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AN EMPIRICAL STUDY ON BINARIZATION OF NATURAL SCENE WORD IMAGES USING TRADITIONAL METHODS

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ABSTRACT. Text extraction from ever increasing multimedia content is very helpful for a number of applications such as location information, content based information retrieval, intelligent transport and text-to-speech systems to name a few. Binarization is an essential pre-processing operation, whose results may greatly affect the output of text extraction systems. In this study, four well-known document based binarization algorithms have been tested for their suitability to natural scene word images. Results on a dataset of 100 Gurmukhi word images shows that Otsu algorithm outperforms as compared to other three methods.

1. INTRODUCTION

Text extraction from natural scene images is very challenging and require more sophisticated techniques as compared to document images due to innate nature of irregular susceptible environment, unspecific text location and colour [1]. The natural scene image content has increased tremendously in last few years due to rapid growth in mobile phone penetration across the nations. The research community has shown a great interest in testing the existing document analysis methods and propose the newer techniques for processing text in scene images [2]. Few example natural scene images are shown in Figure 1.

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(A) Both Roman and Gurmukhi script words

(B) Gurmukhi script words only

FIGURE 1. Natural scene images containing text

Binarization is a process to convert the grayscale image into two-tone logical image consisting of black and white pixel values corresponding to foreground and background respectively. Binarization is an object segmentation technique, which is based on supposition that object and background are clearly distinguishable from differences of their gray levels [3]. Traditional thresholding based binarization techniques are generally classified either as local or global [4]. Global thresholding uses a single intensity value to partition the objects and background in whole image. While in local thresholding, a different threshold value is calculated for a local neighborhood of the image instead of a single value and different parts of the image are segmented this way. Global methods are generally faster as compared to local ones and produce good results for fine quality document images. While local methods such as adaptive binarization are more suitable for degraded and camera captured images having uneven intensity [5].

Binarization is one of the pre-processing steps in optical character recognition and document analysis [6]. Binarization is normally carried out to speed up computation and economize memory space [7]. Document image binarization has been studied extensively in the past and is quite a mature field. Still a method for binarization of scene image with comparable accuracy is not available till date [8]. Selecting a suitable binarization technique for scene text is very difficult, as scene images usually suffer from noise and various degradations.

In this paper, performance evaluation of four traditional thresholding based binarization algorithms has been tested on natural scene word images. The aim of the study is to test the suitability of existing binarization methods on scene images containing text. The paper is organized as follows. Section 2 describes the sample dataset images used for the current study and Section 3 describes the methodology adopted. Comparative results of four methods are presented in Section 4 and Section 5 presents the conclusion and future scope of work.

2. DATASET

Though binarization results are not affected by a particular script, but the scope of current study is limited to scene images containing Gurmukhi text, as author's interest lies primarily in this field [9]. Due to absence of any standard dataset of Gurmukhi scene images, the natural scene images as described in an earlier study [9] are used to test the performance of various binarization methods. The scene images have been self-captured in an open environment under good lighting conditions and manual segmentation has been carried out to obtain individual word images. These word images have varying resolution and size as shown in Figure 2.

FIGURE 2. Sample Gurmukhi scene word images

3. METHODOLOGY

Four existing thresholding methods have been selected for the scope of current study for a fair representation of well-known algorithms and existing results on document images [10]. The binarization algorithms are:

(i) Otsu, a global thresholding technique [11]

(ii) Niblack, a well-known adaptive local binarization method [12]
(iii) Sauvola, a local thresholding method [13]
(iv) Bradley, a local thresholding method [14]

The experiments have been conducted in MATLAB on pre-segmented scene word images. The coloured word image has been first converted to grayscale image using inbuilt MATLAB function *rgb2gray*, as binarization methods cannot be applied directly onto colured images. The otsu threshold value has been calculated with MATLAB inbuilt function *graythreh* and image has been binarized with *im2bw* function. MATLAB implementation of Niblack [15], Bradley [16] and Sauvola [17] has been used respectively to test the results. The four methods have been tested on various scene text images and the results have been compared qualitatively.

4. Results & Discussion

The four existing binarization algorithms have been tested to analyses their performance and suitability for scene text images. The results have been evaluated based on visual observation with respect to image quality. The results are shown in Figure 3.

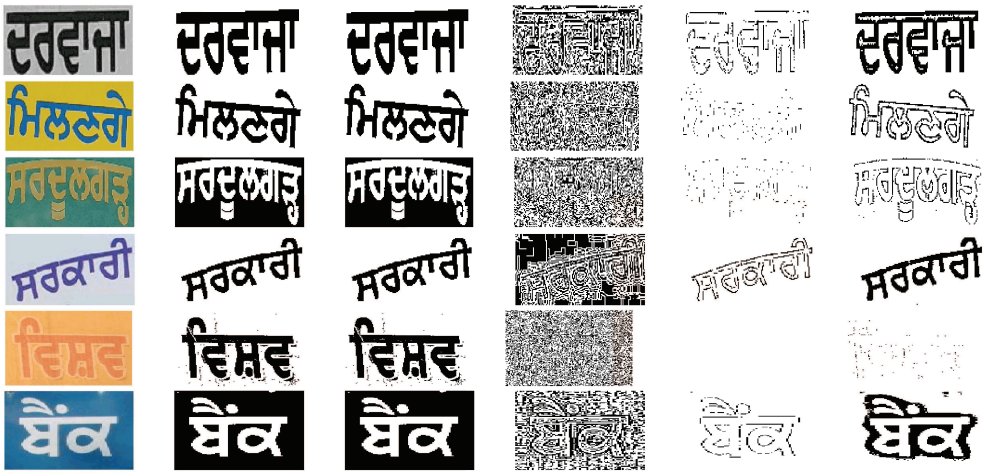

Figure 3. Comapring Binarization results on various thresholding algorithms, from left to right: Original image, Graysclae, Otsu, Niblack, Bradely and Sauvola

The following observations can be drawn on the basis of results of experimentation:

(i) The global thresholding algorithm Otsu outperform all other methods for a fine quality image.
(ii) The adaptive binarization algorithm Sauvola performs very well on those images where there is adequate difference between the intensity values of background and foreground objects.
(iii) Bradely technique works well for only those images having white background.
(iv) Niblack approach does not produce satisfactory results for most of the images.

The percentage accuracy results of binarization are shown in Table 1 as calculated visually.

TABLE 1. Table showing %age accuracy of various methods

Method	**Otsu** [11]	**Sauvola** [13]	**Bradley** [14]	**Niblack** [12]
Accuracy (%age)	82	55	34	5

5. CONCLUSION

Four most commonly used binarization algorithms have been selected for the current study and experiments have been performed on self-captured dataset of scene images containing Gurmukhi text. The visual results shows that Otsu method is able to binarize majority of the dataset images. Sauvola also works well for images having enough intensity difference.

In future, a suitable technique may be proposed for binarization of low resolution scene images which give better results as compared to traditional methods.

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