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A Survey on Quality Assessment And Enhancement of Document Images

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Abstract: *With the advancement of technology, there has been a tremendous rise in the volume of captured and distributed content. Image acquisition can be done with the help of scanners, cameras, smart phones, tablets etc. Document retrieval and recognition systems require high quality document images but most of the time, the images acquired suffer from various degradations like blur, uneven illumination, low resolution etc. To reduce the processing time and get good results, we require methods to evaluate and improve the quality of such images. This paper reviews the quality assessment methods and enhancement techniques for document images. It presents a survey of the work that has been performed in the field of document image quality assessment and enhancement.*

Keywords: Document image processing, Quality assessment , OCR accuracy, Camera captured documents

1. Introduction

Capturing of documents using a handheld camera is preferred to acquiring images by scanning these days for no contact images, flexibility and low cost involved. But quality of camera captured documents is lower than scanned documents as camera acquired documents contain various degradations such as blur, perspective distortions, character smear, uneven lightning etc. But the application areas cannot be ignored such as digitization of books, digitization of historical documents, finding text in scene images, mobile OCR etc. Document image quality assessment is a measure of text distortion. It is necessary to evaluate the quality of a document image to save the processing time by any document recognition system. Low quality documents give poor results. Document images contain various degradations such as blur, uneven illumination, perspective distortion, low resolution, smear etc. Hence there is requirement of enhancement algorithms for improving the quality of degraded images for enhancing the readability of the documents as well as improve the performance of document processing systems. Therefore this paper is an attempt to review the various quality assessment and enhancement methods for document images. It is divided into three sections. Section II covers quality assessment methods and metrics while section III focuses on quality assessment techniques whereas section IV concludes the work with direction of future work.

2. Quality Assessment of Document Images

Quality assessment refers to the process of evaluating the image quality with some metrics based on different features. There is a mandatory need of maximizing the readability of the document images. Since some images are degraded in the process of acquisition,

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we need assessment methods so that enhancement can be performed. While some of the metrics correlate OCR accuracy with the degradations, other view it through human perception. Hence we have various methods for quality assessment in document images. There are broadly three image quality assessment methods: full reference, reduced reference and no reference methods. The full reference methods need a high quality image to assess the quality in comparison, reduced reference methods require some properties of the high quality image based on which the quality of an image can be assessed. Whereas no reference methods pose no requirement for a high quality image as they evaluate quality solely based on the properties of the input image. We have a greater need for no reference methods as we do not have a high quality image always available as required strictly in case of full reference methods while some. The major assessment methods reviewed from the previous work are as follows:

Xujun *et al.* [1] presents a method to estimate image quality by measuring the degree of degradation. It deals with blurring as well as several other degradations found in camera captured document
images. The method predicts the impact of degradations on OCR error rate.

Jayant *et al* [2] created a dataset of camera captured documents containing various blur levels. A case study was also performed with three quality estimation methods for the prediction of OCR quality and their advantages and disadvantages were evaluated.

Tayo *et al.* [3] presents an objective user centred function that evaluates the distortion level in a
document image. It focuses on human perception of quality which is required in case of historical images.

Rusinol *et al.* [4] focuses on the estimation of focus quality as a metric for quality estimation to predict OCR accuracy. Gradient based features are found to correlate best with OCR engines response.

Amina [5] presents a blur image quality metric based on MMD which is a nonlinear transform and the blur is treated as convolution noise.

Taegeun *et al.* [6] proposes a no reference method for predicting perceptual quality of camera captured images based on spectral statistics..

Ke *et al.* [7] presents a no reference image quality metric which combines two existing quality assessment models, one being the free energy based and the other based on structural degradation.

Qing *et al.* [8] focuses on a no reference blur assessment method related to perception utilizing the feature termed as GPS(Gradient Profile Sharpness)

Ming-Jun *et al.* [9] concentrates on no reference image quality assessment based on multi resolution decomposition methods. It takes into account natural scene statistics.

Karen *et al.* [10] brings out a new no reference image contrast feature to help in selecting the best operating parameters for image enhancement algorithm.

Table 1 lists out the various quality assessment methods and their unique focus areas as some of the methods take blur into consideration, while some deal with a mix of degradations.

Table 1. Summary of Various Quality Assessment methods

S.No	Author	Year	Source	Major Findings
1	Xujun *et al*	2011	IEEE	It presents a new no-reference image QA method that evaluates the impact of degradations in an image on OCR error rate.
2	Jayant *et al*	2013	CBDAR	It provides with a publically available database of camera captured documents containing various levels of blur. 3 image QA approaches are evaluated to bring out the best.
3	Tayo *et al*	2012	IEEE	It proposes a user centred objective function to evaluate level of degradation in a document image. This is a human perception of quality metric.
4	Rusinol *et al*	2014	IEEE	It focuses on a QA metric that estimates focus quality for processing in OCR and considers out-of-focus blur.
5	Amina *et al*	2011	IEEE	It presents a no-reference blur image QA metric based on MMD.
6	Taegeun *et al*	2014	IEEE	It proposes a no-reference QA metric based on spectral statistics.
7	Ke *et al*	2013	IEEE	It presents a no-reference QA metric that combines 2 previous QA models.
8	Qing *et al*	2013	IEEE	It concentrates on a no reference image blur QA metric which is perceptual and based on GPS.
9	Ming-Jun *et al*	2009	IEEE	It presents a no-reference QA metric that takes into account natural scene statistics.
10	Karen *et al*	2013	IEEE	It focuses on a no-reference QA metric that provides new features for selecting optimal parameters.

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2. Quality Enhancement of Document Images

Images acquired from handheld cameras suffer from a lot of degradations such as blur, uneven illumination, perspective distortion, low resolution, character smear etc. Degradations lead to low readability, deteriorated recognition and hampers the performance of a document processing system. Hence it becomes necessary to enhance these images in order to remove these degradations or reduce their effect so as to achieve higher OCR accuracy in most of the cases. While some of the researchers have worked on improving the binarization technique which is an initial step before OCR, others have worked on specific issues like blur, illumination, resolution etc. The previous work done in this area is summarized as follows:

Bukhari *et al.* [11] proposes a new adaptive binarization technique for distorted camera captured documents. Global binarization is found to give better results for degraded camera captured documents.
Utpal *et al*[12] presents an image enhancement method for historical documents based on ICA to improve their OCR accuracy.
Fabian *et al.* [13] focuses on enhancement of ancient handwritings whose images are taken through multispectral scan and then their dimensionality is reduced utilizing LDA; the method is then evaluated using OCR.
Soo-Chang *et al.* [14] presents an image enhancement method that focuses on removal of uneven illumination using EMD(Empirical Mode Decomposition).
Aishwarya *et al.* [15] presents a method for enhancing the region of an image using specular reflection. This method focuses on the scene images and deals with the degradations that are caused by light.
Henry *et al*. [16] presents a technique for image enhancement of camera captured document images. It addresses poor illumination, fading and noise and helps in achieving improved OCR accuracy.
Zhan *et al.* [17] proposes a resolution enhancement algorithm based on interpolation to improve recognition rate in a document with low resolution.
Chethan *et al.* [18] presents an image enhancement technique for lightning correction and improve data quality for camera captured documents using homomorphic and morphological filtering.
Khairunnisa *et al.* [19] proposes an enhancement technique for a low contrast image and focuses on insufficient light using fuzzy technique by modifying the membership function. The method is found to perform in minimum processing time when compared to others.
Nibal *et al.* [20] proposes an image enhancement method for removing blur by making use of sparse based methods using non local means for document images.
Jian *et al.* [21] proposes an image enhancement algorithm based on watershed segmentation for solutions such as lightning correction and color correction as well as text sharpening.
Gaofeng *et al.* [22] brings out a new method for correcting geometric distortions in camera captured document images with the help of two structured beams.
Anand *et al.* [23] focuses on solution of OCR issues related to camera captured images and also provides a solution for the detection of misaligned text.

Table 2 lists out the various quality enhancement techniques, what degradations they deal with and what is the use for each technique.

S.No	Author	Year	Source	Major Findings
1	Bukhari *et al*	2011	Journal	It proposes a new adaptive binarization technique to improve OCR processing for distorted document images.
2	Utpal *et al*	2013	IEEE	It presents an image enhancement method for historical documents based on ICA to improve OCR accuracy.
3	Fabian *et al*	2012	IEEE	It discusses an image enhancement technique using LDA for multispectral scans to improve OCR accuracy.
4	Soo-Chang *et al*	2014	IEEE	It focuses on an image enhancement technique to correct uneven illumination in text images using EMD.
5	Aishwarya *et al*	2011	IEEE	It presents an image enhancement techniques for scene images utilizing specular reflection.

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6	Henry *et al*	2014	IEEE	It presents an image enhancement technique called retinex to address poor lightning,noise and fading to improve OCR accuracy.
7	Zhan *et al*	2013	IEEE	It proposes a resolution enhancement technique using interpolation to improve recognition.
8	Chethan *et al*	2013	IEEE	It addresses uneven illumination, color abnormalities and poor data quality using homomorphic filters.
9	Khairunnisa *et al*	2009	IEEE	It deals with inadequate lightning by modifying membership function in fuzzy logic and has minimum processing time.
10	Nibal *et al*	2013	IEEE	It provides a technique to remove blur using non local means to improve OCR accuracy.
11	Jian *et al*	2007	CBDAR	It corrects poor illumination, uneven color and performs text sharpening.
12	Gaofeng *et al*	2014	CVPR	It provides a method to correct geometric distortions using 2 structured beams.
13	Anand *et al*	2009	Springer	It provides a solution for detecting misaligned text.

3. Conclusion

There exist various quality metrics for document images and OCR accuracy is found to be an important quality indicator for document images. Since camera captured document images suffer from degradations such as blur, uneven lightning, low resolution etc. Though there have been some enhancement techniques developed to enhance the OCR accuracy of these images, most of them address blur. Therefore there is a requirement of more enhancement techniques that deal with various degradations and help in improving the OCR accuracy rate of camera captured document images. Further work can be done in the direction of creating enhancement algorithms that deal with various types of degradations and doing work related to out of focus camera captured images as major work has been done for motion blur and out of focus images still need more attention to be enhanced and get better results.

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