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Enhancement of Document Images using Geometrical Operations and Bilateral Filter

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***Abstract*: Medical report is a requisite document for health care professionals in diagnosis, long-term monitoring and patient assessment. Electronic records are suitable for keeping up-to-date, accurate and complete records. For predicting diseases from the medical report, several parameters like age, gender, symptoms, etc. must be known. The relevant data required is extracted using optical character recognition. The idea behind this system is to extract relevant data from the medical report and predict the diseases from the collected data-set. The major step examined here is the pre-processing stage that includes deskewing, equalization, thresholding and denoising.**

***Keywords*: Document Image Processing, Pre-processing, Deskewing, Equalization, Thresholding, Denoising**

1. Introduction

Text extraction from images have been a major topic in the field of Computer Vision. Text in images provides high information that can work as the basis for a variety of applications, yet the accuracy of text extraction is influenced by the quality of the images. When considering the creation of digital copies of handwritten notes, the quality of an image remains a major factor affecting the accuracy of text extraction. As a result, the commercial applications of this technology has been limited. Pre-processing techniques are usually layered on top of other functions to further enhance the text extraction quality. In this paper, we study the outcome of basic pre-processing techniques that are used in document image processing.

2. Related Works

Pre-processing techniques are applied on gray level and binary document images i.e., binary images containing graphics or text [1]. In character recognition systems most of the applications use gray or binary images since processing color images is more difficult and time consuming. Those images also contain non-uniform background which makes the extraction of the document text from the image difficult without performing some kind of pre-processing. Therefore, the desired result from pre-processing is a binary image containing text only. Correction and detection of skewness is important. There are many factors for skewness in document images [2]. Traditional Histogram equalization (THE) is a known technique for enhancing the contrast of an image [3]. In various fields such as medical image processing and radar image processing histogram equalization is applied [4].

There are cases which require higher brightness preservation and are not handled by Histogram Equalization(HE), Brightness Preserving Bi-Histogram Equalization (BBHE), Root Mean Square Value of Histogram Equalization (RMSHE) and Dualistic Sub-Image Histogram Equalization (DSIHE).

The Minimum Mean Brightness Error Bi-Histogram Equalization (MMBEBHE) is a novel extension of BBHE. The idea lies on separating the histogram using the threshold level that would yield minimum Absolute Mean Brightness Error (AMBE). The utmost goal behind the MMBEBHE is to allows maximum level of brightness preservation in Bi-Histogram Equalization to avoid unwanted artifacts and irregular enhancement due to excessive equalization while enhancing the contrast of a given image as much as possible [5], [6].

Document image thresholding is performed in the pre-processing stage for document analysis [7]. There are various global and local thresholding methods available such as Ni-black, Sauvola method and Otsu's Method. Otsu's method is a global thresholding method. That finds the threshold which separates the gray-level histogram in optimal way into two classes, foreground class and the background class, then calculates the threshold value [8]-[10].

Ni-Black is the local thresholding method. It divides the histogram of the image into two probability distributions, one that represents the text and the other that represents the background [8]. The drawback of this method is that it suffers from the problem of local thresholding, because it provides unwanted details of the binarized images that might not be necessary for the processing.

Sauvola method is a local thresholding method. It solves the black noise problem, depends on the impact on the standard deviation value by using a range of gray-level values in the images [8].

3. Pre-Processing of Document Images

In order to extract the necessary information from the

document images, Pre-processing is an important step, as extraction from a noisy environment would have less accuracy. The steps include deskewing, equalization, thresholding and denoising.

A. *Deskewing*

Deskewing is basically the process of removing skews from the images [11]. Skew may occur in scans because of the camera fault, misalignment in the scan or because the placement of the paper was not completely flatted when scanned. Deskewing is also called auto straighten.

Geometric corrections eliminate flaws due to curve, simple imaging setups produces geometric distortions in the resultant 2D images because of the non-planar geometric shapes of some documents. Geometric correction also corrects the effect of crushing of the characters.

B. *Equalization*

Equalization is a technique used for contrast enhancement. Contrast Limited Adaptive Histogram Equalization(CLAHE) is a novel method for enhancing medical images. It is a variant of adaptive histogram equalization. Increasing the contrast and preventing over amplification is the advantage of CLAHE [11], [12]. The algorithm partitions the images into contextual regions and applies histogram equalization to each region. This evens produce the distribution of used gray values and thus make hidden features of the image more visible.

C. *Thresholding*

Thresholding is a process that converts a color or gray-scale image into a binary image. Thresholding is applied before OCR, because the contrast between binary image allows an OCR engine to more easily differentiate eloquent detail from the background. In thresholding gray scale or color images are represented as binary images by picking a thresholding value. In this paper we are using a combination of Otsu's thresholding method. It selects threshold by minimizing the within-class variance of the two groups of pixels separated by the thresholding operator.

Algorithm of Otsu's method [13]:

1. Calculate probabilities and histogram of each intensity level.
2. Set up initial $\mu_i(0)$ and $\omega_i(0)$.
3. Step through all possible thresholds maximum intensity
    1) Update μ_i and ω_i.
    2) Calculate $\sigma_b^2(t)$.
4. Desired threshold corresponds to the maximum $\sigma_b^2(t)$.

D. *Denoising*

After performing all the above pre-processing steps there may be some amount of noise remaining in the document images. Noise deteriorates image quality and also result in loss of important information hidden in images. Hence the denoising step is important. So for denoising the document images we use bilateral filter to make the document ready for the further steps involved. Bilateral filter is pixel-based approach i.e., it makes a nonlinear combination of similar pixel values. It reduces the blurriness while working with color images. It preserves the edge by removing noise [14].

The equation for bilateral filter is [14], [15]:

$$I^{\text{filtered}}(x)=1/W_p \Sigma I(x_i) f_r(|| I(x_i)-I(x)||) g_s(||x_i - x||)$$

After this morphological closing operation is performed on the filtered image. Morphological closing operation is done in order to remove small holes from the image. In mathematical morphology closing operator is very important which can be derived from fundamental operation of erosion and dilation [16].

4. Experimental Results

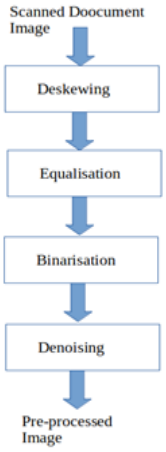

Fig. 1. Pre-processing stage

Fig. 2. Original Image of medical report

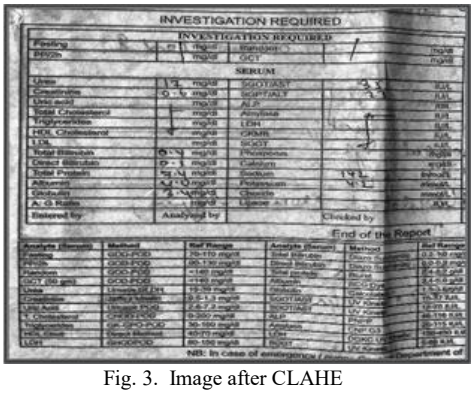

Fig. 3. Image after CLAHE

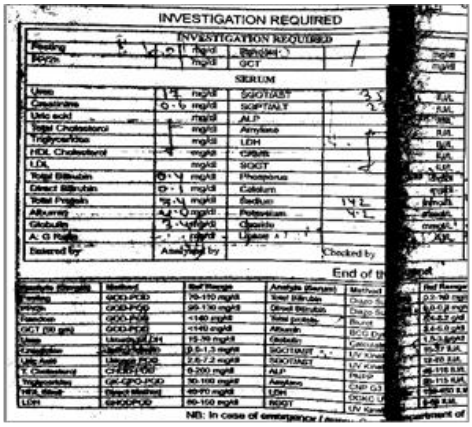

Fig. 4. Otsu thresholding

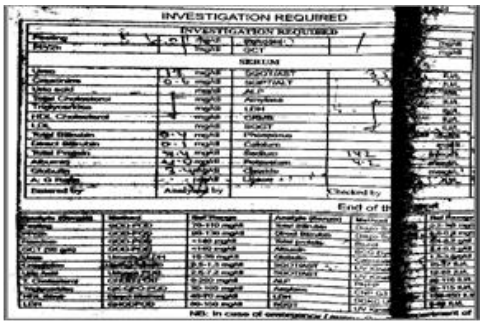

Fig. 5. Bilateral filter

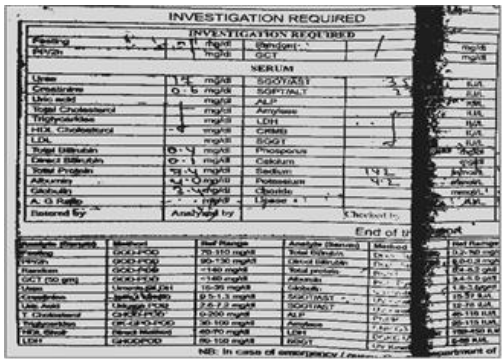

Fig. 6. Morphological closing

5. Conclusion

Pre-processing is an essential process in any architecture that includes the extraction of information from a document image. According to the requirement of the applications various different pre-processing techniques are used and developed. In this paper we do an in-depth study of different pre-processing methods that are required for document image processing. From the study it is found that optimal result can be obtained using Contrast Limited Adaptive Histogram Equalization with Bilateral Filtering and Otsu's Thresholding.

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