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UNDERWATER IMAGE ENHANCEMENT AND COLOR CORRECTION: A REVIEW

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Abstract: Images taken from underwater usually suffer from the problems of quality degradation and distortions due to various factors such as absorption, scattering, presence of the suspended particles, etc. To address these problems, a series of underwater image enhancement and restoration technologies are applied to underwater vision tasks. There are various methods like filtering based methods, color correction based methods, image fusion based methods, and deep learning methods for underwater image enhancement This paper is to review different image enhancement techniques and an image enhancement method is proposed here.. A novel color correction method based on color filter array(CFA) and an enhancement method based on Retinex with dense pixels and adaptive linear histogram transformation for degraded color-biased underwater image is proposed here .This aim to bring more enhancement in underwater degraded images with high fidelity leading to an improved global contrast, reduced noise level, and also retaining intricate and sharp details of the original images**.**

***Index Terms* - Image enhancement , underwater image color correction ,color filter array, Retinex, McCann Retinex**

I. INTRODUCTION

Enhancement of underwater images plays a crucial role in ocean resource exploration, marine engineering etc. These images faces color castes and look bluish due to wavelength dependent and selective light absorption. The red channel in the image fades firstly, when the distance between camera and the image scene is increased. The red channel map became darkened and red pixel value becomes small. So these type of images should be corrected. The contrast of the image is unsatisfactory when scattering happens.

The RGB values of images captured by digital cameras with CFA are dependent and coupled because of interpolation process. So compensating red channel attenuation from green and blue channel is more preferable. For handling low brightness and blurred images efficiently Retinex models are being widely used. McCann Retinex method uses spiral path for pixel comparison to estimate illumination.

Researchers strive to capture underwater images of high quality for several applications such as robotics, rescue missions, ecological monitoring, real time navigation, etc. Our review provide researchers with the necessary background to appreciate challenges and opportunities in the field of underwater image enhancement and color correction.

II. LITERATURE SURVEY

An approach based on slide stretching is presented in this paper. Contrast stretching of RGB to equalize color contrast in image and saturation and intensity stretching of HSI to increase true color and solve problem of lighting is the two fold objective of this paper. Interactive software has been developed and its results are given in the paper.[1]

In this paper Unsupervised colour correction method (UCM) is used. UCM is based on color balancing, contrast correction of RGB color model and contrast correction of HSI color model. By equalizing color values color cast is reduced and then enhancement to a contrast correction method is applied to increase the Red color by stretching red histogram towards the maximum, blue histogram is reduced by minimizing the blue histogram and for contrast correction the Saturation and Intensity components of the HSI color model have been applied to increase true color and improve illumination saturation and intensity are used here. The results are also compared with other three methods namely gray world, white patch and histogram equalization. Better results are obtained using this method.[2]

A novel strategy put forward in this paper to enhance the images and videos. Input and weight measures are derived from degraded version of image in this strategy which was built on fusion principle. To overcome limitations of underwater medium they define two inputs which are color corrected and contrast enhanced version of original underwater image/frame. To increase the visibility of the distant objects degraded due to scattering and absorption four weight maps are also defined here. Temporal coherence between adjacent frames are supported by this fusion framework so performing an edge preserving noise reduction strategy. Main characteristics of the enhanced images/videos are reduced noise level, better exposedness to dark region improved global contrast. [3]

A novel retinex based approach is proposed in this paper to enhance the degraded single underwater image. To address color distortion a color correction strategy is applied, then variational framework of retinex is proposed to decompose reflectance and illumination, reflectance and illumination are enhanced using different strategies. The enhanced image is obtained by combining both reflectance and illumination. The enhanced result is improved by color correction, lightens dark regions, naturalness preservation, and well enhanced edges and details.[4]

This paper proposes an effective algorithm to recover underwater images by simplifying the Jaffe-McGlamery optical model. To estimate the background light and the transmission a red-dark channel prior was derived here. A low pass filter was developed by analyzing point spread function physical properties to deblur the degraded image. Proposed algorithm can recover degraded images by eliminating the influence of absorption and scattering. [5]

This paper integrates the modification of image histogram into two main color model –RGB and HSV. In RGB model blue channel is stretched toward the lower level, red channel is stretched toward the upper level, green channel is stretched to both directions. Then the image is converted into the HSV color model, wherein the S and V components are modified within the limit of 1% from the minimum and maximum values. The proposed method provides an average mean square error (MSE) and peak signal to noise ratio (PSNR) of 76.76 and 31.13 respectively.[6]

This paper proposed new method called dual-image Rayleigh-stretched contrast-limited adaptive histogram specification that integrates global and local contrast correction. Global contrast correction generates dual-intensity images, which are then integrated to produce contrast-enhanced resultant images. Subsequently, such images are processed locally to enhance details. . Qualitative and quantitative results show that the contrast of the resultant image improves significantly.[7]

In this paper weakly supervised color transfer is used to correct color distortion. The proposed method relaxes the need for paired underwater images for training and allows the underwater images being taken in unknown locations. Inspired by cycle-consistent adversarial networks, they designed a multi-term loss function including adversarial loss, cycle consistency loss, and structural similarity index measure loss, which makes the content and structure of the outputs same as the inputs, meanwhile the color is similar to the images that were taken without the water. These method produces visually pleasing results, even outperforms the state-of-the-art methods.[8]

Based on adaptive parameter acquisition a method called Relative global histogram stretching(RGHS) was proposed in this paper. Two parts of this method are contrast correction and color correction. The contrast correction in RGB color space firstly equalizes G and B channels and then re-distributes each R-G-B channel histogram with dynamic parameters that relate to the intensity distribution of original image and wavelength attenuation of different colors under the water. by stretching the ‘L’ component and modifying ‘a’ and ‘b’ components in CIE-Lab color space contrast correction is performed. They achieved better perceptual quality, higher image information entropy, and less noise by using the method proposed here.[9]

In this paper they propose single image approach which is built on blending of two images together ,these images are directly derived from color compensated and white balanced version of original image. Along with the images their weights are also defined to transfer edges and color contrast to output image. They also adopted multi-scale fusion strategy to avoid sharp weight map transition. here enhanced images and videos are characterized by better exposedness of the dark regions, improved global contrast, and edges sharpness. Their validation also proves that our algorithm is reasonably independent of the camera settings, and improves the accuracy of several image processing applications, such as image segmentation and key point matching.[10]

In this paper underwater image enhancement is done by the method similar to fusion principles, they create two forms of images from original image and these two channels are modulated by their corresponding weights. Main innovation of this paper is multilevel decomposition based on *lp*-norm (*p* D 0; 1; 2) decomposition. . According to the different sparse representation abilities of *lp*-norm to an image's spatial information image is decomposed into three: detail level, structure level, and illuminanace level. Three levels are manipulated separately, according to specific underwater imaging conditions; we carefully select two input channels and their three associated global contrast, local contrast, and saliency weight measures. This method generates output with more accurate details and a better illuminant dynamic range.[11]

Model inspired by the morphology and function of teleost fish retina is proposed in this paper. The feedback from color-sensitive horizontal cells to cones and a red channel compensation are used to correct the non-uniform color bias. For color enhancement and color correction the ganglion cells with color-opponent mechanism are used. To reconstruct the enhanced image from the outputs of ON and OFF pathways of fish retina a luminance based fusion strategy is adopted by them. Extensive qualitative and quantitative evaluations on various underwater scenes validate the competitive performance of these techniques. This model also significantly improves the accuracy of transmission map estimation and local feature m point matching using the underwater image.[12]

Underwater image processing has been used in a wide variety of fields, such as underwater microscopic detection, terrain scanning, mine detection, telecommunication cables, and autonomous underwater vehicle. Underwater imaging can be divided into two methods 1) underwater image dehazing and 2) underwater image color restoration. This paper presents the reason for underwater image degradation, surveys the state-of-the-art intelligence algorithms like deep learning methods in underwater image dehazing and restoration, demonstrates the performance of underwater image dehazing and color restoration with different method, introduces an underwater image color evaluation metric, and provides an overview of the major underwater image applications [13]

III. METHODOLOGY

The proposed model consists of several steps which are given in above flow chart. Firstly, color-distortion correction for red channel from green channel and blue channel. Then by using McCann Retinex (MR) algorithm the image transformed from RGB space to HSV space, is processed by with dense pixels to make its illumination become more uniform. Then to further solve color cast of underwater images white balance algorithm is used. Finally, after the image is transformed back to RGB color space, it is adjusted by CLAHE (Contrast Limited Adaptive Histogram Equalization)to enhance contrast.

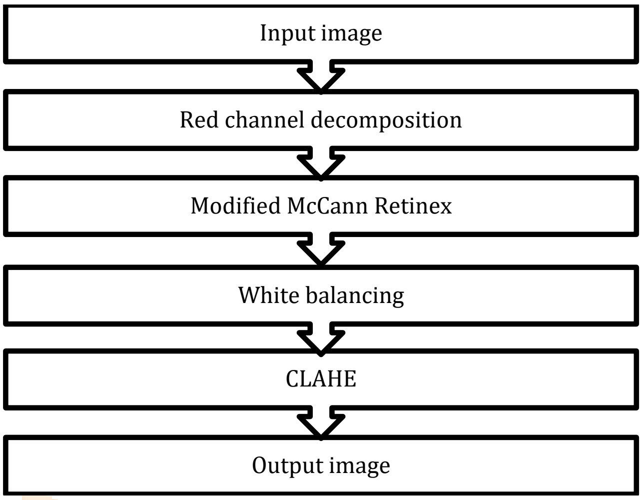

Fig1: Flow chart of proposed model

IV. CONCLUSION

We reviewed several paper based on underwater image enhancement and proposed a method for enhancement and color correction of degraded underwater image. By the proposed method better results will get compared to other methods. And the output images of this can be used for classification and detection used in applications like marine fouling, ocean mining etc.

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