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Literature Survey On Dewarping Of Document Images

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Abstract— Dewarping of camera document images has become lot of interest in the past. It is due to its inefficiency in the document readability and also it affects the accuracy of an OCR application, a two-step approach for efficient dewarping of camera document images is used. In the first step, coarse dewarping is used with the help of a transformation modelling which it maps the projection of a curved surface to a 2D rectangular area. This projection is bounded with two curved lines which fit to the top and bottom text lines with the two straight lines which fit to the right and left text boundaries. In the second step, fine dewarping is used based on the detection of words. Lower and upper word baselines are used to normalize the detected words.

Keywords— dewarping; SIFT; LSE; polynomial regression; Euclidean distance

I. INTRODUCTION

A document image of bounded volumes when captured by camera or flatbed scanning and performing nonlinear warping text are strongly distorted and influences the performance of further processing. For document image dewarping there are so many approaches. These approaches are classified into 3-D document shape reconstruction and 2-D document image processing. The second approaches only use 2-D information only. In Usage of continuous skeletal image representation for document images dewarping [6] method use the outer skeleton of the text images. This method is sensitive to the deformation of vertical borders of text block, so its accuracy is low. Correcting document image warping based on regression of curved text lines [3] method, the document image is divided into shaded and non-shaded regions. After separation, model the warped text lines with quadratic reference curves using polynomial regression. In this method the images must be gray scale and have the shaded regions. Dewarping of document image by global optimization [7] method the warping model of the document image is defined by cubic splines. Each line is approximated by using some characteristics. For black objects the approximation process is so hard. In two step dewarping of camera document images [1], the images are directly applied and use the segmentation method in the first step. Then perform the transformation modelling for mapping the projection of curved surface. Fine Dewarping is the second step, which perform positioning all the words to upper and lower baselines. In this paper, these three document dewarping methods are discussed.

II. METHODOLOGY FOR DOCUMENT IMAGE DEWARPING TECHNIQUES PERFORMANCE EVALUATION

In this methodology first manually mark some points on the warped image which is used to represent the text lines of the original image. Then the marked points are matched to the corresponding points of the dewarped image by using SIFT transform. Finally the extraction of the dewarping evaluation measure is performed based on the estimated of the cubic polynomial curves which fit to the matched points. The flowchart describes distinct stages of the evaluation methodology.

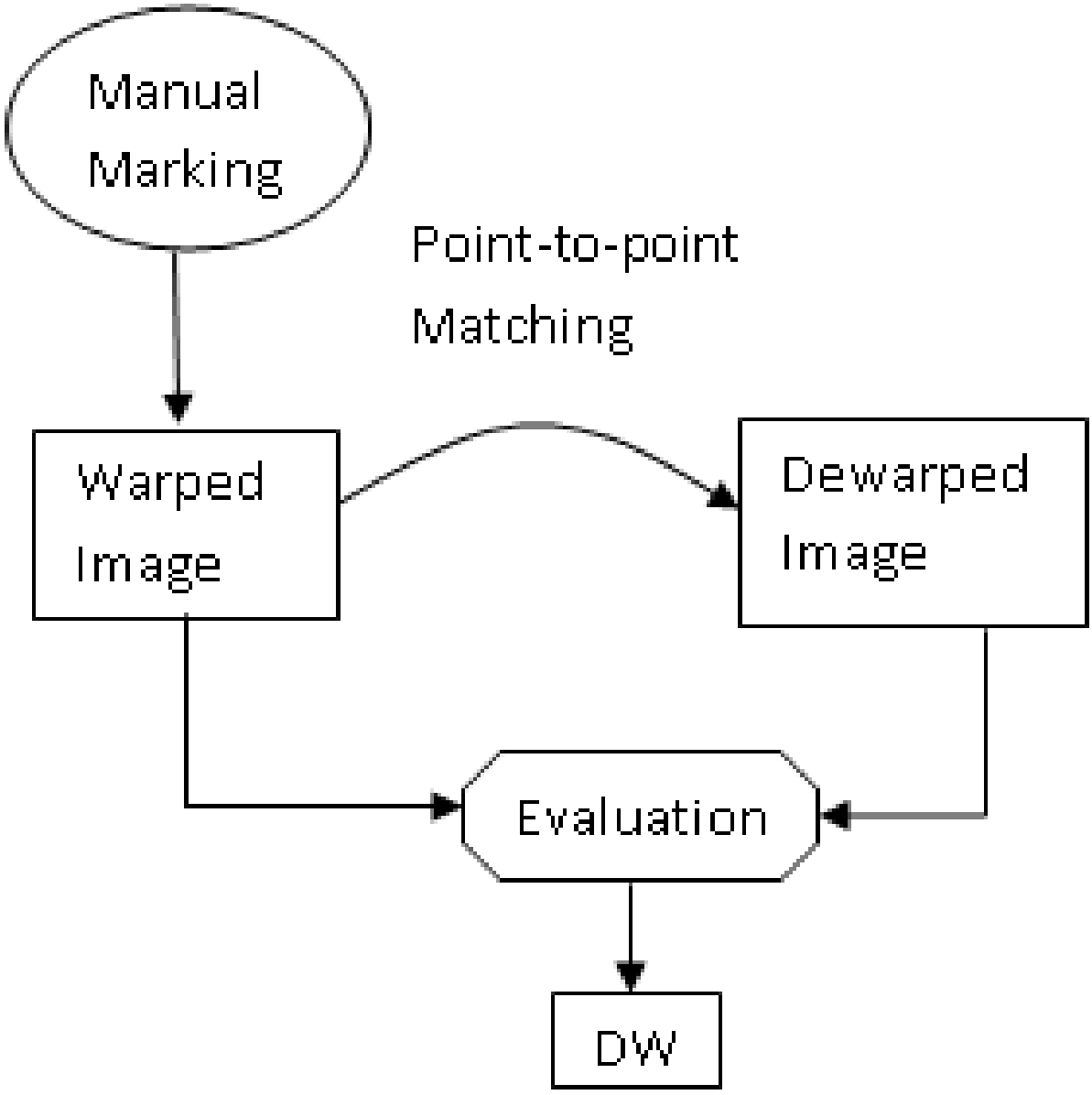

Figure 1. Flowchart of the evaluation methodology

2.1. Manual marking on the warped image

This stage requires the user's intervention and this should be done only once for each warped image. The user marks set of points in the middle of the main body of the words and each set correspond to a representative text line of the image.

2.2. Point-to-Point Matching

The manually marked points of the original image are matched with the corresponding points of the dewarped image by using the SIFT transform. Looking in scale space for maxima or minima at the difference of Gaussian image SIFT identifies the key points and each of these are used to generate feature vector. These vectors are called SIFT keys.

2.3. Evaluation

In this final stage dewarping evaluation measure is computed which reflects the entire performance of a dewarping technique. Each text line of the document is approximated with the cubic polynomial curves by using the selected set of points of the warped image and the matching points of the

dewarped image. The integral of each cubic polynomial curve over an interval delimited by the curve end points indicates the performance of the dewarping technique. When the j^{th} text line in the dewarped image is a horizontal straight text line Dw_j measure is equal to one. When the dewarped image is the same, Dw_j measure is equal to zero. So, it can be observed that the measure of dW_j varies from 0 to1. Higher the measure of DW, better the performance of the dewarping technique.

III. CORRECTING DOCUMENT IMAGE WARPING BASED ONREGRESSION OF CURVED TEXT LINES

First find the boundary between the shaded area and the clean area by using run length method. Then remove the shade by using modified NIblack's method and for noise filtration construct the connected components. This system replaces the restoration part to straighten curved text lines using the methods described below.

3.1. Multi column detection

By projecting the bounding boxes of the connected components compute the vertical projection profile .Then the system segments it into number of columns of text. The system next mark the columns that have connected components located in shaded area according to the shade boundary and processes these components for each column.

3.2. Processing the clean area

For each partial straight text line the system classifies the connected components into two classes such as characters and symbols. To model the alignment of the text, generate a pair of top and bottom straight reference lines by applying linear regression twice.

3.3. Processing the shade area

For each curved text line approximate the alignment of the in-shade connected components by two quadratic reference curves. Polynomial regression using least mean square is applied twice with the coordinates.

3.4. Straightening the warped text line

The partial curved and straight text lines are naturally combined in to a set at a complete text lines. The location adjustment is done by calculating the relative position of this connected component.

IV. TWO STEP DEWARPING OF CAMERA DOCUMENT IMAGES

In this paper, two step dewarping of camera document images [1], to recover the camera document images, here apply two main steps .i.e., coarse dewarping and fine dewarping. Before proceeding to these steps the black and text borders are removed after the image binarization.

4.1. Coarse dewarping

In this step for achieving coarse dewarping of the document images the projection of curved surface is mapped to a 2D rectangular area. This is done by extraction of curved surface projection and then applying the transformation model.

Extraction of curved surface projection indicates that the two curved lines which fit to the top and bottom text lines and two curved lines that fit to the left and right boundaries. The left and right straight line segment estimation is done in various steps. For detecting the left text line, first detect all the left most points in each text line and calculate the average value of x coordinates them. To eliminate the text lines which do not start from the beginning of the document check whether the difference between x coordinates and the average value greater than the average character height. To get the straight line that fit all the remaining points use Least Square Estimation method. After this process the left and right text boundaries are defined as:

$$Y_l = a_l x + b_l$$

$Yr = arx + b_r$

Then find the top and bottom curved line segment by choosing the proper text line which is used to estimate the curved line. The text line selected must not be too small. This is done by selecting the

text line which satisfies the condition that the average of sum of distance between the leftmost point of a text line and the left straight line and the distance between the right most point of that text line and the right straight line is less than the double of average character height. All the upper points of the selected text line are detected and find the coefficients of the polynomial curve that fit all the points that are detected by using Least Square Estimation method. After this process the curved line for top and bottom is defined as:

$$Y=a_{u1}\,x^3+a_{u2}x^2+a_{u3}x+a_{u4}$$

$Y=a_{l1}\,x^3+a_{l2}x^2+a_{l3}x+a_{l4}$

The extraction of curved surface projection is as shown in figure2 [1].

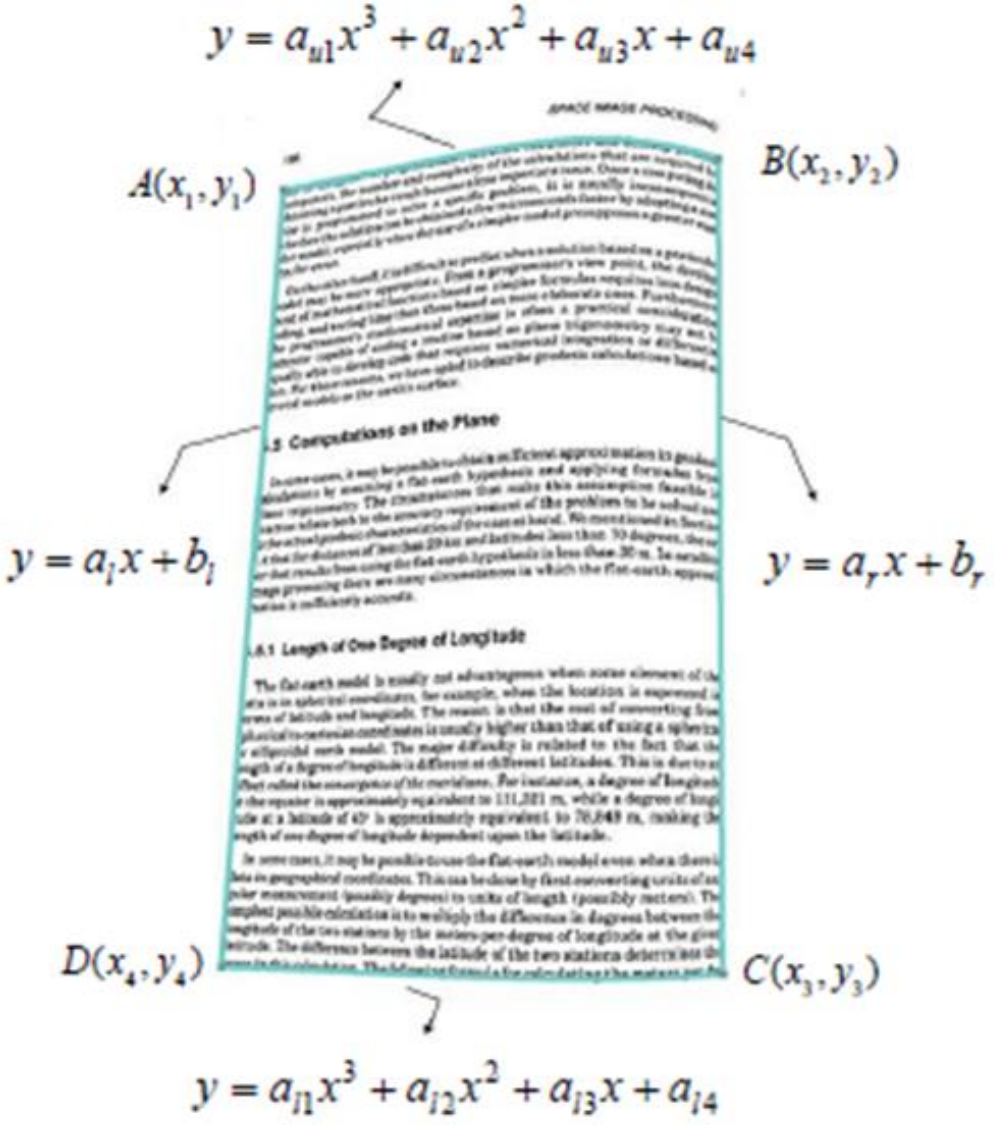

Figure 2. Extraction of curved surface projection

Next is the transformation process. For transformation first allocate the rectangular area of width equal to the minimum of arc length between AB and DC and height equal to minimum of Euclidean distance of AD and BC. The corner points are calculated as follows:

$x'_1 = x_1$, $y'_1 = y_1$

$x'_2 = x'_1 + \text{width}$ $y'_2 = y'_1$

$x'_3 = x'_2$ $y'_3 = y'_2 + \text{height}$

$x'_4 = x'_1$, $y'_4 = y'_3$

Create the correspondence between the curved line segment points and repeat this for all points which are inside the projection area.

4.2. Fine Dewarping

Second step is the fine dewarping of the transformation model. This is done by text line and word detection and then upper and lower baseline estimation of word and finally the text line dewarping. During text line and word detection, remove all the non-text components from the dewarped image after coarse dewarping step. After that the upper and lower baselines which delimit the main body of the word is detected. Finally all detected words are rotated and translated during text line dewarping step and then add all the removed components.

V. CONCLUSION

Dewarping of camera document images suffer from distortion and surface deformation. To rectify this, a two-step approach for efficient dewarping of camera document images is used. In the first step, a transformation model is used which maps the curved surface into a 2D rectangular area. This is known as coarse dewarping of document images. In the second step, text line and word segmentation are used. This is known as fine dewarping of document images. From the survey, it is clear that two step approaches can improve the performance of the restored images and eliminates surface deformation.

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