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Sturdy Binarization Method to Enhance Historic Document Images

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Abstract: In this paper, a sturdy binarization model for historic documents and manuscripts is proposed, The three main steps in this proposed method are: preprocessing, main binarization, and post-processing. The preprocessing step mainly involves image denoising followed by some morphological operations. Then, we use the phase congruency features for the main binarization step. After completing the binarization steps on the input images using phase congruency features and a denoised image, finally the enhancement processes are applied as post-processing. The complete experimental consequences on different data sets display the sturdiness of the proposed binarization method on diverse kinds of degradation and document images.

Keywords: Binarization, phase congruency features, document enhancement, robustness.

I. INTRODUCTION

Protecting and storing an abundance of olden historically important documents and manuscripts is one of the Library's primary jobs. However many environmental causes, improper handling, and the poor quality of the materials used in their creation cause them to suffer a excessive measure of degradation. Nowadays, there's a strong move towards digitization of these manuscripts to preserve their content for future. The large quantity of digital data produced may need automatic processing, enhancement and recognition. A key step in all document image processing is binarization.

Binarization is a process where each pixel in an image is converted into one bit and assign the value as '1' or '0' depending upon the mean value of all the pixel. If pixel value greater than mean value then its'1' otherwise its'0' as binary image is a digital image that has only two possible values for each pixel. When a pixel is selected in an image, a sensitivity is added to or subtracted from the value concerning the value of the selected pixel to set a threshold value range. Next, when another pixel is selected, the sensitivity is added to or subtracted from the value concerning the value of the selected pixel and a new threshold value range is set containing the calculation result and the already setup threshold value range. The pixel with the value concerning the value of any pixel in the image within the threshold value range is extracted as the same brightness as the selected pixel and the extraction result is displayed.

For the ensuing document image processing tasks, a fast and accurate document image binarization technique is important. Many research studies have been carried out to unravel the issues that arise in the binarization of old document images characterized by many types of degradation, including faded ink, bleed-through, show-through, and uneven illumination. Moreover there are variations in pattern of hand written and machine printed documents that raise the difficulties related to the binarization of historic document images.

Fig. 1. Sample degraded historic document image

To the best of our knowledge, none of the proposed methods can deal with all types of documents and degradation. In this paper, a sturdy binarization method is proposed for the binarization and enhancement of historical documents and manuscripts.

II. LITERATURE REVIEW

In this section, we describe some of the binarization methods.

A. Adaptive Binarization Method

Gatos et al proposed this binarization method based on low-pass filtering, foreground estimation, background surface computation, and a combination of these. This method is used to extract useful information from document images, especially those poor quality ones with non-uniform illumination, low contrast, undesired shadows and random noise, by formulating the binarization decision in terms of contrast instead of gray values.

B. Lu's Method

This binarization method is proposed by Lu et al which is mainly based on background estimation and stroke width

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estimation. First, the background of the document is estimated by means of a one-dimensional iterative Gaussian smoothing procedure. Then, for accurate binarization of strokes and sub-strokes, an L1-norm gradient image is used. This method won the DIBCO 2009 competition and was one of the first methods to make a breakthrough in text binarization.

C. Su's Method

Su et al proposed this binarization method using local maximum and minimum to build a local contrast image. Then, a sliding window is applied across that image to determine local thresholds. A version of this method shared 1st place with another method, out of 17 algorithms entered in the H-DIBCO'10 contest. In a local contrast image is combined with a Canny edge map to produce a more robust feature map. This method performs better than above binarization methods.

However various binarization methods more than these, has been significant research activity attempting to improve the data from old degraded historical documents. In practice, the perfect solution is however impossible as the none of existed binarization methods can deal with all types of documents and degradation and also less efficiency since they produces rough binarization. In this paper we introduce a new approach that overcomes these problems.

III.PROPOSED METHOD

The proposed binarization method is an extended version of the existed binarization methods. In this method The final binarized output image is obtained by processing the input image in three steps: 1) Preprocessing, 2) Main Binarization, and 3) Postprocessing. The flowchart of the proposed binarization method is shown in Fig. 2 and each step is discussed individually in the subsections below.

A. Preprocessing

In the preprocessing step, we use a denoised image instead of the original image to obtain a binarized image in rough form increasing 5% improvement, normalized denoised image and also a canny edge map.

Denoised Image: An image denoising method proposed by Kovesi is used in this paper, which is based on the assumption that phase information is the most important feature of images. It uses non-orthogonal, complex valued log-Gabor wavelets, which extract the local phase and amplitude information at each point in the image. The denoising process consists of determining a noise threshold at each scale and shrinking the magnitudes of the filter response vector appropriately.

Normalized Denoised Image: We used Otsu's method on the normalized denoised image, where normalized denoised image is obtained by applying a linear image to transform on the denoised image. This approach can also remove noisy and degraded parts of images, because the denoising method attempts to shrink the amplitude information of the noise component. The problem with this approach is that it misses weak strokes and sub-strokes. So to solve this problem, we combine this binarized image with an edge map obtained using the Canny operator.

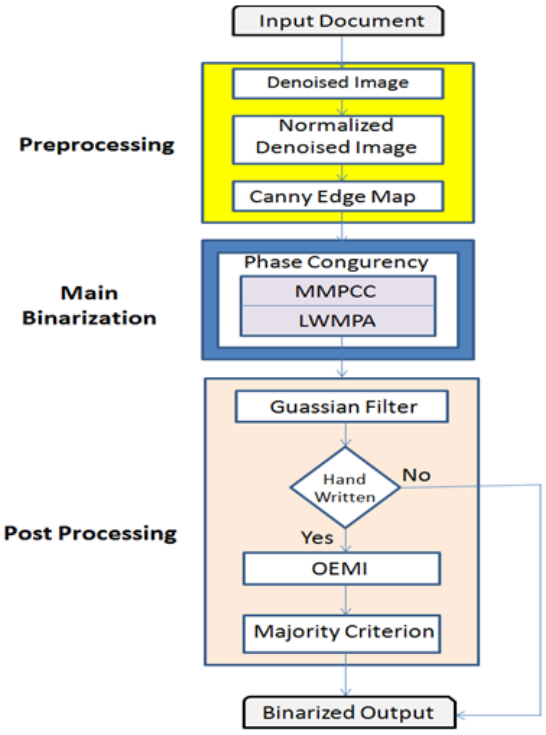

Fig. 2. Flowchart of proposed binarization method

Canny Edge Map: This step uses canny operator which is applied on the original document image for removing those combinational edges without any reference in the aforementioned binarized image. We then compute a convex hull image of the combined image. At the end of this step, the structure of foreground and text is determined. However, the image is still noisy, and the strokes and sub-strokes have not been accurately binarized.

B. Main Binarization

The next step is the main binarization, which is mainly based on phase congruency features: the maximum moment of phase congruency covariance (MMPCC) and the locally weighted mean phase angle (LWMPA).

Maximum Moment of Phase Congruency Covariance: In this paper, MMPCC is used to separate the background from potential foreground parts. This step performs well, even in badly degraded documents, where it can reject a majority of badly degraded background pixels by means of a noise modeling method.

Locally Weighted Mean Phase Angle: The LWMPA is also based on Kovesi's phase congruency model which says that the pixels of interest are at those points where the phase of the Fourier components is at its maximal. However this feature map is used to compute the local phase and the local amplitude of the transform at a given wavelet scale.

C. Postprocessing

In this step, we apply enhancement processes. This step mainly consists of gaussian filter, median filter, object exclusion map image (OEMI) and majority criterion.

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Adaptive Gaussian Filter: The Gaussian smoothing filter is used to obtain a local weighted mean as the reference value for setting the threshold for each pixel. We use a rotationally symmetric Gaussian low-pass filter to further enhance the binarization output and to separate background from foreground.

Document Type Detection: At this step, we determine the type of input document we are dealing with. Here we propose to apply the enhancement processes that are after this step to the handwritten documents only, and not to machine printed documents. We use the standard deviation of the orientation image that was produced during calculation of the phase congruency features. By considering the foreground pixels of the output binary image obtained, we see that the standard deviation value of the orientations for these pixels is low for handwritten document images and higher for machine-printed documents.

Object Exclusion Map Image: The IOEM is based on a combination of a median filter and a binary map. By using binary map any object without a reference in this map will be removed from the final binarization results. This approach can remove noise, local bleed-through, and interfering patterns. And a median filter can reject salt-and-pepper noise in the presence of edges.

Majority Criterion: The majority criterion is mainly based on a denoised image. It supposes that early binarization steps to provide an optimal or near optimal recall value. Then, based on the fact that a foreground pixel should have a lower value than its adjacent background pixels, exclusion over the foreground pixels is performed.

IV. RESULTS

The proposed binarization method is evaluated on a number of old degraded document images to retrieve the data from various types of degradation.

Fig. 3. (a) An old degraded document image;
The outputs of (b) Preprocessing, (c) Main Binarization, and (d) Postprocessing.

The following Fig. 3. shows one of the historic document adapted to the proposed method consists of three major steps: preprocessing in which image is denoised, main binarization which mainly uses phase congruency features and post processing for enhancement of an image.

The results obtained using the proposed method on different historic document images shows the sturdiness of our method compared to all other binarization methods like adaptive binarization method, Lu's method, Su's method, multi-scale binarization method and so on.

V. CONCLUSION & FUTURE WORK

In this paper, we introduced an image binarization method that uses the phase information of the input image, and phase-based features extracted from that image. Phase-preserving denoising followed by morphological operations are used to preprocess the input image. Then two phase congruency features are used to perform the main binarization. For post-processing, we have proposed a few steps to filter various types of degradation for enhancement of an historic document image. Moreover the method has been tested and our experimental results demonstrate its promising performance. In future, we plan to expand the application of phase binarization features for retrieving the data by preserving its colour.

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