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   RESEARCH METHODOLOGY

   RESULTS & DISCUSSION

   FINDINGS

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FACE DETECTION IN NIGHT VISION IMAGES: AN APPLICATION OF BPDFHE METHODOLOGY

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ABSTRACT

In this era, the importance and usage of face detection has reached its apex as it finds a lot of applications in Surveillance, Biometrics, Social Networking Sites, photo tagging, password protection, security etc. Scholars in the field of digital image processing are facing huge challenge to prescribe a methodology that is simple to implement and relatively faster to operate in 'subjective contrast enhancement' of an image. This paper attempts to detect face in Night-Vision Images. Although there are a few existing 'complex but not robust' methodologies for face detection in Night-Vision Images, we have attempted to present a simple, efficient but faster approach for the same. As a part of preprocessing, this study grossly follow the Histogram equalization methodology for enhancement of the contrast of image and specifically the Brightness preserving dynamic fuzzy histogram equalization technique (BPDFHE) proposed by Sheet et al,2010. The process followed by the authors is not complex to implement and is faster than the other widely used methods for detecting face in night time images. Furthermore, the process works best in a controlled environment and when only the face is exposed with a little exposure of skin.

KEYWORDS

Global Histogram Equalization, Dynamic Histogram Equalization, Preserving Dynamic Histogram Equalization, Brightness Preserving Dynamic Fuzzy Histogram Equalization, Flood Fill.

1. INTRODUCTION

Face Detection, irrespective to the time of capturing the image, can have a huge implementation on the fields of Surveillance, photo tagging, password protection and security. Scholars in the field of digital image processing are facing huge challenge in prescribing a methodology that is simple to implement and relatively faster to operate in 'subjective contrast enhancement' of an image. The design of the Face detection Device is expected to be based on a common hardware platform that uses minimum system resources. This paper is a humble attempt in this area of research.

As a part of preprocessing we would grossly follow the Histogram equalization methodology for enhancement of the contrast of image. In general, the main objective of an image enhancement is either to identify the hidden image details or to enhance the image contrast. Histogram equalization (HE) is very popular and widely used technique for enhancing contrast of image since HE is computationally fast and simple to implement [1, 2]. Special Digital Cameras are required to capture the Night-time Images and then the image can be easily processed in a personal computer with very limited resources.

2. SURVEY OF LITERATURE

Although the HE is very popular technique but it has some limitations. The use of HE is rarely suggested in some consumer electronic applications like, video surveillance, digital camera, television, etc., as HE tends to introduce some noisy artifacts and artificial enhancement, including intensity saturation effect [3]. One of the probable reasons for these type of problems is that the HE normally changes the brightness of the image significantly and makes the output image saturated with very bright or dark intensity values.

In order to preserve the essential qualities of image, several improved brightness preserving histogram equalization techniques have been proposed. R. C. Gonzalez et. al [4] introduced Global Histogram Equalization (GHE), it introduces major changes in the image gray level when the spread of the histogram is not significant and cannot preserve the mean image-brightness.

Kim proposed brightness preserving bi-Histogram equalization technique (BBHE) [5], which parts the input image histogram into two on the basis of the mean of the input image, and subsequently each part is equalized independently resulting preservation of the mean brightness as the original mean brightness is not disturbed and retained as such. Using median of the input image brightness in partitioning histogram ,Wan et al. posited dualistic sub-image histogram equalization technique (DSIHE), [6]. The technique, on other counts, is similar to BBHE . Chen and Ramli proposed minimum mean brightness error bi-histogram equalization (MMBEBHE), which is nothing but an extension of the BBHE method [7]. This algorithm finds the minimum mean brightness error between the original and the enhanced image. It employs the optimal point as the separating point instead of the mean or median of the input image. Though these methods can perform good contrast enhancement, they also cause more annoying side effects depending on the variation of gray level distribution in the histogram. Recursive mean separate HE (RMSHE) is another improved version of BBHE [8]. Unlike BBHE, recursive methodology is propped to separates the histogram into multi-sub-histograms instead of two sub-histograms. Initially, two sub-histograms are created based on the mean brightness of the original histogram. Next, the mean brightness of the two sub-histograms obtained is used as the second and third separating points. The process is posited to continue until the desired numbers of sub-histograms are created. Then, the HE approach is applied independently on each of the sub-histograms. In sum, although the mean brightness is well preserved by the methods discussed above but they cannot substantially expand the region of sub-histogram located nearer to the minimum or maximum value of the dynamic range. The methodologies are not free from the shortcomings like, washed-out appearance, undesirable checkerboard effects, etc.

Abdullah-Al-Wadud et al. introduced a dynamic histogram equalization (DHE) technique [9] which is claimed to be superior than the above mentioned methods to tackle the detected limitations of the partitioned HE methodologies . DHE partitions the original histogram based on local minima. However, DHE also suffers from many limitations and fails to preserve the proper brightness of images. Recently, Ibrahim and Kong proposed brightness preserving dynamic histogram equalization (BPDHE) technique [10].This method partitions the image histogram based on the local maxima of the smoothed histogram. It assigns a new dynamic range to each partition and finally the output intensity is normalized to make the mean intensity of the resulting image equal to the input one. The BPDHE , in general, performs well in preserving the mean brightness, the ratio for brightness normalization plays a vital role in the whole game. A small ratio value fails to enhance the contrasts significantly and a large ratio value (more than 1) may cause to exceed the maximum intensity value of the output dynamic range. The exceed pixels quantized the maximum intensity value of gray levels and produce intensity saturation problem (in general, in widely used software's environment like, MATLAB).

Brightness preserving dynamic fuzzy histogram equalization technique (BPDFHE) has been proposed by Sheet et al. which is an enhanced version of BPDHE [11]. The BPDFHE technique manoeuvres the image histogram in such a way that no remapping of the histogram peaks occurs; only redistribution of the gray-level values in the valley portions between two consecutive peaks occurs. The results using BPDFHE method depicts well-enhanced contrast and little artifacts. The fuzzy logic-based histogram equalization technique is suggested to use for both gray scale and color images as it drastically reduces the unwanted over enhancement of brightness and noise amplifying and improves the local contrast of the original image. First, fuzzy histogram is computed using fuzzy set theory. Second, the fuzzy histogram is separated into two based on the median value of the original image. Finally, the HE approach is applied independently on each sub-histogram to improve the contrast.

This paper chooses BPDFHE technique over the other histogram equalization techniques for its merits to study and suggest a method in detecting face in night vision images. The methodologies discussed in this paper are very popular and widely used in literature. Detailed elaboration and symbolic presentation of the methodologies referred above are seems to be excess as the detailed discussions are also available in text books. The remainder of this paper is organized as follows.

The proposed methodology, algorithm for fuzzification and enhancement and results are presented in Section III and Section IV concludes this paper.

3. EMPIRICAL METHODOLOGY, ALGORITHM AND RESULTS:

This paper basically is concerned to detect a face in a night-time image. Recognition of the face by extracting its morphological features is beyond the scope of this paper. The methodology comprises of very basic and simple steps. After surveying the major literature we choose BPDFHE technique suggested by Sheet et al[11] over all the other techniques because: i).it works well for noisy images, ii) contrast enhancement is appropriate for night time images and iii) mean brightness of the image is preserved since the peaks in the histogram are not tampered.

Folowing Sheet et al, [11], the methodology used in this study consist of the following steps:

i. Histogram equalization of Input image using BPDFHE that involves:

a). Fuzzy Histogram Computation.

b). Partitioning of the Histogram.

c). Dynamic Histogram Equalization of the Partitions.

d). Normalization of the image brightness.

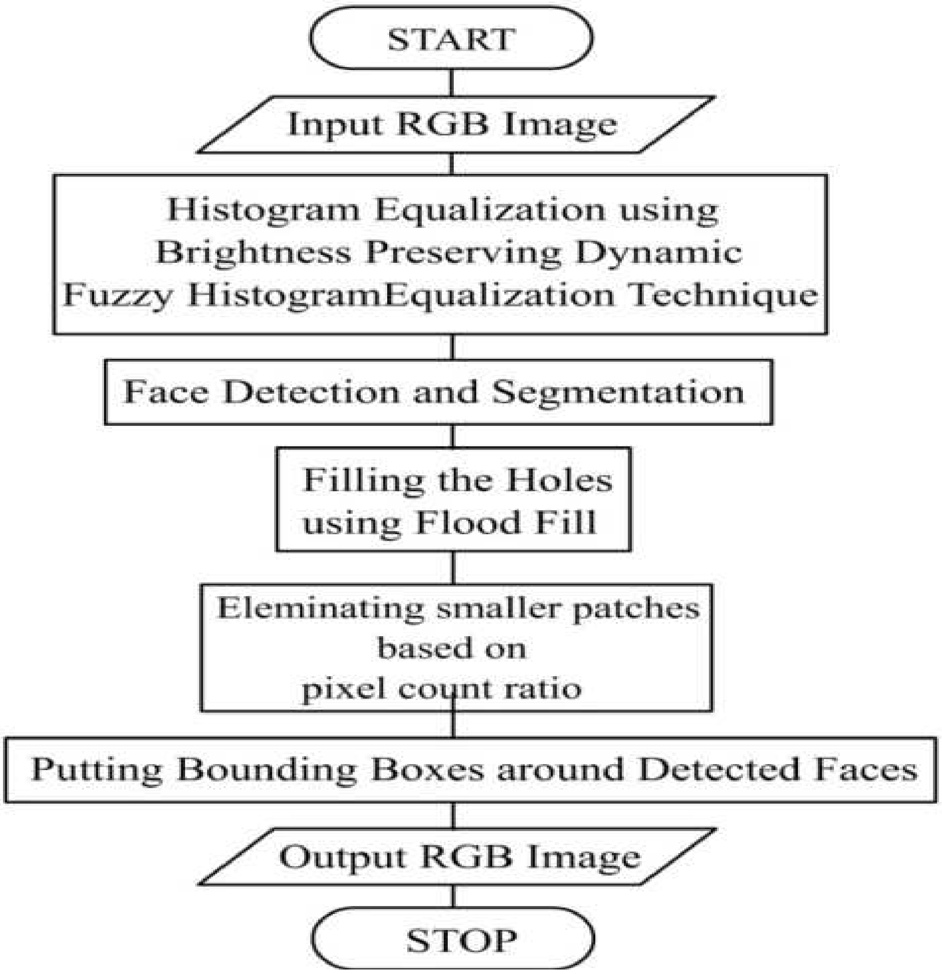
ii. Face detection and Segmentation

iii. Filling the holes using Flood Fill

iv. Eliminating smaller patches based on pixel count ratio

v. Putting Bounding boxes around detected face

FIGURE 1: FLOW DIAGRAM OF THE METHOD FOLLOWED



In the first step contrast enhancement is done on the image so that the pixels in the image having low brightness intensity gains higher brightness. The Brightness Preserving Dynamic Fuzzy Histogram Equalization technique is followed according to the steps suggested by D. Sheet et al. We are, for the brevity of the paper, not going into further details. The next step deals with the identification of the skin regions. We have dynamically extracted the skin of the face but there remained some error as it detected some patches of skin as well from other body parts. To reduce the impact of the problems we have, at the first step, created a binary image with some white patches which are nothing but the detected skin. Then the face detected was filled using flood fill method to get a uniform white blob. In the next step, the smaller patches were removed, that is, the noises were removed. Then we have plotted the bounding boxes around the detected faces. .

4. RESULTS AND DISCUSSION

The above mentioned steps were carried on a real time image. The table 1 shown below lists the task performed serially for a sample image.

TABLE-I: SAMPLE RESULT FOR TEST IMAGE

Operation	Output
Original Image	
Image after contras enhancement.	
Image after converting to Binary Image.	
Image after filling holes.	
Image after removing smaller patches.	
Image after putting Bounding Boxes.	

Here we considered an image (see Original Image, Table 1) as our input image and after applying Brightness Preserving Dynamic Fuzzy Histogram Equalization technique we got the Image after contras enhancement (see Table 1).Then we have applied face detection and segmentation techniques and got the third image which captured and detected most of the facial parts along with some noise as in Image after converting to Binary Image (see Table 1). Then we filled the holes to remove the shadows of the eyes and the noses to get a bigger and cleaner white blob as depicted in Image after filling holes (see Table 1). Now to remove the noise if we can remove the smaller white patches based on pixel count ratio then we would get an image which mostly contains the face portion (see Image after removing smaller patches, Table 1). Finally we put the bounding boxes around the face detected and got the final output-image (see Image after putting Bounding Boxes, Table 1).

CONCLUSION

The method suggested by this study is not complex to implement and is faster in operation as compared to the other existing methods for detecting face in a night time image. The image found to work best in a controlled environment and when only the face is exposed with a little exposure of skin. The failure rate is low compared to other techniques. Furthermore any advanced image enhancement technique can be used and the suggested methodology can also be expanded to detect faces in videos.

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