A HYBRID APPROACH TO DETECT AND CORRECT A SKEW IN SCANNED DOCUMENT IMAGES USING FAST FOURIER TRANSFORM AND NEAREST NEIGHBOR ALGORITHM

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Abstract- Document image processing has become an growingly important technology in the automation of office documentation tasks. When a document is scanned through automatic document scanners either mechanically or manually for digitization, it often suffers from some degree of skew or tilt. This paper describes two algorithms to estimate the text skew angle in a document image. The skew angle is obtained by looking for a peak in histogram of the gradient orientation or Fourier analysis of the input grey-level image. Then the skew image is corrected by a rotation at such an angle which is estimated by the algorithm. The method is not limited in the range of detectable skew angles and the achievable accuracy. To measure the processed time and speed taken by skew detection algorithm, the Fast Fourier Transform technique is applied as it is fast approach for finding the angle of skewed document. Nearest neighbor method is founded on connected components in which the first nearest-neighbors of all connected components are and the histogram of the direction vectors for all nearest-neighbors is acquired. Finally, in order to evaluate the performance of the proposed methodology we compare the experimental results with those of well-known existing methods.

Keywords- Skew Detection, Scanned Documents, Fast Fourier approach, nearest neighbour approach, Skew Correction.

I. INTRODUCTION

In past, textbook system is used to protest the records and information in offices. textbook system is not efficient way for keeping the records because it has many drawbacks- time consuming process ,low security, low efficiency, inconsistency of data, difficult to compensate in case failures, difficult to achieve operation like editing, searching etc. Maintenance of textbook system was challenging task. That's why, every field is moving from paper work to electronic documents, this action is known as automation of office documentation. Organizations are moving at a fast rate from paper to electronic documents. However, large amounts of paper documents fetched from a recent past are still needed. Digitalization of documents emerges as a bridge over the gap of past and present technologies. Scanners have an inclination use for the digitalization of documents. The main problem in this field is that very often documents are not always correctly placed on the flat-bet scanner either manually by operators or by the automatic supporting device. This very frequent problem yields rotated images. For humans, rotated images are sharp for visualization and introduce extra difficulty in text reading. For machine processing, image skew creates a number of problems that extension from needing extra space for storage to making more sensitive the recognition and transcription of the image by automatic OCR tools. These reasons make skew detection and correction periods a common place in any environment for document processing. Gernally, the digitalization process of documents yield images rotated of small angles in relation to the original image axis. The skew commense makes more difficult the visualization of images by human users. Moreover, it increases the complexity of any kind of automatic image recognition, degrades the performance of OCR tools, increases the space needed for image storage, etc. So, skew correction is an important part of any document processing system being a matter of concernment of researchers for almost two decades now. The search for faster and good quality solutions to this problem is still on.

II. RELATED WORK

There are several popular methods for skew estimation and correction. In this section, we discuss some of the methods that have been implemented till date.

Aditya et *al*. (2013) presented a algorithm that functions on an embedded system for hand-writer recognition where the memory was required. The demerits of this algorithm were that it cannot detect a document skewed at 180 degrees.

Kaur et *al*. (2013) presented a hybrid approach to determine the processed time and speed taken by skew detection approach, the Fast Fourier Transform (FFT) technique was applied as it is the fast method for determing the angle of skewed document.

Kaur and Jindal (2011) presented a method provided a very efficient way to calculate the Skew. The method included an accurate evaluation of skew, within-line, and between-line spacing and locates text lines and text blocks.

Papandreou and Gatos (2013) described the details of the contest including the evaluation measures used as well as the performance of the twelve approaches

submitted by ten different groups along with a short description of each method.

Sunanda et *al*. (2014) proposed a method uses an efficient algorithm for baseline correction. This approach differs from machine learning approaches, which need manual pixel assignment for baseline.

Shah et *al*. (2014) proposed algorithm for skew detection and correction of handwritten and printed Gujarati document using Linear Regression technique. They proposed a novel method for skew correction using Hough transform which could detect skew with large angles.

Singh et *al*. (2013) proposed different approaches for the text skew estimation in binary images/gray scale images.

Wagdy et *al*. (2014) presented a method based on the extreme point's properties to achieve the corners of rectangle which fits the largest connected component of the document image. The angle of that rectangle represented the angle of document skew.

III. DOCUMENT SKEWNESS AND ITS REASONS

The alteration of paper documents to electronic format is routinely done for record management, automated document archiving, document delivery, journal distribution etc. The stages of document conversion include image processing, scanning, displaying, text recognition, image and text database formation and quality assurance. Through the scanning process, the whole document or a portion of it is procure through a loose-leaf page scanner. Sometimes pages are not fed properly into the scanner causing skewness of these bitmapped-image pages. A skew in document can be detected by human vision easily and the skew correction can be done by re-scanning the document, however for mild skew it may not be possible to mark its skew as human vision system fails to identify it. Even a smallest skew angle existing in a specified document image results in the loss of segmentation of complete characters from words or a text lines, while the distance between the character reduces. However, the OCRs and document retrieval systems are very sensitive to skew in document images. It is very important to detect and correct skewness.

There can be many reasons for skewness in document images. But there are three most basic causes are enumerated below:

1. Skew in Scanning Process
2. Skewed Handwriting
3. Skewed Original Document

There are basically three types of skew in the images like on the basis on number of skew angle and orientation three types of skew arises in scanning the document:

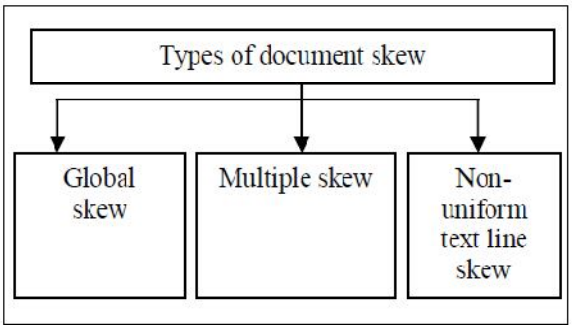

Fig. 1. Types of document skew.

1. Single Skew: 1. Single Skew: In this skew, whole document is skewed to single angle. Most of document images have this type of skewness. This work deals with Single Skew problem. A lot of work has been done in this field and lot of research is still going on.

2. Multiple Skew: In this, scanned document can have many sections; each may be skewed to different angle. Detecting such type of skewness needs lot of efforts. Multiple Skew problem exists rarely and has not got lot attention from researchers.

3. Non-uniform text line skew: when documents contain several orientation in the single line is called as Non-uniform text line skew. In non-unifrom text line skew there are several orientation in each line of the document. Every line of a document skewed on multiple angles. Detecting such type of skewness needs lot of efforts. Multiple Skew problem exists rarely and had not got lot attention from researchers.

IV. EXISTING SKEW DETECTION APPROACHES

For a proper processing of documents, the input to the algorithms should produce errors as small as possible. The causes for errors for algorithms include skewed scanned documents, fuzzy and noisy images. Skew detection and correction is a part of preprocessing stage, stage which affects the performance of an OCR system significantly if not detected and corrected properly. The skew angle of a few degrees has a significant effect on these methods and thus it is important to accurately estimate and eliminate the issues of the skew.

The big problem of the skew algorithms is that usually an error free algorithm is time consuming, and a fast approach had a low accuracy, so usually it has to be "give-and-take" between these two problems.

Several approaches have been proposed as alternatives for skew angle detection of document images. All of them take a dominant text area to be present in order to work properly. Main approaches for skew detection include:

1. Hough transform
2. Projection Profile
3. Nearest neighbor
4. Principal Component Analysis

5. Cross-Relation
6. Histrogram analysis
7. Fast fourier tranfom

Fast fourier transform: By using 2D Fast Fourier transform. The image is filtered in the Fourier domain to retain predominantly text and edge information. A direction histogram is extracted from the Fourier spectrum of the image. The histogram yields the predominant direction of text in the document. We can get estimated angle form the predominant direction of text.

FFT is the faster interpretation of discrete Fourier transform. Discrete Fourier transform produces discrete frequency domain. It obtains frequency over only one period of continuous frequency domain. When the region of one frequency cycle is examined, it is concluded that there is even symmetry around the center point, the Nyquist frequency. The phase at maximum frequency is the skew angle. If the signal X(K) is periodic, band limited and sampled at Nyquist frequency then FFT is obtained by ( ) Σ ( ) (1) where WN = and r=1, 2 … N-1. The FFT based skew estimation approach can be applied for both types of document images (text/pictures). FFT can be applied to find the skew angle for both text and document images. It is less accurate than radon transform.

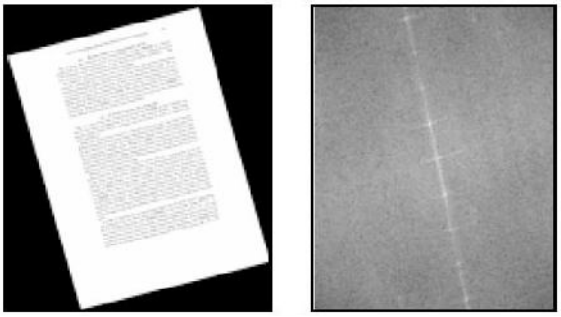

Fig 2. Fast fourier transform method.

Nearest neighbor: Nearest neighbor: This method is be founded on connected components in which the first nearest-neighbors of all connected components are and the histogram of the direction vectors for all nearest-neighbors is acquired. By using Histogram peak, the skew angle can be found.

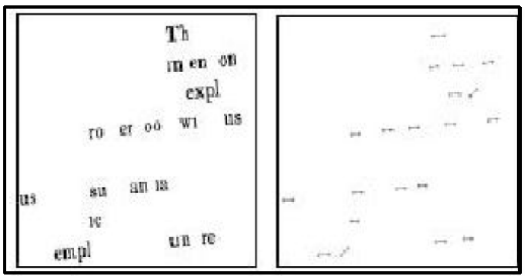

Fig. 3. Nearest neighbor method.

The advantage of 1st-NN method is that it is not limited to any range of skew angles. Although, in the presence of noise and sub parts of characters, accuracy of this method decreases significantly. However, this method requires special attention for dealing with different scripts, and broken characters, and heavily predicates on the quality of the binarization process output. This dependency can be very problematic when dealing with complex or degraded data, such as historical documents.

V. METHODOLOGY

The algorithm to be implemented is based on Fast Fourier transform and nearest neighbor approach to detect and correct the skew in the text document image. Rotation correction is necessary in unconstrained handwritten word recognition because most character based recognition methods are not designed for rotation free. The algorithm for Skew Detection and correction is given below:

Algorithm:-

Step 1: Input scanned text document Image.

Step 2: Preprocessing:- After image binarization, apply noise removal and border elimination techniques to prepare the image for skew detection.

Step 3: Apply FFT to measure the angle. FFT takes following steps:-

1. Apply FFT to image plane.
2. Coefficients of power spectrum are calculated.
3. A directional criterion for each angle is then calculated.
4. The angle that maximizes the directional criterion is assumed to give the skew angle of the image.

Step 4: Apply NN on the resultant image of FFT. It takes the following steps:-

1. Determine connected components.
2. Find nearest neighbor of each component using Euclidean distance.
3. Find the angle between centroids of nearest neighbor components.
4. Accumulate the angles in a histogram.
5. The dominant peak in the histogram indicates the skew angle.

Step 5: Calculate the skewed angle with the help of above two approaches.

Step 6: Rotate the Image on the angle detected in step 4.

Step 7: Save the contents of the Image.

Step 8: Display Result to the user.

VI. IMPLEMENTATION RESULTS

Fig. 4 shows the input text scanned at some arbitrary angle. In this case the angle is known for test purposes and is equal to 30 degrees. The geometric transformation is used to rotate an input image by 30 degrees. So that if deskewing algorithm works

correctly , the resulting de-skewing angle has to be very close to 30 degrees. Because of rounding errors the resulting angle can't be exactly 30 degrees but if it is close, for example the error is less than 0.1 degrees, then from human point of view it will be completely de-skewed.

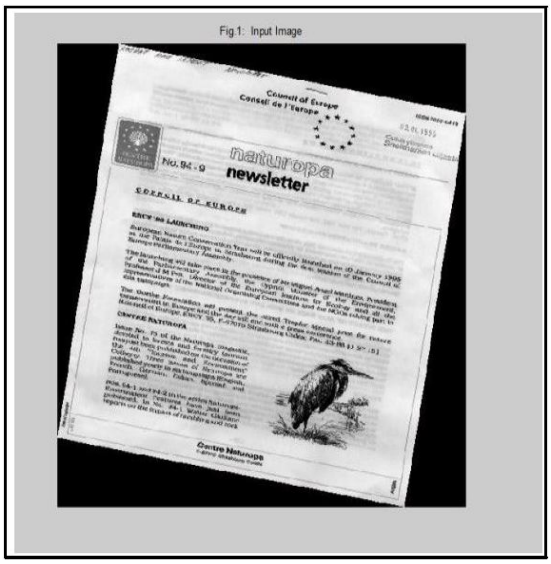

Fig. 4. The input document image.

Fig. 5. shows the spectrum of the input image and as it was expected most of the energy is distributed along the axis parallel and perpendicular to text lines and greed.

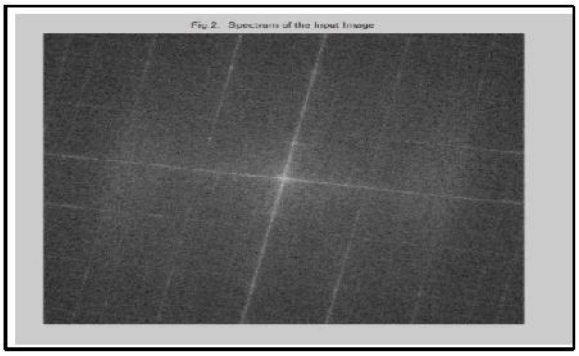

Fig. 5. Spectrum of input image.

Next as shown on Fig. 6 the spectrum of the input image was segmented in four quadrants corresponding to quadrants of Cartesian coordinate system.

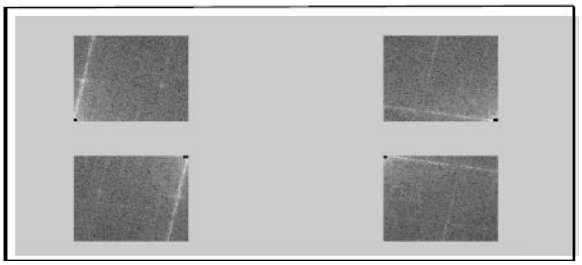

Fig. 6. Spectrum of the Input Image Segmented in four Quadrants.

Fig. 7 shows the de-skewed text after applying the rotational transformation to the input image at determined above angle.

Clearly the brightest points of the spectrum make up the lines that make the same angles with x and y axis as the original document placed on the scanner. The spectrum image was segmented this way because each quadrant processed by itself should result in right de-skewing angle. And to increase accuracy and minimize possibility for error an average of for resulting errors can be obtain. Also as it shown in Fig. 6 there is little black square in the corner of each quadrant. It was done to mask the pixel in the middle of the spectrum image and some pixels around it because the following algorithm is based on finding the brightest points in each quadrant and the middle point is the brightest since it is an average value but this point doesn't help in finding the angle so it needs to be ignored.

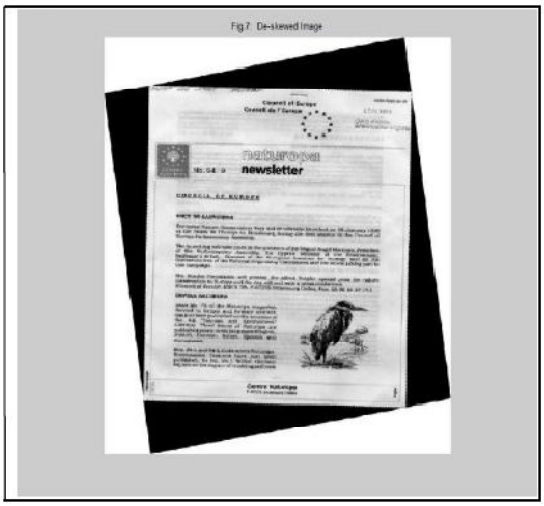

Fig. 7. Deskewed image

Fig. 8 shows the resultant image after applying nearest neighbor method. This algorithm applies the connected component analysis to the original image. The nearest-neighbor chain are extracted from the adjacent nearest neighbor pairs, in which the slopes of the nearest-neighbor chain with a largest possible number of components are computed to give the skew angle of document image.

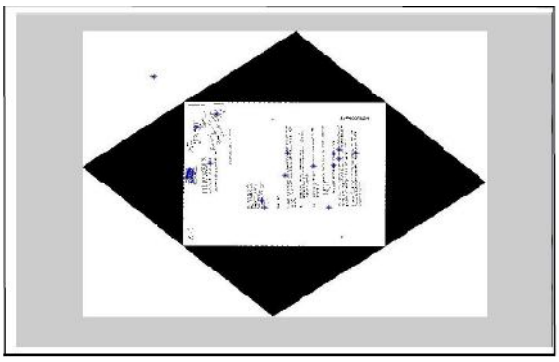

Fig. 8. Resultant image after applying NN.

Histograms are deployed to plot the frequency of the contents present in the image. However for compressed data, we have used histogram to plot the run frequency information. Fig. 9 shows the histogram for the sample document considered above.

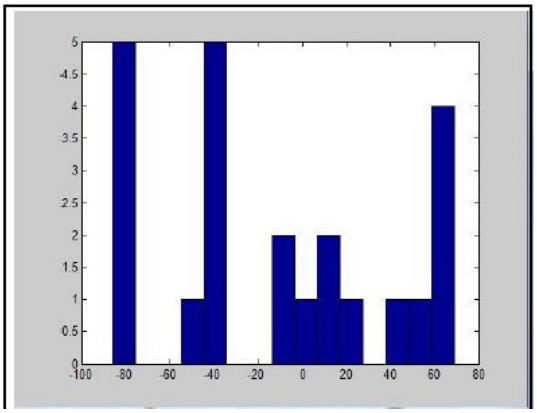

Fig. 9. Histogram of input image

The efficiency of the proposed algorithmic model is evaluated by testing the algorithm for different data sets. Table 1 gives error calculation for obtained skewed angle as compared to original skewing. It is observed that the proposed algorithm gives 0.5758 % of error.

Table 1. Evaluation of proposed method.

S. no	Actual angle (^{0})	Detectecd angle (^{0})	Error	Time (sec.)
1.	48	47.4242	0.5758	0.001982
2.	48	48.184	-0.184	0.010202
3.	-10	81.0621	-91.0621	0.002106
4.	-10	80.7004	-90.7004	0.0015444
5.	10	9.1377	0.8623	0.0007644
6.	10	11.3639	-1.3639	0.00082681
7.	10	10.1589	-0.1589	0.0023244
8.	20	18.6896	1.3104	0.001482
9.	30	30.6676	-0.06676	0.00156
10.	40	40.5589	-0.5589	0.00117

In the fields of science, engineering, industry, and statistics, the efficiency of a measurement system is the degree of closeness of measurements of a quantity to that quantity's actual value.
Comparison between existing technique and proposed technique:

From the above table it has been obtained that the proposed method has more accuracy in comparison to the results of existing method and with less time consuming. The overall accuracy of proposed system is 96% wherease of existing system is 95%. Figure 10. shows the comparison between the actual and detected angle of the scanned document by applying proposed technique and analysis of existing and proposed techniques.

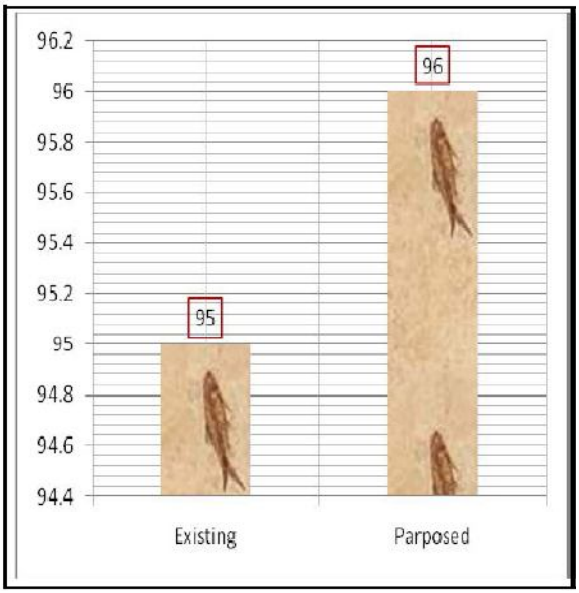

Fig. 10. Accuracy comparison between existing technique and proposed technique.

CONCLUSION

A new strategy is proposed for deciding the skew point of digitized records. The outcomes got are exceedingly precise and less drawn out with better speed as contrast with the other existing strategies. The exactness accomplished a skew point determination inside of the scope of ±45 level of genuine skew edge. The benefit of the system over most different methods is the simplicity of recognizing skew over ±45 degree skewed point. Precision is likewise close to 96% and time for ascertaining the skewed point is under one second (normal) for every checked documents. The obliged time by utilizing recurrence space to distinguish skew edge is very corresponded to skew edge. Our proposed system provides better results than exiting techniques in the term of time, accuracy, and angle detection.

Execution assessment has demonstrated that proposed calculation is great result for deciding the point of a picture however there is one impediment it doesn't work with soft computing and wrapped images. In near future work we will detect the skew using soft computing in wrapped images.

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