Improvement in image enhancement using recursive adaptive Gamma correction

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ABSTRACT - *The "Adaptive Approach for Historical or Degraded Document Binarization" is that in which Libraries and Museums obtain in large gathering of ancient historical documents printed or handwritten in native languages. Typically, only a small group of people are allowed access to such collection, as the preservation of the material is of great concern. In recent years, libraries have begun to digitize historical document that are of interest to a wide range of people, with the goal of preserving the content and making the documents available via electronic media. But for historical documents suffering from degradation due to damaged background, stained paper, holes and other factors, the recognition results drop appreciably. These recognition results can be improved using binarization technique. Binarization technique can differentiate text from background. The simplest way to get an image binarized is to choose a threshold value, and organize all pixels with values greater than this threshold as white, and every other pixels as black. The problem arises, how to select the correct threshold. The selection of threshold is performed by two methods: Global, Local. Our main focus is to effectively binarize the document images suffering from strain & smear, uneven backround, holes & spot and various illumination effect by applying Adaptive Binarization Techniques. Our objectives is to Study various Traditional Binarization Techniques and to develop a hybrid binarization technique which will be more efficient than traditional techniques in term of noise suppression, text extraction and enhance the document to make it better for readability & automatic Document analysis. Result is analyzed and obtains which conclude that.*

Keyword: *Global, Local, Binarization, illumination, hybrid Binarization, historical documents.*

1. Introduction

Images are the most common and convenient means of conveying or transmitting information. An image is significance a thousand terms. Pictures in brief convey information on positions, sizes and inter-relationships among objects. They describe spatial information that we can recognize as objects. Human beings are superior at derive information from such images, because of our native visual and mental abilities. About 75% of the information received by human is in pictorial form.

The image enhancement is one of the significant techniques in digital image processing. It has an important role in many fields such as medical image analysis, remote sensing, high description television, hyper spectral image processing, microscopic imaging etc [21]. The contrast is the difference in visual properties that distinguish an object from other object and from the background. In other words, it is the difference between the darker and the lighter pixels of image. If the difference is large the image will have high contrast otherwise the image will have low contrast. The contrast enhancement increases the total contrast of an image by making light colors lighter and dark colors darker at the same time. It does this by surroundings all color components below a specified lower bound to zero, and all color components above a particular upper bound to the maximum intensity i.e. 255. Color components between the upper and lower bounds are set to a linear ramp of values between 0 and 255. Because the upper bound must be larger than the lower bound, the lower bound must be between 0

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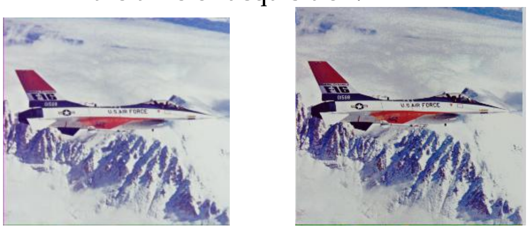
and 254, and upper bound must be between 1 and 255. Enhanced image can also be described as if a curtain of fog has been removed from the image [19].

There are a number of reasons for an image to have poor disparity:

- The device used for imaging is of poor quality.
- Lack of expertise of the operator.
- The undesirable outside conditions at the time of acquisition.



Original Image Enhanced Image

Figure 1.1: Image Enhancement

Image enhancement is among the simplest and most appealing areas of digital image processing. Fundamentally, the idea behind enhancement techniques is to bring out detail that is hidden, or simply to highlight certain features of interest in an image. An example of enhancement is shown in Figure in which when contrast is increased and filtering is done to remove the noise it looks better from input image.

Contrast Enhancement Methods

Image enhancement methods based on redistributing the probability densities are indirect methods of contrast enhancement. In these methods, the image intensities can be redistributed within the dynamic range without defining a specific contrast term. Histogram modification techniques are most popular due to their easy and fast implementation [2]. In these methods histogram equalization (HE) is one of the most frequently used technique. The fundamental principle of Histogram equalization is to make the histogram of the enhanced image to have approximately uniform distribution so that the dynamic range of the image can be fully exploited. However the original HE always causes several problems:

• It lacks of adjustment mechanism to control the level of the enhancement and cannot make satisfying balance on the details between bright parts and dark parts.

• It may over enhance or generate excessive noise to the image in certain applications.

• It may sometimes dramatically change the average brightness of the image.

Various methods have been published to limit the level of contrast enhancement in Histogram Equalization (HE). Most of them are carried out through modifications on the HE. For example, in the Brightness preserving Bi- Histogram Equalization (BBHE) [26], two separate histograms from the same image are formed and then equalized independently, where the first one is the histogram of intensities that are less than the mean intensity and the second one is the histogram of intensities that are greater than the mean intensity. BBHE can reduce the mean brightness variation. In Dualistic Sub-image Histogram Equalization (DSIHE) [42], two separate histograms are created according to the median gray intensity instead of the mean intensity. Although DSIHE can maintain the brightness and entropy better, but both DSIHE and BBHE cannot adjust the level of enhancement and are not robust to noise. Consequently, several problems will emerge when there are spikes in the histogram. The Recursive Mean Separation Histogram Equalization (RMSHE) [12] enhances image by iterating BBHE. The mean intensity of the output image will converge to the average brightness of the original image when the iteration increases. Accordingly the brightness of the enhanced image to the original image can be maintained much better. Although the methods mentioned above can often increase the contrast of the image, these approaches usually bring some undesired effects.

In [2] the technique known as Adaptive gamma correction using weighting distribution (AGCWD) was presented that modify histograms and enhance contrast in digital images. In this paper, a hybrid HM (histogram modification) method was proposed by combining TGC (Transform based gamma correction) and THE (Traditional histogram equalization) methods. In this method cumulative distribution function (CDF) is utilized directly and normalized gamma function is applied to modify the transformation curve. In adaptive gamma correction (AGC) method compensated CDF is used as an adapted parameter. The AGC method increases low intensity and avoids significant decrement of high intensity. In Weighting distribution the input histogram or probability distribution function (PDF) is modified in such way that the infrequent gray levels are given relatively more probabilities (or weights) than the frequent gray levels. Results of paper showed that this method produced enhanced images of comparable or higher quality than those produced using previous methods.

In recursively separated and weighted histogram equalization (RSWHE) method preserves the image brightness and enhances the image contrast. RSWHE first segments the histogram into two or more sub histograms recursively based on the mean or median of image. Then the histogram weighting module modifies the sub histogram through weighting process and then the histogram equalization module equalizes the weighted sub histograms independently. The recursive separation helps in preservation of mean brightness.
The research worked is focused on improving brightness of images by preserving mean brightness and avoiding unfavorable artifacts by integrating RSWHE and AGCWD methods.

2. Literature Survey

Stark J.A (2000), in this paper proposes a scheme for adaptive image contrast enhancement based on a generalization of histogram equalization (HE). HE is a useful technique for improving image contrast, but its outcome is too rigorous for many purposes. However, significantly diverse results can be obtained with relatively minor modifications. A brief explanation of adaptive HE is set out, and this outline is used in a conversation of past suggestions for variations on HE. A key characteristic of this formalism is a “cumulating function,” which is used to produce a gray level map from the local histogram [37].

Chen S.D, et.al, (2004) proposed an extension of BBHE referred to as minimum mean brightness error bi-histogram equalization (MMBEBHE). MMBEBHE had the feature of minimizing the difference between input and output image’s mean. MMBEBHE can preserve brightness better than BBHE and DSIHE. MMBEBHE has limitation of high computational complexity. Hence, this paper further proposed a generalization of BBHE referred to as recursive mean-separate histogram equalization (RMSHE). RMSHE was featured with scalable brightness maintenance. [12]

Celik T, et.al, (2011) proposed an algorithm which enhances the contrast of an image using inter pixel contextual information. The algorithm uses a two dimensional (2D) histogram of the input image constructed using mutual relationship between each pixel and its neighboring pixels. Then a smooth 2D target histogram is obtained by minimizing the sum of Frobenius norms of the differences from the input histogram and the uniformly distributed histogram. Diagonal elements of the input histogram are mapped to the diagonal elements of the target histogram to achieve enhancement. [8]

He .R, et al., (2011) developed a new method for image contrast enhancement. The novelty of this method was that the weighted average of histogram equalization and exponential transformation are combined and the level of the contrast improvement is adjustable by changing the weighting coefficients. The proposed algorithm achieved adjustable contrast enhancement for color image and also weakened the situation of lacking color due to the risen of intensity, thus increasing the image saturation. [21]

Chauhan R, et.al, (2011) showed brightness preserving weight clustering histogram equalization (BPWCHE) can simultaneously preserve the brightness of the original image and enhance visualization of the original image. BPWCHE assigns each one non-zero bin of the original image histogram to a take apart cluster, and computes each cluster's weight. Then, to decrease the number of clusters, use this criterion to merge pairs of neighboring clusters. The clusters acquire the identical partitions as the resulting image histogram. Lastly, transformation functions for each cluster's sub-histogram are calculated based on the traditional HE method in the new acquire partitions of the resulting image histogram, and the sub histogram gray levels are mapped to the result image by the corresponding transformation functions showed that BPWCHE can preserve image brightness and enhance visualization of images more effectively than Histogram Equalization. [6]

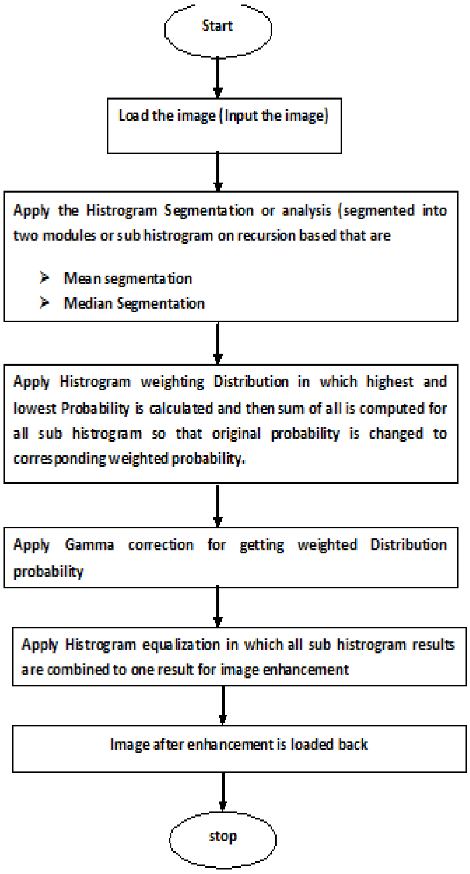
Ravichandran, et.al (2012), in this Histogram based image enhancement technique is mainly based on equalizing the histogram of the image and increasing the dynamic range corresponding to the image. As a result, such image creates side-effects such as washed out appearance and false contouring due to the significant change in brightness. In order to rise above these troubles, mean brightness preserving, in these methods partition the histogram of the original image into sub histograms and then independently equalize each sub histogram with Histogram Equalization which as contrast enhancement in low illumination environment and are collected using low light environment images so, the histogram modification algorithm is simple and computationally effective that makes it easy to implement and use in real time systems [34].

3. Research methodology

The technique to enhance images will be implemented using MATLAB. MATLAB is a tool for numerical computation and visualization. The basic data element is matrix. An image in MATLAB is treated as a matrix. MATLAB has built in support for matrices and matrix operations, rich graphics capabilities and a friendly programming language and development environment. In image contrast enhancement following steps will be followed:

1. Image acquisition.
2. Calculate histogram of image.
3. Apply improved technique on histogram of image.
4. Obtain enhanced image.
5. Performance measure of method by calculating various parameters.

Flow chart of Proposed Algorithm



4. RESULT AND DISCUSSION

The proposed algorithms has been experimentally worked out on gray scale images as well as on color images. Our performance on is meseaured with various parameters such as PSNR. MSE, AMBE which are tested on images of gray sclae and color. In each testing image we have used all image enhancement techniques such as Histogram equalization (HE), Brightness preserving bi histogram equalization (BBHE) and Recursively separated and weighted histogram equalization (RSWHE) for comparing our results. These techniques are compared using parameters PSNR (Peak Signal-to-Noise Ratio), MSE (Mean Square Error) and AMBE (Absolute Mean Brightness Error). Comparison of these techniques on grayscale images is shown in Figure 4.1 and comparison on color images is shown in Figure 4.2.

4.1 RESULTS ON GRAYSCALE IMAGES

Figure 4.1: Comparison on Grayscale test images for Couple image, War-plane image, Girl image

The values of Parameters i.e quality metrics for the gray scale images had been inputed by the proposed algorithm and existing techniques which is shown in table 4.1, 4.2, 4.3. from the table below it is verfied that PSNR, MSE, ABME values are better of our proposed method as compared to the existing techniques.

TABLE 4.1

PSNR (Peak Signal-to-Noise Ratio)

Images	HE	BBHE	RSWHE (r=2)	AGCWD (r=0, g=0)	Rec+AGCWD (r=2,g=0) (Proposed)
Couple image	64	64	70	66	72
War-plane image	58	61	69	59	71
Girl image	72	72	70	72	73

TABLE 4.2

MSE (Mean Square Error)

Images	HE	BBHE	RSWHE (r=2)	AGCWD (r=0,g=0)	Rec+AGCWD (r=2,g=0) (Proposed)
Couple image	2.38	2.37	6.70	1.51	4.27
War-plane image	9.49	4.65	8.95	8.57	5.60
Girl image	3.68	3.89	6.82	2.25	2.95

TABLE 4.3

AMBE (Absolute Mean Brightness Error)

Images	HE	BBHE	RSWHE (r=2)	AGCWD (r=0,g=0)	Rec+AGCWD (r=2,g=0) (Proposed)
Couple image	4.30	7.30	1.78	9.47	1.10
War-plane image	4.78	1.46	1.86	5.44	9.04
Girl image	5.32	7.90	1.91	8.93	1.24

The performance of image contrasting or enhancing technique is compared through the evaluation of quantitative mesure such as MSE,PSNR and AMBE quality metrics. There is large improvement in the value of PSNR (Peak Signal to Noise Ratio) for our proposed algorithm as compared to other techniques. As MSE (Mean Square error) and AMBE (Absolute Mean Brightness Error) is less in case of proposed algorithm for all the images shown above in figure 4.1 of gray scale.

CONCULSION

Recursive Mean-Separate Histogram Equalization (RMSHE) with scalable brightness preservation is analyzed with HE and BBHE. Histogram analysis providing spatial information of single image, based on probability and statistical inference. Main goal is to provide high level brightness preservation to unpleasant artifacts and equalization while enhancing contrast. By using weighting distribution we smooth fluctuant for avoiding generation of unfavorable artifacts. Automatically gamma correction is used for smoothing curves. It also reduces computational time. The analysis shows that the output mean will converge to the input mean as the number of recursive mean-separation increases. This allows scalable degree of preservation range from 0% (output of HE) - 100% (getting back the original image). In real life applications, the variety of image involve are often too wide to be covered with only a specific level of brightness preservation.

FUTURE WORK

The work, up to the current stage has shown how it enhances the images, next our purposed method is to work on Novel enhancement method video sequences. It also suggested is to look into proper mechanism to automate the selection of the recursion level that gives optimum output. This thesis also suggests looking into the effective implementation of RMSHE, in the similar fashion of how Quantized Mean-Separate HE [5] has been proposed as a cost reduced implementation for BBHE.

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