

Figure 5: (a) rotated and (b) Compressed Skewed Images.

Figure 6(a) and 6(b) shows the four quadrants of the Fourier spectrum of an image and output image rotated by -25.38 degree using experimental technique.



(a)



(b)

Figure 6: (a) four quadrants of Fourier spectrum and (b) Ouput De-skewed Image.

Table 1 (a) and (b) shows the results obtained by proposed and existing techniques. In proposed method, some scanned documents have been selected and after that thresholding is applied on them to convert into binary level documents. The main goal of proposed method is to speed up the skew angle detection. For better comparison, the similar documents have been taken as input as taken by Aradhya et al. [7] 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.

Sr. No.	Actual Angle	Detected Angle	Error	Accuracy	Time Second
1	-30	-30.43	0.014	98.58%	0.202
2	-20	-20.11	0.005	99.45 %	0.296
3	-10	-10.43	0.04	95.88%	0.192
4	-5	-4.90	0.02	98%	0.203
5	-3	-3.01	0.003	99.66%	0.111
6	1	0.77	0.23	77%	0.154
7	3	2.32	0.23	77%	0.126
8	5	5.02	0.004	99.6%	0.110
9	10	10.95	0.095	91.32%	0.173
10	15	15.26	0.017	98.29%	0.156
11	18	17.32	0.038	96.22%	0.134
12	19	19.39	0.02	98.34%	0.224
13	20	20.30	0.015	98.52%	0.216
14	25	25.38	0.015	98.50%	0.257
15	27	27.72	0.027	97.40%	0.277
16	30	29.80	0.006	99.33%	0.205
17	33	32.53	0.014	98.57%	0.347
18	40	40.16	0.04	99.60%	0.187
19	42	41.05	0.023	97.73%	0.257
20	45	44.34	0.015	98.53%	0.239

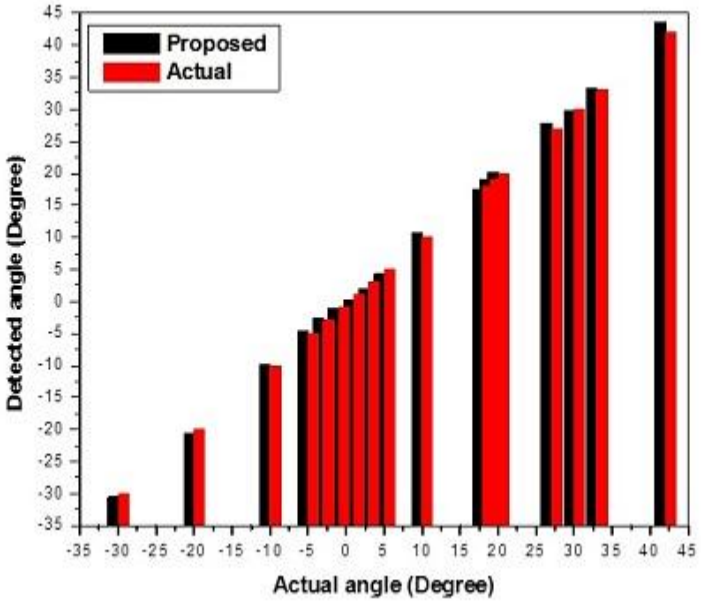
(a)

Sr. No.	Actual Angle	Detected Angle	Error	Accuracy	Time Elapsed(in Seconds)
1	3	2.89	0.037	96.33%	1.78
2	5	5.08	0.016	98.42%	1.68
3	10	9.86	00.014	98.60%	1.77
4	15	15.12	0.008	99.21%	1.70
5	20	20.11	0.005	99.45%	1.80
6	30	30	0.00	100%	1.71
7	40	39.89	0.002	99.72%	1.72
8	45	44.98	0.00004	99.75%	1.74

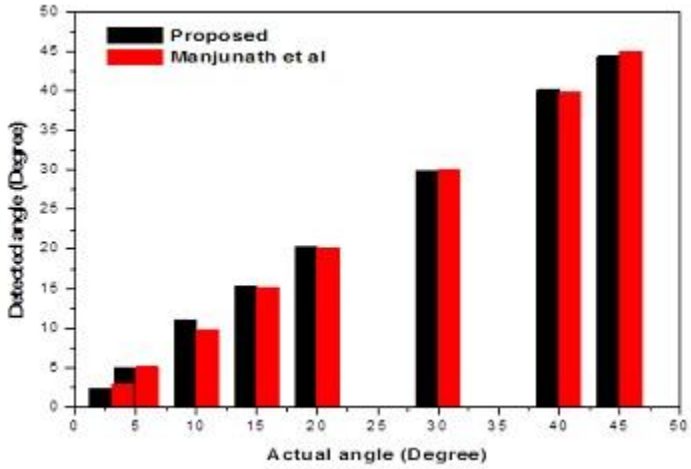
(b)

Table 1: (a) Evaluation of proposed and (b) existing technique.

From the above tables it has been obtained that the proposed method has almost similar accuracy in comparison to the results of existing method but with less time consuming. Figure 7 shows the comparison between the actual and detected angle of the scanned document by using proposed technique (a) and comparison of existing and proposed (b) techniques.



(a)



(b)

Figure 7: (a) Detected angle of the proposed technique and (b) Detected angle of the proposed technique.

Accuracy comparison

Accuracy rate must be improved to achieve good results. It increases with decrease in error rate and increase reliability of algorithm.

Figure 8 shows the comparison of accuracy rate of existing technique [7] and proposed technique

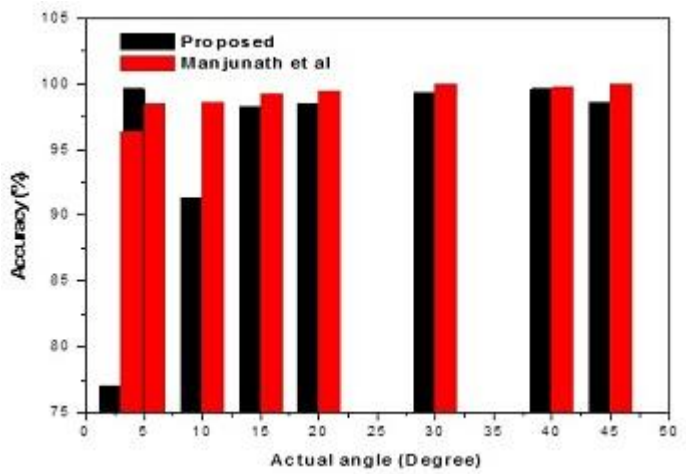


Figure 8: comparison of accuracy.

The accuracy results obtained are nearly similar to the results of existing technique.

Time comparison

Time is defined as the time taken by the algorithm to run and it is directly proportional to number of input elements. Also the speed is inversely proportional to the time. The comparison of time taken for detection of the skew angle of scanned document by existing technique [7] and proposed technique has been compared in figure 9.

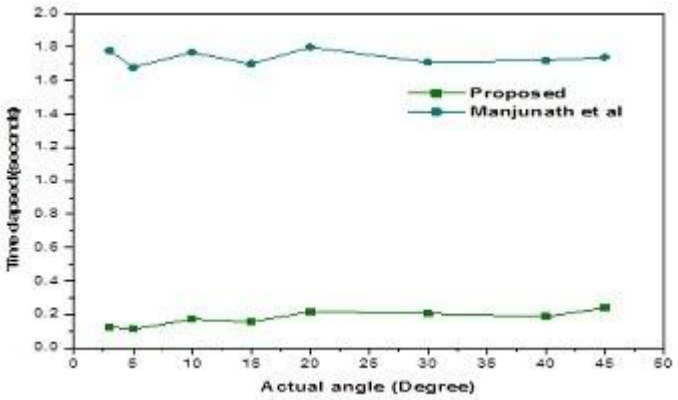


Figure 9: comparison of Time.

6 CONCLUSION AND FUTURE WORK

6.1 Conclusion

In this paper, a new technique is proposed for determining the skew angle of digitized documents. The results obtained are highly accurate and less time consuming with better speed as compare to the other existing methods. The accuracy achieved a skew angle determination within the range of ±45 degree of true skew angle. The advantage of the technique over most other techniques is the ease of detecting skew over ±45 degree skewed angle. This technique calculates the processed time of skewed angle of different handwritten English documents, Journals, Text-Books, different languages,

documents with different fonts and printed documents. Accuracy is also near to 95% and time for calculating the skewed angle is less than one second (average) for all scanned images.

6.2 Future Work

Performance evaluation has shown that proposed algorithm is quite good result for determining the angle of an image but there is one limitation it does not work with small resolution images and error is considerable in the case of small degree skewed images. In this technique we have taken pre-processed images, In near future work will to detect low resolution noised skewed images angle correctly and to reduce the elapsed time to detect the angle of skewed image.

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