Improved Skew Detection and Correction Approach Using Discrete Fourier Algorithm

Ruby Singh, Ramandeep Kaur

Abstract— The main objective of Image processing is to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. But when they are needed to be converted into electronic form, it has to be done through scanning. One of the major problems in this field is that if the document to be read is not placed at 90^0. This will result with a skewed image. Skew refers to the text which neither parallel nor at right angles to a specified or implied line. Character recognition is very sensitive to the page skew, skew detection and correction in document images are the critical steps before ayout analysis. To achieve the objective of Skew detection and correction, a new improved strategy is proposed which uses the Fourier transformation and angle of elevation theory to detect the skewness angle first and then skew correction algorithm will come in action. As Fourier transform will speed up the algorithm so speed no longer is an issue for proposed algorithm. Also angle of elevation theory has ability to detect angle in efficient manner. Proposed algorithm is designed and implemented in Matrix Laboratory by taking a sample of 120 different Skewed images. These images include documents having different languages: - English, Hindi, Punjabi and Pictures.

Keywords—Skew detection, Fast Fourier transform, Discrete Fourier transform, Radon transform, Moments.

I. INTRODUCTION

Image processing can be broadly defined as the manipulation of signals which are inherently multidimensional. The most common such signals are photographs and video sequences. The goals of processing or manipulation can be (i) compression for storage or transmission; (ii) enhancement or restoration; (iii) analysis, recognition, and understanding; or (iv) visualization for human observers. The use of image processing techniques has become almost ubiquitous; they find applications in such diverse areas as astronomy, archaeology, medicine, video communication, and electronic games. Nonetheless, many important problems in image processing remain the subject of the research for several decades. One of the main problems is discussed in this paper that is Skew detection and correction. Most of the times, document analysis systems require prior skew detection and correction before the images are forwarded for character recognition, layout analysis, document image mosaicking and many other applications. Many approaches of skew detection can process pure textual document images successfully. But it is a challenging problem to process documents with large areas of non-textual contents.

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The largest classes of methods for skew and correction are based on

- Hough transform,
- Straight line fitting,
- Moments,
- Nearest-neighbor,
- Projection-profile analysis,
- Fourier-transform

Hough transform [1] provides accuracy and simplicity. But due to slow speed many researchers work on its speed complexity without compromising the accuracy. So, for improving computational efficiency of Hough transform. There are various variations have been proposed to reduce the computational time for skew angle. A new method which reduces the time complexity without compromising the accuracy of Hough transform was introduced but it shows that each method have their own speed for different scripts.

[2] has studied that the Hough transform provides a robust technique for skew detection in document images, but suffers from high time complexity which becomes prohibitive for detecting skew in large documents. It can only be applied to pure text sub region in the whole image and any non-text sub-region selection will not give accurate results.

[3] proposed a skew detection method based on straight-line fitting using a concept of eigen-point. After the relations between the successive eigen-points in every text line within a suitable sub-region were analyzed, the eigen-points most possibly laid on the baselines are selected as samples for the straight-line fitting. This works well, when only a pure text sub-region in the whole image is selected.

[4] used the moments technique for the first time by proposing a simple and fast algorithm that works with any kind of objects, like bend lines (not only straight lines), pictures, columns of text etc. The orientation θ of this object between the principal axis and the horizontal axis gives an exact estimation of the skew angle. There exists a disadvantage that the angle must be in the range of -30 degrees to +30 degrees. [5] This paper introduces the extension to the moment based method for the text skew estimation. To be used for the handwritten text, an extension of the moment-based method with the introduction of bounding boxes has been introduced. The application of the moment-based method to the connected components estimates their local text skew.

[6] proposes an improved method of nearest-neighbor for detecting skew based upon chain. It is able to deal with documents of different scripts such as English, Tamil and Chinese. This Improved Skew Detection and Correction approach using Discrete Fourier Algorithm method has high accuracy but with size restriction drawback.[7] detects the global skew angle of document images within the

range -90 degrees to 90 degrees with a generic, scale-independent technique. By using the same framework, the algorithm is then extended for Roman script documents so as to cope with the full range -180 degrees to 180 degrees. The improved version is very fast and requires no explicit parameters. They offer the greatest flexibility, accuracy and run-time performance.

In this paper, an improved technique using Fast Fourier transformation to detect and correct the skews of an image is proposed. There already exists a technique [8] which has used Fourier transformation for skew detection but that technique does not provide the next step of Skew correction. In order to remove the existing problem a new improved strategy is proposed which uses the Fast Fourier transformation and angle of elevation theory to detect the skewness angle first and then skew correction algorithm will come in action. As Fourier transform will speed up the algorithm so speed no longer is an issue for proposed algorithm. Also angle of elevation theory has ability to detect angle in efficient manner.

The paper organization is as follows: Section 2 presents the existing Fourier transform based algorithm. Section 3 explains the improved algorithm by introducing next step of Skew correction using angle of elevation theory. Section 4 describes the experiments. Section 5 makes the conclusions.

II. EXISTING ALGORITHM

The skew determination technique by Lowther, Chandran, et al. by using a new Averaged Block Directional Spectrum (ABDS). The technique 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. The algorithm used for skew determination[8].

1. Image Subdivision - the image is divided into blocks of size NxN.
2. Fourier Analysis - the full Fourier spectrum is computed for each block (using FFT) and represented with the origin at the centre. In this algorithm thewindow at the origin is not removed. All values in the Fourier spectrum are normalized to the range [0, 1] to obtain consistency between blocks.
3. Mean Fourier Calculation - The Fourier transform for all blocks is averaged together to form a single Fourier block for applying the Radon transform.
4. Apply a Mask - A donut shaped mask is applied to the mean Fourier block to remove DC and very low spatial frequency components and to make the radial bands of uniform bandwidth in all directions.
5. Approximate Angle Calculation - Apply a modified Radon transform to the mean Fourier block in the range [-90°, 90°] in angle increments of 1°. The peak of the Radon transformation is taken as the approximate angle of skew.
6. Refined Angle Calculation - Apply a second modified Radon transform to the mean Fourier block in the range ±t° of the approximate skew angle, in smaller angle increments.

III. PROPOSED ALGORITHM

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, analyse, and evaluate the digital images to prove the effectiveness and efficiencyof the proposed strategy. The new proposed algorithm includes 7steps, out of which Step 1 to Step 3 shows the technique to find the skew angle using Fast Fourier transform and Step 4 to Step 7 shows the technique to correct that skew angle using angle of elevation theory.

1. Input an Image - This loads an image, it can be either in two-dimensional or three-dimensional plane.
2. Preprocessing - This preprocesses the image, that means it converts the truecolor image RGB to the grayscale intensity image. RGB2GRAY converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance.
3. The Skewness angle by taking highest frequency of Fourier Transformation - This finds the skew angle using fast Fourier transformation. When this step is performed, it actually first finds the skew angle of each quadrant of the image and then combine those angles to find the skew angle of the whole image.
4. Subtract 90o from the detected angle - In this step, this subtracts the detected angle from 90o.
5. Shift the angle anticlockwise -This shifts the angle anticlockwise with respect to 90o for correcting the skew angle.
6. Rotation- If the calculated angle's highest frequency corresponding to 90o, then rotate the image to 90o.
7. Now, apply inverse FFT- At last, this applies the inverse Fast Fourier transformation. This returns the inverse discrete Fourier transform (DFT), computed with this fast Fourier transform (FFT) algorithm.

A fast Fourier transform (FFT) algorithm is used to compute the discrete Fourier transform (DFT) and its inverse. A Fourier transform converts time (or space) to frequency and vice versa; an FFT rapidly computes such transformations. The Discrete Fourier transform (DFT) converts a finite list of equally spaced samples of a function into the list of coefficients of a finite combination of complex sinusoids, ordered by their frequencies, that has those same sample values. An FFT is a way to compute the same result more quickly: computing the DFT of N points in the naive way, using the definition, takes $O(N^2)$ arithmetical operations, while an FFT can compute the same DFT in only O(N log N) operations. The difference in speed can be enormous, especially for long data sets where N may be in the thousands or millions.

IV. EXPERIMENT RESULTS

Proposed algorithm is designed and implemented in Matrix Laboratory by taking a sample of 120 different Skewed images for testing. These images include documents having different languages:- English, Hindi, and Pictures.

The experimental results of the proposed algorithm are shown. Firstly, an image having any format is read. Figure 1 shows the original color image and different corners of the skewed input image. In addition to the original image, we have also shown the 4 different corners of the respective image by cropping its corners. This is done for a specific purpose which will be explained later on. Figure 2 shows the input image just in an enlarged form and figure 3 shows the spectrum of the image for finding the quadrants of the spectrum of the image in next figure. Now, Figure 4 shows the first, second, third and fourth quadrant of the spectrum of the image for detecting the skew angle of each corner or quadrant of the image. Then after combining all the angles of the quadrants we can get the skew angle of the whole image. At last for correcting the skew, we will rotate the image anticlockwise gives us a deskewed image as shown in figure 5.

Figure 1: The original color and different corners of the skewed image.

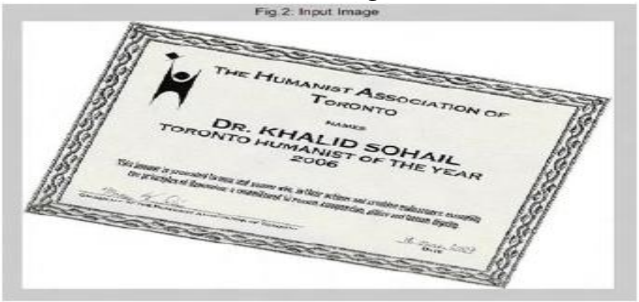

Figure 2: The input image in enlarged size.

Figure 3: The spectrum of the input image

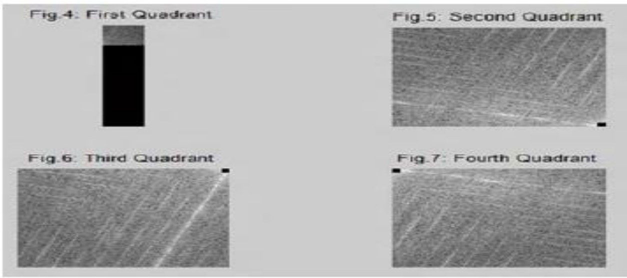

Figure 4: The four quadrants gives the highest frequencies using Fast Fourier transformation

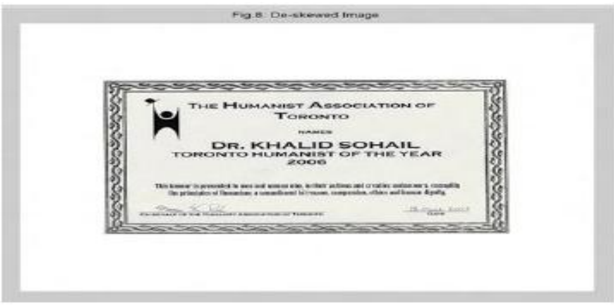

Figure 5: De-skewed image after correction using angle of elevation theory.

V. CONCLUSION

There are so many ways for detecting and correcting a slant or skew in a given document or page. Like, Hough transformation, Fourier-transformation, nearest neighbor, cross- correlation, moments, etc. But mostly every technique has some limitations, like some of them provide us speed but are suitable only for small text, some provide us accurate results but are slow in speed. In order to reduce this problem a new improved strategy is proposed which uses the Fourier transformation and angle of elevation theory to detect the skewness angle first and then skew correction algorithm will come in action. As Fast Fourier transform will speed up the algorithm so speed no longer is an issue of proposed algorithm. Also angle of elevation theory has ability to detect angle in efficient manner. . This mainly includes the new proposed algorithm which shows the working of algorithm step by step. A fast Fourier transform (FFT) algorithm is designed to compute the discrete Fourier transform (DFT) and its inverse. The new proposed Figure 3: The spectrum of the input image algorithm is designed and implemented in Matrix Laboratory. The input images included scripts in English, Hindi languages and also images with pictures.

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