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LOW RESOLUTION ENHANCEMENT USING MULTI EXPOSURE IMAGE FUSION

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Abstract **- Generation of high dynamic range(HDR) image by making use of single input low resolution image is presented. The proposed approach Firstly, generates over and under exposed images with the help of adaptive weight histogram separation (AWHS). Secondly, this makes it possible to enhance the contrast of an image by contrast enhancement techniques such as linear stretching and contrast limited adaptive weight histogram equalization (CLAHE). Finally obtained three different exposed images are fused to obtain the HDR image. Multi exposure image fusion is one of the widely adopted quality enhancement technique. Experimental results show that the proposed system provides higher quality HDR images compared to the existing methodologies.**

Index terms-Multi exposure image fusion (MEF), High dynamic range(HDR), AWHS, linear stretching(LS), CLAHE.

I. INTRODUCTION

Multi exposure image fusion is one of the widely adopted quality enhancement technique. As the name signifies that MEF takes the multi exposed images i.e images of different exposure and are fused to produce an output image HDR which is more informative than any of the input image[1]. High dynamic range imaging technique has been widely used in the emerging technologies mainly for digital environment/imaging. In HDR imaging a multi exposed images are fused into a single image which mainly overcome the limitations in the dynamic ranges of existing approach. As a result the fused image will have high quality in terms of higher amount of information[2].

Recently various techniques have been proposed to produce HDR image. In this technique, differently exposed images are captured and fused. After obtaining the fused result quality assessment has been made by comparing it with the 8 different multi exposure image fusion algorithm[1]. Aysun et al[2] proposed a novel algorithm based on fuzzy fusion based high dynamic range, where fuzzy logic approach is used at the fusion stage. Hence making the computation light-weight and enables to obtain the ghost-free HDR images.

Huang et al[3] proposed an image enhancement technique using CLAHE combined with DWT. Firstly original image is decomposed into low frequency and high frequency components, this is done by DWT. Then low frequency components are enhanced by CLAHE retaining the high frequency components, since it contains detail information. One of the major enhancement was done, no other processing was made. The drawback of this method is only image multi exposure retinex model in order to obtain high dynamic range image. This method decomposes the input image into intensity component and reflectance component and finally these two components are merged together to obtain the fused image. Gu et al[5] computed an algorithm to obtain multi exposure image in the gradient field. This method is suitable for only static scene(for still images), it fails for dynamic scene such as capturing moving objects like walking individual, bus etc. It introduced occlusion and ghost effect which cannot be avoided.

II. PROPOSED SYSTEM APPROACH

The proposed system has got three main important steps. First step is to generate low intensity image from single input original image with the help of an adaptive weight histogram separation approach. In second step the obtained low intensity images are enhanced using a contrast enhancement technique which includes linear stretching and CLAHE. Finally three exposed image are fused using multi exposure algorithm to obtain high dynamic range image. The flow chart of the proposed system is as shown in Fig.1. The proposed approach utilizes adaptive weight histogram separation is presented by Pei et al[6]. Since fixed weight is not suitable for wide range images.

Thus proposed system obtains adaptive weights for input images. It is to note that 'V' channel is used for this process. The AWHS method is applied to only value channel, in order to obtain two different exposed images i.e under exposed and over exposed images. After obtaining these images linear stretching and CLAHE are executed, in order to obtain final over and under exposed images. Finally HDR images is constructed from these three differently exposed images by making use of multi exposure image fusion algorithms.

A. Adaptive weight histogram separation

Histogram separation is one of the important stage in the generation of HDR image because it directly affects the subsequent stages in HDR process. The WHS presented by Pie et al[6] divided the input low resolution image into two separate images by making use of an adaptively computed weight

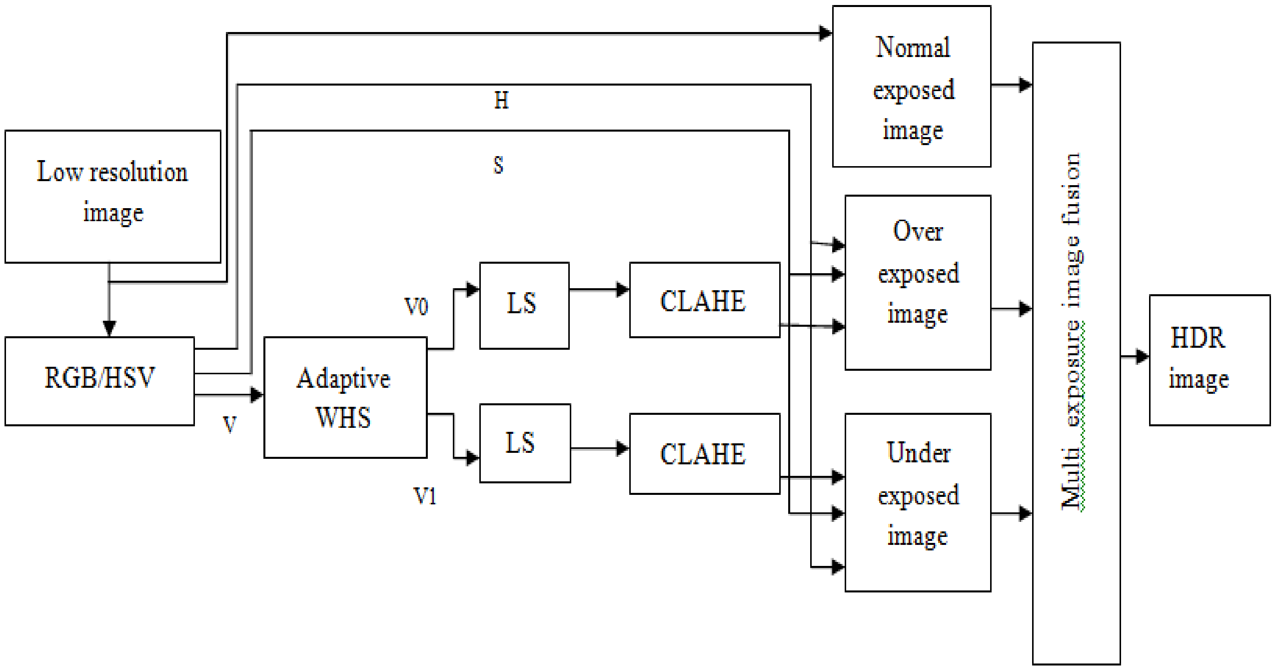

Fig.1. The flowchart of proposed system

The AWHS is carried out using data separation unit, which divides an image dataset into two subset. It is further possible to separate subsets into subsequent subsets by making use of dataset hierarchy. Hv denotes histogram of the V channel of the input image Hv(l) denotes the number of pixels with grey level l in V, where l ranges from 0 to 255 for an 8 bit image[2].

Step1: Computation of threshold

$$\tau = \underset{0 \le t < V}{\arg\min} \left| W - \frac{1}{n} \sum_{l=0}^{t} Hv(l) \right| \qquad (1)$$

Where t denotes a grey level value and n is the total number of pixels in the dataset, W is an experimentally determined weighting factor controlling the size of the two separated subsets.

The proposed approach mainly utilizes adaptive weight histogram separation scheme which separates the input image histogram to obtain high resolution image. The experiments performed shows that smaller weight factor resulted in the loss of details in the HDR image, in case of higher weighting factor does not improve the dynamic range of input image. At mid range weighting factor does not improve the image quality. Hence it is very important to decide a proper weighting factor for different input images.

The ratio of dark region to overall pixel intensities is given by

$$r = \frac{\sum_{m=a}^{b} H_v(m)}{\sum_{l} H_v(l)} \qquad (2)$$

Where a and b are fixed intensity levels that corresponds to the dark region in the input image. Note that a and b are set to 0 and 64 respectively

Step2:- This step divides the input histogram into 2 sub histograms based on the threshold

$$H_{v_0}(l) = \begin{cases} H_v(l), & \text{if } \; l < \tau \\ 0, & \text{otherwise} \end{cases} \qquad (3)$$

$$H_{v_1}(l) = \begin{cases} H_v(l), & \text{if } \; l > \tau \\ 0, & \text{otherwise} \end{cases}$$

Two images are obtained by dividing the input histogram into 2 sub histogram by making use of adaptive weight histogram separation approach. First image is referred to as Vo contains intensity levels from 0 to threshold τ to maximum pixel i.e 255, it is performed for an 8 bit image. The first image Vo and second image V1 are used to obtain under and over exposed images.

B. Linear stretching

Linear stretching is preliminary step before CLAHE is to be applied. Linear stretching is one of the contrast enhancement technique. It can be formulated as

$$Vo\_LS(x,y) = \frac{V0(x,y) - \min(V0(x,y))}{\max(V0(x,y)) - \min(V0(x,y))} \times 255 \qquad (4)$$

Where Vo(x,y) denotes the images obtained by applying AWHS and Vo_LS(x,y) represents the over exposed image obtained after the linear stretching technique. Similarly V1_LS(x,y) is obtained in the same way for under exposed image

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C. Contrast limited adaptive histogram equalization

After linear stretching the next step is applying CLAHE to the obtained image, in order to improve the local details and edges in the HDR image. Celebi [7] propose to utilize CLAHE with linear stretching in order to improve the dynamic range for under water image. Adaptive histogram equalization(AHE) is a method for local contrast enhancement technique and it is an extension to the traditional histogram equalization technique. It mainly divides the image into non- overlapping regions and applies histogram equalization to each sub region in order to redefine the pixel values of the images.

CLAHE is an improved version of AHE which prevents over amplification of noise by limiting the contrast. In CLAHE each sub-histogram is partially flattened by clipping levels, where the values above the threshold are clipped off and redistributed to the other bins in the histogram. By selecting the clipping levels the undesired noise can be avoided.

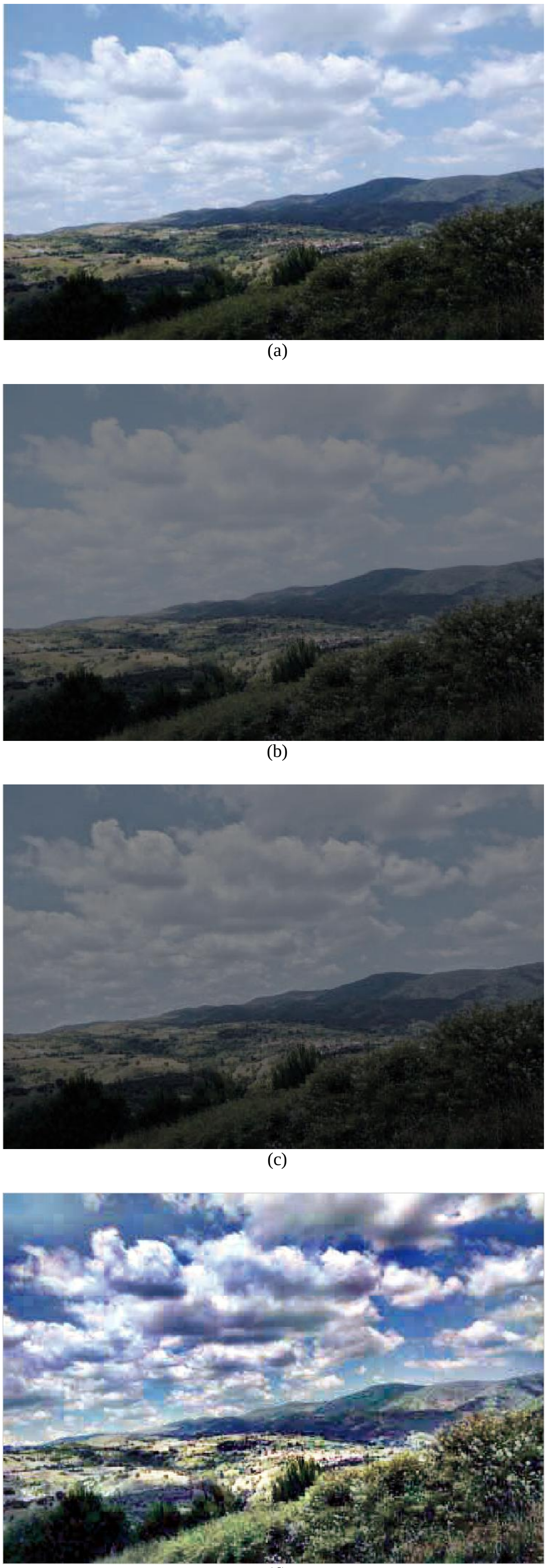
CLAHE is applied to both Vo_LS and V1_LS which enhances the local details of the image. The final stage of the proposed method is the fusion of obtained under exposed, over exposed and normally exposed image to generate the HDR image. Firstly over exposed V-channel is combined with unprocessed hue and saturation channels to obtain over exposed image. Like wise under exposed V channel is combined with unprocessed hue and saturation channel to obtain under exposed image. The main criteria of fusion is to extract the best parts of differently exposed images and fuse them to generate a high quality image. From multi exposure image fusion High dynamic range image can obtained, after which quality assessment is carried out by measuring some parameters like MSE, PSNR and Structure Similarity Index(SSIM).

III. EXPERIMENTAL RESULTS

The proposed system is examined with various HDR images obtained from the different approaches i.e local energy weight and global energy weight . Fig.2 shows comparative results of different approaches. Lm et al[8] approach generated HDR image using fixed weight. The proposed system generates HDR image using adaptive weight where the output will be of high resolution clarity image where the local details of an image will be clearly visible. It can better explained by the parameters i.e PSNR, MSE and SSIM. Table.I gives the results of different approaches as defined earlier. So by the proposed architecture an HDR image is obtained from the low resolution input image

Table I. Image Quality Assessment

Different Approaches	**MSE**	**PSNR**	**SSIM**
Proposed System	0.0385	68.3260	0.61486
Global Energy Weight	0.0474	67.4300	0.99177
Local Energy Weight	0.0538	66.8736	0.99063



(a)

(b)

(c)

(d)

Fig.2. Performance comparison (a) Original image, (b) HDR image obtained by local energy weight, (c) HDR image obtained by global energy weight, (d) HDR image obtained by the proposed method

IV. CONCLUSION

In this paper, an approach to generate HDR image using single input image is demonstrated. This approach utilizes adaptive weight histogram separation technique in order to produce over exposed and under exposed images. The CLAHE contrast enhancement scheme extracts the local details of the image efficiently. produces an HDR image of attractive quality with finer vision capability. The proposed system generates ghost-free HDR Finally, the proposed fusion approach produces an HDR image of attractive quality with finer vision capability. The proposed system generates ghost-free HDR

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