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SURVEY ON METRIC RECTIFICATION OF WARPED DOCUMENT IMAGES

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Abstract— **Metric rectification method is to restore an image from a single camera-captured document image. This method construct an isometric image mesh technique by exploiting the geometry of page surface and camera. It uses a general cylindrical surface (GCS) to model the curved page shape. It introduce a paraperspective projection to approximate the nonlinear perspective projection. A set of close-form formulas derived for the estimate of GCS directrix and document aspect ratio. This provides a straightforward method for image metric rectification. This paper focus on the survey of metric rectification established by different authors.**

Keywords—**Document image analysis, image geometry, geometric restoration, mesh warping.**

I. INTRODUCTION

Digital cameras are widely used in optical character recognition (OCR) for capturing the images of documents. Curved document rectification have various advantages against flatbed scanners. They are portable, fast responsive, and able to capture document images from any viewpoint. Using this system, fragile historical documents can be captured through contactless way; which cannot be pressed onto a flatbed scanner. In this system, a metric rectification method is used for removing the nonlinear geometric distortions in a document image captured by a camera. This takes advantage of the properties of printed horizontal text lines on a document page to construct an isometric mesh. Then, a mesh-based image warping technique is implemented to flatten the curved image. The proposed method provides a straightforward solution for restoring an image from a single camera-captured document image. It is able to rectify the distortions caused by page curl, perspective, and their coupling simultaneously.

Optical character recognition (OCR) is mechanical or electronic conversion of images, that is convert handwritten or printed text into machine-encoded text. It is widely used in the form of data entry from printed data records, passport documents, banking statements, computerized receipts, static-data mail printouts, or any suitable documentation. It is a common method for digitizing printed texts so that it can be electronically edited, searched, stored more compactly, it displayed on-line, and used in machine processing area such as machine translation, text-to-speech, key data and text mining. OCR method is a research field in pattern recognition, artificial intelligence and computer vision.

Document image rectification algorithm depends on the detection of the frame that contains the text into the image. Then performing transformation of the points contained in the frame from real-world coordinates to image plan coordinates. This algorithm includes four main steps: Pre-processing, Text-lines detection, Page layout, and detection. This method rectification using projective transformation. Document image has unknown structure and find the potential alignment in the image. The Arabic languages have a very interesting property that the horizontal projection of text lines gives maximum values at the base line of text lines. Therefore, use of this property to detect text lines through Hough transform used to detect potential text lines in camera image.

This system propose a metric rectification method for restoring an image from a single document image captured by an uncalibrated camera. This method employs a General Cylindrical Surface (GCS) to model the page shape. Then, the properties of horizontal text lines under perspective projection are exploited to build an isometric mesh. Finally, a mesh-based image warping is implemented to remove the distortions. This system use a global image transformation by constructing an isometric image mesh. This method does not assume equal line spacing of the printed textual contents. Two horizontal text lines are used for a metric image rectification.

Character in text image and video is an important part in advanced language content of image. Here converting images into binary image, and combined text image character with mathematic morphology. Then selecting morphological factors, baseline position, and distortion parameters. And affine transformation is applied to finish the distortion correction for text images [11]. Distortion correction methods such as, distortion correction method based on model, the distortion correction method based on the edge, the distortion correction method based on the internal features of the text.

Distortion parameters are estimated to rectify the image, which may be scanned text image or natural-scene image that contained multi-kinds of distortion, especially that of the

single-line text. This system mainly consists of pretreatment, inclination deformation rectification, horizontal and vertical perspective deformation rectification.

This work [1] mainly focused on a step-by-step image rectification framework. Which is able to fully rectify the nonlinear geometric distortions, including the distortions caused by perspective, page curl, and their coupling. This framework can be used for 3D shape estimation from perspective geodesics of GCS. A line convergent symmetry about the printed horizontal text lines help to constrain the estimation of model parameters under perspective projection. This method introducing a linear paraperspective projection, and derive a set of close-form formulas for the estimation of GCS directrix and the x-to-y aspect ratio of document. These formulas finally form to a straightforward solution to the problem of metric image rectification. The figure show the overview of this method.

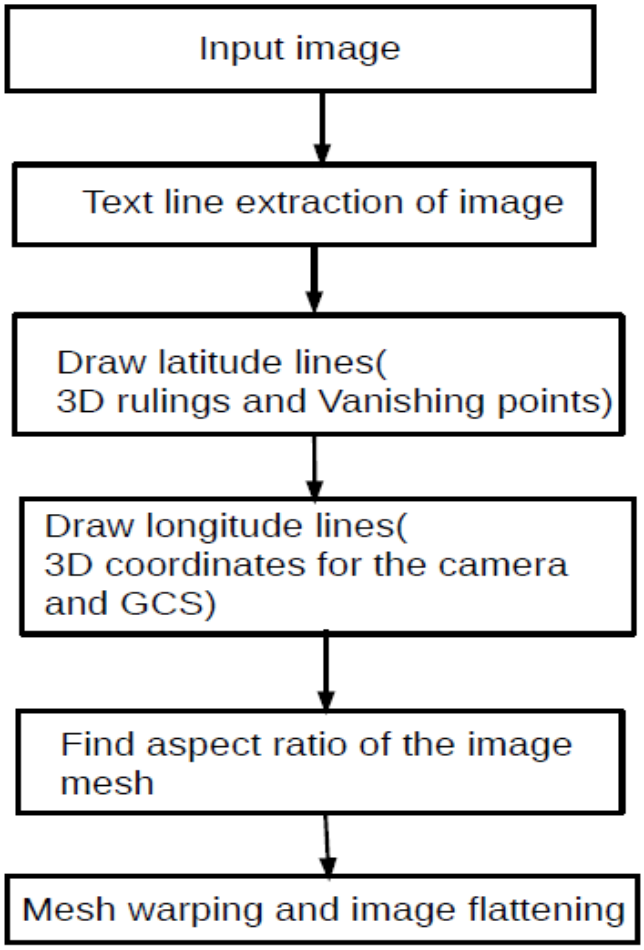

Fig .1 Isometric mesh construction

Text lines fitting method is a major step for metric image rectification, it will affect the subsequent model parameter estimation and isometric image mesh construction. Three basic assumptions are needed for constructing an isometric mesh. First, it assume that the curved page shape is a general cylindric surface. GCS is suitable for modeling the page shape of an opened book. It is also adopted in many restoration system. Second, require that the 3D rulings of GCS are orthogonall to the horizontal text lines. This assumption will lead to a fact that the horizontal text lines on 3D page surface are planar curves. The generalization of this assumption is also possible. W. Third, this assume that the camera is a standard pinhole camera, in which the x-to-y sampling ratio is one and the principle point locates at the image center.

11. LITERATURE REVIEW

Goal of the metric rectification method is to fully rectify the nonlinear geometric distortions in a camera-captured document image, including the distortions caused by perspective, page curl, and their coupling. Finally construct an isometric image mesh, which accounts for underlying geometric distortions. Once such a mesh is available, one can conveniently flatten the curved document image through the mesh-based image warping.

S. S. Bukhari et al. [2] implements Coupled snakelets algorithm for curled text-line segmentation from warped document images. Camera-captured document images usually contain warped/curled text-lines because of geometric and perspective distortions. This method introduced a novel curled text-line segmentation algorithm by adapting active contour. This refer to active contour model for the text-line segmentation of coupled snakelets. This algorithm uses only top and bottom points of connected components within a curved document image for detecting text-lines. It estimates a local pair of x-line and baseline of each connected component using top and bottom points, and then each group of overlapping and touching pairs of x-line and baseline is considered as a segmented text-line.

Huaigu Cao et al. [3] presented a cylindrical surface model to rectify the bound document image. The surface of the document is modeled by a cylindrical surface. A cylindrical surface model is proposed to describe the relationship between the surface of the bound documents and its image formed on image plane. This method is then applied to the pre-processing of OCR. This making remarkable improvement in the recognition quality. This approach required that the generatrixes of the cylinder parallel of the image plane.

Zhang et al. [4] proposed a new resolution-free restoration system that adopts a simpler connected component analysis. Here, first identify the shade region and binarize the image using a modified Niblacks method to remove the shade. Noise is removed using a connected component analysis. A top-down approach is applied to cluster connected components in the clean area into straight text lines, and alignments of text are modeled by straight reference lines using a linear regression. A bottom-up method is applied to cluster the connected components in the shaded region into warped text lines, and polynomial regression model are used to model the warped text lines with quadratic curves. Corresponding warped text and linear text alignments in both areas are then paired up. The curved text lines are restored by correcting the

quadratic curves based on the corresponding straight line text. Also this system improve OCR accuracy for low resolution images. The disadvantage is that it is not solve the problem of complex document images involving multiple pages, graphical contents, and other language texts.

Geometric and photometric restoration method is used to restore the 2D content printed on distorted documents. This system uses a structured-light setup to acquire the 3D surface of the document and a high resolution image. The 3D data is used to correct geometric distortion and classify illumination and reflectance images to correct shading distortion. This system can process arbitrary geometric distortions, and not requiring any pre-assumed parametric models for the documents geometry. The illumination correction using the 3D shape to distinguish content edges from illumination edges to recover the 2D contents reflectance image while making no assumptions about light sources and their positions [9].

Brown et al. [10] proposed a new framework for restoring manuscript images by removing the shape distortion that results from images of damaged (warped and deformed) documents. The purpose of this restoration is to create a planar representation of a planar document that has undergone an arbitrary and unknown rigid deformation. To accomplish this restoration, this framework acquires and flattens the 3D shape of a warped document to determine a nonlinear image transform that can correct for image distortion caused by the documents shape. And this framework is designed for use in library and museum digitization efforts where old and badly damaged manuscripts are imaged. Here using a physically-based mass-spring particle system to guide iterative unwarping process. This restoration algorithm produces a new image that realistically represents the manuscript should appear if it were once again flattened. The disadvantage is that no correction for image cues such as shading or shadows that may be present in original image.

M. Sun et al. [5] implements Geometric and Photometric restoration method is used to restore the 2D content printed on distorted documents. This system uses a structured-light setup to acquire the 3D surface of the document and a higher solution image. The 3D data is used to correct geometric distortion and classify illumination and reflectance images to correct shading distortion. This system can process arbitrary geometric distortions, and not requiring any pre-assumed parametric models for the documents geometry. The illumination correction using the 3D shape to distinguish content edges from illumination edges to recover the 2D contents reflectance image while making no solution about light sources and their positions [3].

Fujimoto et al. [6] presented a new distortion correction method for digital camera document images based on shape from parallel geodesics. This method consider parallel lines corresponding to character strings on extended surface become parallel geodesics on a curved paper can be modeled by a ruled surface. The projected geodesics and rulings exist in the input image derived from the perspective transformation. The main process of this method include extracts the projected geodesics, and estimates the projected rulings in the input image, estimates the ruled surface of the curved paper, and generates the corrected image. The projected rulings are estimated by the condition derived from only parallelism of geodesics without the equal spacing requirements. This method can estimate the ruled surface model directly by differentiation for numerical operations, integration and matrix inversion without any iterative calculation.

Z. Zhang et al. [7] proposed De-shading and de-warping model. This is used to restore the document image by using the book surface shape and albedo distribution. In de-shading restoration system recalculates the image intensity for each pixel. This method include the factors are, first build the practical model (consists of geometric model and optical model) to reconstruct the 3D shape of book surface. Next is to restore the scanned image using this shape based on de-shading and de-warping models. Finally, compare the OCR results on the original and restored document image. This system can remove the shade, and adjust the warped book surface. Also this method improve OCR test on the restored document image.

Liang et al. [8] proposed a geometric rectification framework for restoring the frontal-flat view of a document from a single camera-captured image. This extracts the 3D document shape from a single 2D image and performs shape-based geometric rectification method to restore the frontal-flat view of the document. The output image is comparable to scanned images and significantly OCR is more compatible than the input. This approach estimates 3D document shape from texture flow information obtained directly from the text image without requiring any additional 3D data or prior camera calibration. This method provides a unified solution for both planar documents and curved documents and can be applied in mobile, camera-based document analysis applications. This method consider three assumptions; first the document page should contain a sufficient printed text content. Second, the document is flat or smoothly curved. And third, the camera is a standard pin-hole camera in which the x-to-y sampling ratio is the principal point that located at the image center.

Tsoi et al. [11] proposed a multi view document rectification method. This is a new technique that uses multiple images of bounded and folded documents to rectify the imaged content such that it appears flatten and photometrically uniform. This approach works from a sparse set of uncalibrated views of the document which are mapped to a canonical coordinate frame using the documents boundary. A composite image is constructed from the canonical views which significantly reduces the effects of depth distortion without blurring artifacts. In addition, a new technique to estimate the illumination of variation in the individual images allowing the final composited content to be photometrically rectified. This approach is straight-forward, robust, and it produces good results.

III CONCLUSION

Isometric mesh construction is a method used to rectify the non-linear geometric distortion in camera captured images such as perspective, page curl etc. It is a straight forward method for image rectification. It is insensitive to viewing angles, shapes of document pages and camera positions. This isometric mesh is constructed from printed horizontal text lines in the document page. A general cylindrical surface (GCS) method is used to model curved page shape. To flatten the curved image a mesh based image warping technique is used. Here a paraperspective projection is used to approximate non-linear perspective projection

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