Volume 5, Issue 6, June 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Survey of Image Binarization Techniques

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Abstract— Document binarization is a dynamic research area from a long time. The decision of the most fitting binarization technique for every case is a difficult task. An overview of image binarization techniques is presented in this paper. A comprehensive survey is given. Existing techniques of binarization concentrate either on discovering a global threshold or adjusting a local threshold for every area keeping in mind the end goal to uproot smear, strains, uneven brightening and so on.

Keywords—Binarization, global thresholding, local thresholding, binary image.

I. INTRODUCTION

Historical documents are valuable source of information however they suffer from many degradation like strains, uneven brightening, ink leakage and seepage etc. From decades, a few scientists have proposed different thresholding methods for binarization of images. Processing of documents of very poor quality due to degradation has been found in literature. Accurate binarization of images is vital for separating the frontal area object from the background. A decent binarization will bring about better recognition accuracy for pattern recognition applications.

Binarization techniques are divided into two groups according to utilization of thresholding methods. One group use global thresholding and the other group use local thresholding. Thresholding is a method of converting a gray-scale image into a binary image by specifying threshold values.

Fig 1. Thresholding

The group that is using global thresholding will use a fixed value of threshold throughout the image where as the group that is using local thresholding uses local thresholds. The techniques that use global threshold works good when the content possesses a large part of the picture and is very much differentiated from the background. Local binarization methods can deal with uneven illumination and content color variations better than global thresholding.

II. EXISTING BINARIZATION TECHNIQUES

Binarization is a topic of research since a decade. There are many algorithms but still none of them provides good results for every image. Some of the existing binarization techniques are discussed below:

1. Otsu

Otsu is the most efficient global thresholding method and was presented in 1979. It basically looks at the histogram of an image. It considers the pixel values and the property to obtain segments. We need uniform pixel values, therefore this method does not look for the edges instead, it looks for the regions inside the segments that we want to segment out. This method is not utilized in case of non-uniform background. Still, to get the rid of problems with non-uniform background, Otsu can be used but in segments by using a moving window. Moving window moves from different regions and then thresholds are computed for each region. In case of overlapping window an average of thresholds is calculated [2].

2. Kitler

This method was proposed by Kittler and Illingworth in 1986. This algorithm is used in case of a discriminant object from background in grayscale images. Background and object class conditional probability density functions are assumed to be normal distributions. This algorithm resolves the Gaussian density fitting problem with minimum error and works by assuming the variance of Gaussian density function as unequal. Error for the fusion of two Gaussians is classified by using a histogram. Kitler method finds the optimal threshold at which the probability of classification error is minimum. This method is satisfied if the object and background are precisely differentiated in terms of grey levels [9].

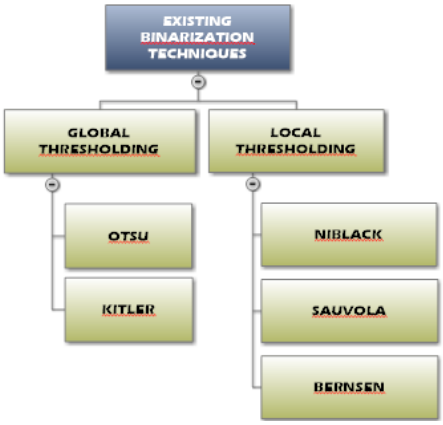

Fig 2. Existing Binarization Techniques

3. Niblack

In this method, a pixel-wise threshold is calculated by using a moving window on a grey-level image. Standard deviation s and mean m of every pixel in the window is calculated, and then threshold is computed by using these values as follows [3]:

$$T = m + k * s$$

Where T is the threshold value, k is a constant whose value lies between 0 and 1. Quality of binarization is defined by the value of k and the size of moving window.

4. Sauvola

Sauvola is a local thresholding algorithm. Local threshold is calculated by computing local standard deviation and local mean. Sauvola's method is an alteration of Niblack's method which is guaranteed to give enhanced performance on documents with uneven illumination, light texture and large variations. Threshold is calculated by using a dynamic range of standard deviation, R as follows [8]:

$$\boldsymbol{T = m * (1 + k (s/R - 1))}$$

where k is a constant, s is standard deviation and m is mean.

5. Bernsen's Method

This method computes the local threshold value by using the mean value of the maximum and minimum intensities of pixels inside a window. When the window is focused at the central pixel(x,y) then, threshold for image I(x,y) is defined as follows:

$$T(x, y) = \frac{Z_{max} + Z_{min}}{2}$$

Z_{max} is the maximum intensity and Z_{min} is minimum intensity of the window. This threshold works appropriately just when the contrast is huge [7]. Contrast is the difference between Z_{max} andZ_{min} [11].

III. RECENT BINARIZATION TECHNIQUES

Recently many new binarization techniques have been proposed. Some of them are as discussed below:

1. Wolf

Wolf et. al, proposed a new method of binarization which works with semantic knowledge so that more accurate results can be obtained. This method is used for binarization of content based images and videos. This method is used for binarization of text boxes. The text included in images and videos are used to get semantic knowledge. In this algorithm, artificial text is localized in videos and images by utilizing gradients. In order to detect this text, morphological operations are performed and the quality of text is improved by robust multiple frame integration [7].

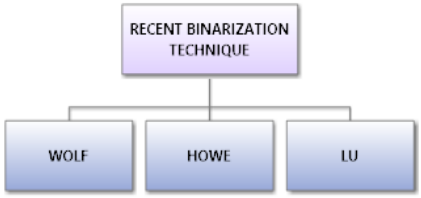

Fig 3. Recent Binarization Techniques

2. Howe

Existing techniques in literature provide results that vary for each image. Howe proposed an algorithm that can cut total error by one-third with regard to the baseline version. Results of several binarization techniques are often proved to be sensitive to the parameters but this algorithm describes an automatic technique for setting the parameters in a manner that match them to the each individual image [6].

3. Lu

Shijian Lu et. al, proposed a novel binarization technique for extracting useful data from degraded documents. In this technique, adaptive image contrast and canny's edge detector are used. Canny's edge detector is used to detect text stroke edge pixels. Adaptive image contrast is amalgamation of local image contrast and local image gradient. This algorithm requires minimum parameter tuning [5].

IV. BINARIZATION TECHNIQUES FOR NATURAL IMAGES

Several algorithms have been proposed to read text from natural images and natural scenes. These methods are used in various applications like robotics, intelligent transport system etc. Following are some of the popular techniques that have been used for image retrieval and reading text from the natural scenes:

Fig 4. Extraction of text from natural scenes[12]

1. Ezaki

Ezaki et al., proposed a framework that reads the text experienced in natural scenes with the mean to give help to visually impaired and blind persons. Automatic text recognition from natural images gets a developing consideration in light due to its applications in robotics, image retrieval and smart transportation system. Firstly, the system tries to find out the image areas having little text. At that point it zooms into the discovered areas to retake higher resolution pictures for the purpose of character recognition [12].

2. Gatos

Gatos et al., presents an objective evaluation methodology for document image binarization techniques that aims to reduce the human involvement in the ground truth construction and testing. A skeletonised ground truth image is produced by the user following a semi-automatic procedure. The estimated ground truth image can aid in evaluating the binarization result in terms of recall and precision as well as to further analyse the result by calculating broken and missing text, false alarms and deformations [10].

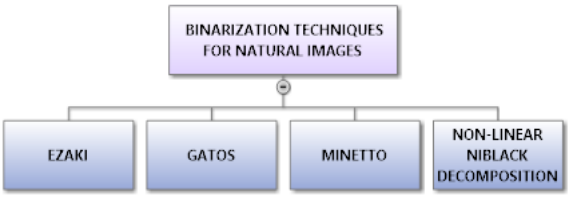

Fig 4. Binarization techniques for natural images

3. Minetto

Text detection and recognition in real images taken in unconstrained environments, such as street view images, remain surprisingly challenging in Computer Vision. Minetto et al., present a comprehensive strategy combining bottom-up and top-down mechanisms to detect text boxes. The bottom-up part is based on character segmentation and grouping. The top-down part is achieved with a statistical learning approach based on box descriptors. A new descriptor, Fuzzy HOG (F-HOG) is fully adapted for text box analysis. To retrieve a location from a textual query: a combination of text box detection technology with OCR on geo referenced street images; a GIS1 system with a fully automatic textual indexing is achieved [1].

V. CONCLUSION

A complete survey of binarization techniques is provided in the paper. Techniques existing in literature are discussed. Recent techniques that are used for binarization now-a-days are elaborated. Text from natural scenes and images are also extracted by using binarization techniques. Binarization techniques for extracting text from natural scenes are also described. In future work, we will use these techniques for binarization of degraded document images.

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