DIFFERENT TECHNIQUES TO DEHAZE AN UNDERWATER IMAGE

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Abstract: ***This paper describes a novel methods or techniques to enhance underwater images by image dehazing or defogging. Underwater images suffer from degradation like haze or fog due to poor visibility conditions and effects such as light absorption, light reflection, bending of light and scattering of light. Scattering and color change are two major problems of distortion for underwater imaging. Scattering is caused by large suspended particles such as turbid water which contains particles, color change or color distortion corresponds to the varying degrees of attenuation confront by light travelling in the water with different wavelengths, rendering ambient underwater environments dominated by a bluish tone. The attenuation of the light is mainly cause of the haze appearance while the fraction of the light scattered back from the water along the sight considerable degrades the scene contrast. This paper proposed a Mix CLAHE (Mixture contrast limited adaptive histogram equalization) method and Dark channel prior principle to enhance underwater images by image dehazing. The enhanced images are characterized by reduced noised level, better exposedness of the dark regions, improved global contrast while the finest details and edges are enhanced significantly.***
Keywords: Underwater image, Contrast limited adaptive histogram equalization (CLAHE), Mix CLAHE, dark channel prior, color models.

I. INTRODUCTION

Underwater imaging is an important in ocean engineering. Underwater images suffer from degradation due to poor visibility conditions and effects such as light absorption, light reflection, bending of light and scattering of light. Attenuation of the light is main cause of the haze appearance[1]. Haze removal is a tough task because fog depends on the unknown scene depth information. Fog effect is the function of distance between camera and object. Hence removal of fog requires the estimation of depth map[2]. When discuss about light absorption, it is well known that water absorbs light in ways that air does not. The amount of light will absorbed as it passes through water. Different wavelengths of light (blue, green, red) will penetrate water to a varying degree. Light is absorbed at the longest wavelength first. Red light is having longest wavelength and it is mostly absorbed under water and blue light and green light are having shortest wavelength as compare to red light and these both lights(blue and green light) are least absorbed but green light absorbed first because it has longest wavelength than blue light. Figure 1 shows an illustration about the absorption of light by water. For every 10m increase in depth the brightness of natural illumination (sunlight) will absorbed by half. Nearly all red lights is absorbed by 50% from the surface but blue continues to great depth. Underwater environments dominated by a bluish tone. That is why most underwater images are dominated by blue-green coloration [3].

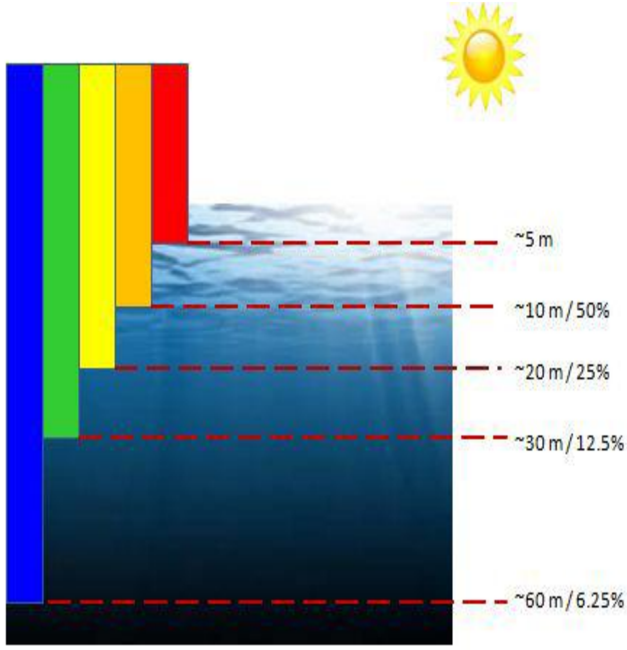

Figure 1 shows Absorption of water by light

II. VISIBILITY RESTORATION TECHNIQUE

For removing haze, fog, mist from the image various technique are used. Typical methods of image restoration to the fog are:

A. Dark channel prior:

Dark channel prior [4] is used for the estimation of atmospheric light in the dehazed image to get the more proper result. This technique is mostly used for non-sky patches, as at least one color channel has very low intensity at some pixels. The low intensity in the dark channel is predominantly because of three components are colourful items, shadows, dark items or surfaces. As the outdoor images are usually full of shadows and colorful, the dark channels of these images will be really dark. Due to fog (airlight), a haze image is brighter than its image without haze. So we can say dark channel of haze image will have higher intensity in region with higher haze. So, visually the intensity of dark channel is a rough approximation of the thickness of haze. In dark channel prior we also use pre and post processing steps for getting better results. In post processing steps we use soft matting or trilateral filtering etc. Let J(x) is input image, I(x) is foggy image, t(x) is the transmission of the medium. The attenuation of image due to fog can be expressed as

$$I_{att}(x) = J(x)t(x)$$

the effect of fog is Airlight effect and it is expressed as

$$I_{airlig\,ht}(x) = A(1 - t(x)) \qquad (2)$$

Dark channel for an arbitrary image J, expressed as J dark is defined as

$$J^{dark}(x) = \frac{min}{y \in \Omega(x)} (\min J^C(Y)) \qquad (3)$$

In this J^c is the color image comprising of RGB components, $\Omega(x)$represents a local patch which has its origin at x. The low intensity of dark channels is attributed mainly due to shadows in images, saturated color objects and dark objects in images. After dark channel prior, we need to estimate transmission t(x) for proceeding further with the solution. Another assumption needed is that let Atmospheric light A is also known. We normalize (4) by dividing both sides by

A. $\frac{I^c}{A^c}(x)$ = t(x) $\frac{J^c}{A^c}(x)$ + 1-t(x) (4)

Figure 2 shows Haze removal results. (a): input haze images. (b): restored haze-free images. (c): depth maps.

B. CLAHE(Contrast limited adaptive histogram equalization)

Contrast limited adaptive histogram equalization short form is CLAHE [3]. This method does not need any predicted weather information for the processing of hazed image. Firstly, the image captured by the camera in foggy condition is converted from RGB (red, green and blue) color space is converted to HSI (hue, saturation and intensity) color space. The images are converted because the human sense colors similarly as HSI represent colors. Secondly intensity component is processed by CLAHE without effecting hue and saturation. This method use histogram equalization to a contextual region. The original histogram is clipped and the clipped pixels are redistributed to each gray-level. In this each pixel intensity is shortened to maxima of user selectable. Finally, the image processed in HSI color space is converted back to RGB color space.

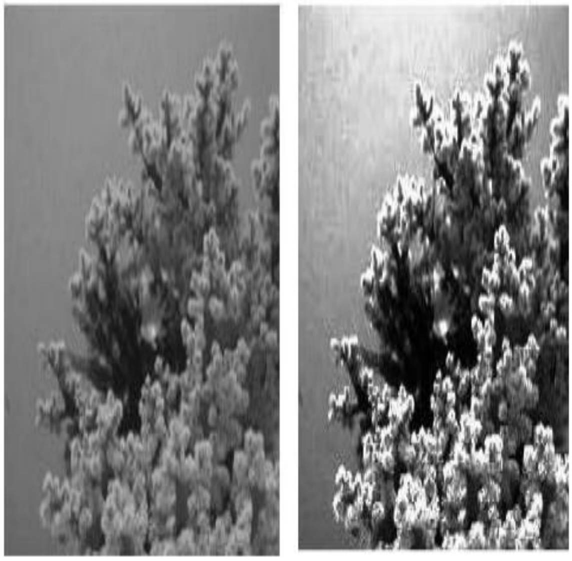

Figure 3 shows (a) Original sea plant image b) CLAHE image

C. Mix-CLAHE

For the enhancement of underwater images mixture Contrast Limited Adaptive Histogram Equalization is used. The enhancement method effectively improves the visibility of underwater images and produces the lowest MSE and the highest PSNR values. Thus, it has shown that the mix-CLAHE based method is promising for classifying coral reefs especially when visual cues are visible [3]

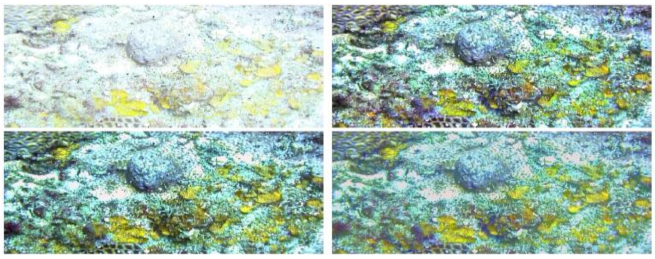

Figure 4 shows Comparison of CLAHE methods on B1. Upper left: original underwater image. Upper right: CLAHE-RGB image. Bottom left: CLAHE-HSV image. Bottom right: CLAHE-Mix image.

D. Wiener filtering

Wiener filtering is based on dark channel prior: Wiener filtering [5] is used to counter the problems such as color distortion while using dark channel prior when the images with large white area is processed. While using dark channel prior the value of media function is rough which create halo effect in final image. So, median filtering is used to estimate the media function, so that edges can be preserved. After making the median function more accurate it is combined with wiener filtering so that the image restoration problem is transformed into optimization problem. This algorithm is useful to recover the contrast of a large white area for image. The running time of image algorithm is also less.

E. Trilateral filtering

This filtering [6] smooth's images without effecting edges, by means of a non-linear combination of nearby image values. In this filter replaces each pixel by weighted averages of its neighbour's pixel. The weight assigned to each neighbour pixel decreases with both the distance in the image plane and the distance on the intensity axis. This filter helps us to get result faster as compare to other. While using trilateral filter we use pre-processing and post processing steps for better results. Histogram equalization is used as pre-processing and histogram stretching as a post processing. These both steps help to increase the contrast of image before and after usage of trilateral filter. This algorithm is independent of density of fog so can also be applied to the images taken in dense fog. It does not require user intervention. It has a wide application in tracking and navigation, consumer electronics and entertainment industries.

III. CONCLUSION

This paper presents some techniques to dehaze a fog from a image and to increase image contrast. Dark channel prior is used to dehaze a fog from image and CLAHE and Mix-CLAHE is used to increase image contrast. Dark channel prior and Mix-CLAHE are used as preprocessing techniques to dehaze fog from a image. Trilateral filtering is used as a post processing technique to remove a noise from a image. In future work we can make a hybrid model of Dark channel prior and mix- CLAHE to dehaze a image and increase its contrast.

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