International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 08 | Aug -2017 www.irjet.net p-ISSN: 2395-0072

Restoration of Old Documents That Suffer From Degradation

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Abstract - *Here I propose a new approach for foreground/background separation to restore degraded ancient documents suffering from recto/verso transparency. This approach is used to process single-sided documents and proceeds in three steps: The first step aims to separate between the background and foreground of the image by a contrast enhancement using gamma correction and histogram stretching. The second step consists in separating the final foreground and the remaining noised pixels. Separation between the initial resulting foreground and the remaining background regions by comparing RGB component with original document, followed by its correction using ostus method, the third step allows the reconstruction of the final restored image using the obtained foreground and background. The new approach presents the advantage of the accuracy of its results.*

Key Words: RGB, Ostus method, Contrast Stretching, Gamma Correction.

1. INTRODUCTION

Ancient documents are a witness of past civilizations. They represent a valuable cultural and scientific heritage. This heritage allows the transmission of knowledge from one generation to another, performing the human evaluation. Therefore, safeguarding and preserving this heritage is of paramount importance. Unfortunately, most of the documents have incurred a progressive degradation and are facing a real danger of disappearance. They suffer from multiple physical degradations that may be biological, chemical or of human origin. Thus, several physical restoration techniques have been used to address these degradations. Indeed, these techniques can reinforce the document supports and slowdown its ageing. However, these techniques represent temporary solutions, which require qualified competences and which can introduce, amongst others, side effects on the processed documents.

To tackle this disadvantage, digitization has been the most adequate solution allowing both the preservation of the patrimonial documents and their diffusion. Digitization brings in these context large possibilities of image processing for their analysis and dissemination for the general public on inexpensive supports. Moreover, it enables the search for information in an easier and more effective way compared to the methods used with the documents on a physical support. In the same way, the duplication of digital data is carried out very quickly without any loss of information.

Here it is targets the restoration of the degradations which includes scanning noise, aging effects, uneven background or foreground, etc.

2. ARCHITECTURE

In the architecture diagram there are four main steps:
1. Loading image document

2. Background extraction

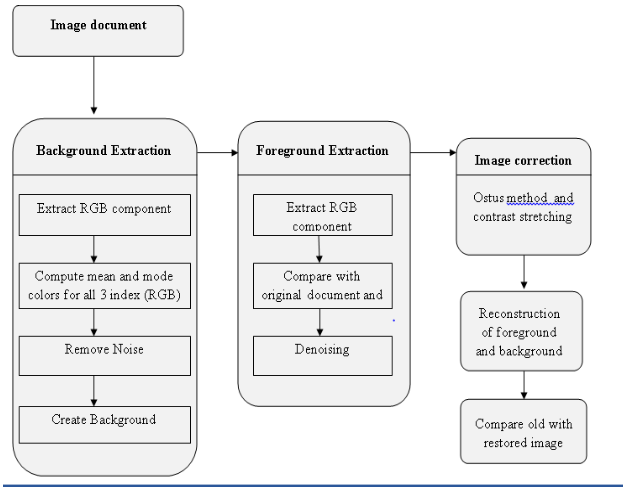


FIG 2.1

3. Foreground extraction

4. Image correction

All the steps are carried out one after the other and then the image is reconstructed with new background and foreground and then the results are compared with original document.

3. ALGORITHM DESIGN

Step1. Load data for restoration

Step 2.Extract background from the detoriated image

Step 3.Extract foreground from the image

Step 4.Perform Gama correction

Step5. Perform Contrast stretching

Step 6.Reconstruction of image by combining output

Step 7.Compare result i.e. to compare old document with restored document

Step 8.Exit from the menu

3.1 Load data

- In load data module an image document is loaded for restoration.
- Image is loaded my interactive method by accessing only images from the directory
- Once the loading of an image is completed then “Done loading image” message is displayed on the screen

3.2 Extract background

- When the image is loaded then red component, green component and blue component of the image are taken for both background and foreground.
- To get only background for processing, background is subtracted from foreground and all subtracted image are added.
- Now the process is to change background. Mean and mode operation is performed and values are extracted.
- A new background is constructed using extracted values, eliminating all uneven background colors.

3.3 Extract foreground

- When the image is loaded then red component, green component and blue component of the image are taken for both background and foreground.
- To get only foreground for processing, background is subtracted from foreground.
- Now the process is to get the normalized denoised image. And the original image is binarized using ostu’s method.

3.4 Gamma correction

Gamma correction, or often simply gamma, is the name of a nonlinear operation used to encode and decode luminance or tristimulus values in video or still image systems. Gamma correction is, in the simplest cases, defined by the following power-law expression:

$$V_{\text{out}} = AV_{\text{in}}^{\gamma} \qquad \text{........(i)}$$

Gamma correction of images is used to optimize the usage of bits when encoding an image, or bandwidth used to transport an image, by taking advantage of the non-linear manner in which humans perceive light and color. The human perception of brightness, under common illumination conditions (not pitch black nor blindingly bright), follows an approximate power function (note: no relation to the Gamma function), with greater sensitivity to relative differences between darker tones than between lighter ones, consistent with the Stevens' power law for brightness perception. If images are not gamma-encoded, they allocate too many bits or too much bandwidth to highlights that humans cannot differentiate, and too few bits or too little bandwidth to shadow values that humans are sensitive to and would require more bits/bandwidth to maintain the same visual quality. Gamma encoding of floating-point images is not required (and may be counterproductive), because the floating-point format already provides a piecewise linear approximation of a logarithmic curve.

Although gamma encoding was developed originally to compensate for the input–output characteristic of cathode ray tube (CRT) displays, that is not its main purpose or advantage in modern systems. In CRT displays, the light intensity varies nonlinearly with the electron-gun voltage. Altering the input signal by gamma compression can cancel this nonlinearity, such that the output picture has the intended luminance. However, the gamma characteristics of the display device do not play a factor in the gamma encoding of images and video—they need gamma encoding to maximize the visual quality of the signal, regardless of the gamma characteristics of the display device. The similarity of CRT physics to the inverse of gamma encoding needed for video transmission was a combination of luck and engineering, which simplified the electronics in early television sets.

3.5 Contrast stretching

Contrast stretching is a common technique, and can be quite effective if utilized properly. In the field of medical imaging or scanned documents, an x-ray camera that consists of an array of x-ray detectors creates what are known as digital radiographs, or digital x-ray images. The detectors accumulate charge (which manifests itself as a larger pixel intensity) proportional to the amount of x-ray illumination they receive, which depends on the quality of the x-ray beam and the object being imaged. A high-density object means less x-rays pass through the object to eventually reach the detectors (hence the beam is said to be attenuated), which results in such higher density areas appearing darker **is a common technique,** and can be quite effective if utilized properly. In the field of medical imaging, an x-ray camera that consists of an array of x-ray detectors creates what are known as digital radiographs, or digital x-ray images. The detectors accumulate charge (which manifests itself as a larger pixel intensity) proportional to the amount of x-ray illumination they receive, which depends on the quality of the x-ray beam and the object being imaged. A high-density object means less x-rays pass through the object to eventually reach the detectors (hence the beam is said to be attenuated), which results in such higher density areas appearing darker.

3.6 Reconstruction

- Processed background and foreground image is taken,
- Then both of them are clubbed together to form a reconstructed or restored image.

3.7 Compare

- Previously loaded image and output image re put side by side to compare.
- Difference can be seen from old degraded image to restored image.

3.8 Exit

- Exits from the menu bar.
- If exit is not done properly then loop will not be terminated.

4. Methodologies

4.1 Ostu's Method

Method: This type of thresholding is global thresholding. It stores the intensities of the pixels in an array. The threshold is calculated by using total mean and variance. Based on this threshold value each pixel is set to either 0 or 1. i.e. background or foreground. Thus here the change of image takes place only once.

The following formulas are used to calculate the total mean and variance.

The pixels are divided into 2 classes, C1 with gray levels [1, ...,t] and C2 with gray levels [t+1, ... ,L].The probability distribution for the two classes is:

$$C_1: \; p_1/w_1(t), \ldots, p_t/w_1(t) \text{ and}$$
$$C_2: \; p_{t+1}/w_2(t), \ldots, p_L/w_2(t)$$

$$\text{Where } w_1(t) = \sum_{i=1}^{t} p_i$$

$$\text{and} \quad w_2(t) = \sum_{i=t+1}^{L} p_i$$

Also, the means for the two classes are

$$\mu_1 = \sum_{i=1}^{t} i p_i / w_1(t)$$

$$\text{and} \quad \mu_2 = \sum_{i=t+1}^{L} i p_i / w_2(t)$$

Using Discriminate Analysis, Otsu defined the between-class variance of the thresholded image as

$$\sigma_B^2 = w_1 (\mu_1 - \mu_T)^2 + w_2 (\mu_2 - \mu_T)^2.$$

For bi-level thresholding, Otsu verified that the optimal threshold t* is chosen so that the between-class variance B is maximized; that is,

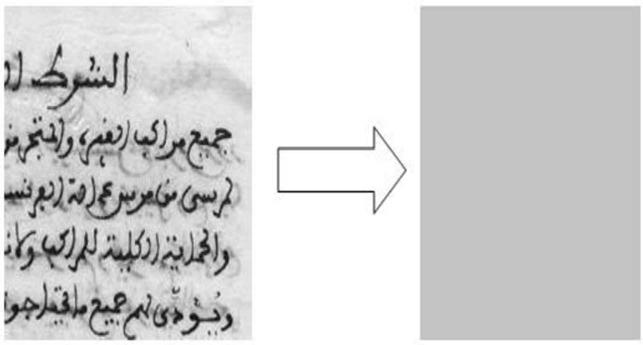
$$t^* = \underset{1 \le t < L}{Arg\,Max} \{\sigma_B^2(t)\}$$

Performance (with respect to our experiments): Otsu works well with some images and performs badly with some. The majority of the results from Otsu have too much of noise in the form of the background being detected as foreground. Otsu can be used for thresholding if the noise removal and character recognition implementations are really good. The main advantage is the simplicity of calculation of the threshold. Since it is a global algorithm it is well suited only for the images with equal intensities. This might not give a good result for the images with lots of variation in the intensities of pixels.

5. Results

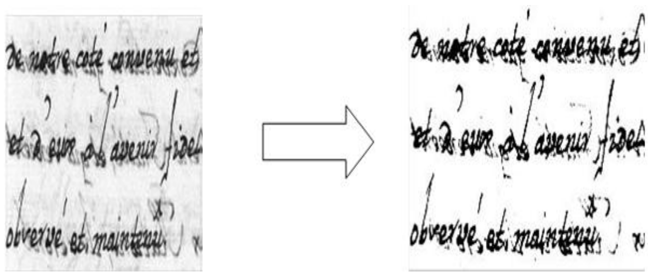
Following are the results showing the outcome at each step and the final result can be compared which is obtained after completion of all actions

5.1.1 Background extraction:



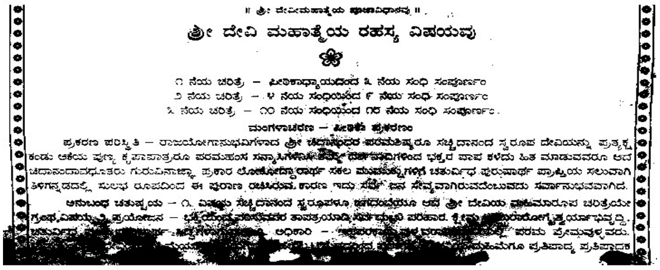
(a) (b)

5.1.2 Foreground separation

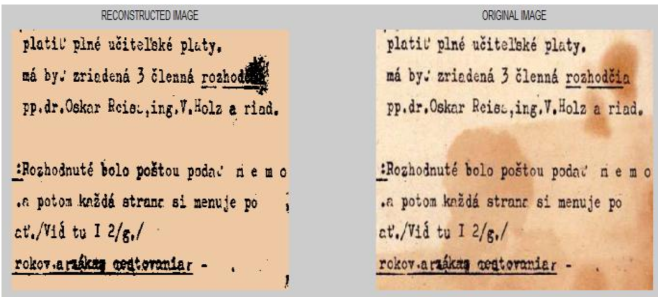


(a) (b)

5.1.3 Gama correction and contrast stretching



5.1.4 Final result and comparison



6. Conclusion

In this system, we have put forward a hybrid approach for restoring images of ancient documents, with irregular background and some transparency degradation. This approach occurs in three stages: a first separation between the foreground and the background based on, gamma correction and histogram stretching, a second separation between the initial resulting foreground and the remaining background regions by comparing RGB component with original document, followed by its correction using ostus method and the reconstruction of the final restored image. The different tests and experimentations have shown that the results are satisfactory and encouraging. The developed tool can be improved to meet other needs in dealing with other problems.

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BIOGRAPHIES

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