Literature Review on Deep-water Image Enhancement

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Abstract: **An underwater images usually suffers from colour imbalance and blurriness due to the longer wavelength of red channel that fades off as it travels into the water. Underwater images will be noisy and hazy due to many disturbances like scattering of light and absorption in the water. There are many various techniques to enhance the underwater images, to get the important faded features and edges which leads to a better quality of the images. This paper, gives a review on various effective techniques that has been used to enhance the images captured underwater which are degraded due to the scattering and absorption.**

Index Terms: **Image Enhancement, WCID, Dehazing, Integrated Colour Model.**

I. INTRODUCTION

Image enhancement refers to sharpening of image features such as edges, boundaries, or contrast to make a graphic display more useful for display and analysis. In the image enhancement process one or more attributes of the image are modified and processed. Enhancement of underwater images has got many techniques in order to remove the noise, haze which may affect and lower the quality of the images captured underwater. Restoration of an image by an underwater environment is challenging compare to the normally captured images, underwater images undergoes different kinds of attenuation of propagation light leading to the poor visibility.

Due to the different physical properties of underwater images, many techniques cannot be applied as many of them like histogram equalization, colour correction and fusion based methods are out of physical model based. Restoration of underwater image is very difficult and challenging as there is a variation and deviation in physical properties. There will be a lot of colour changes as the wavelength varies due to the light reduction underwater. The application of underwater imaging is mostly used in ocean discovery and scientific research and technology. There are types of scattering like forward scattering and backward scattering where the forward scattering forms the blurriness of the of the image and the backward scattering gives the contrast limitations of the image. Hence, there invented a lot more techniques like wavelength compensated image dehazing, integrated colour model, histogram equalization and many more which will be able to remove these obstructions in getting a clear underwater image.

II. LITERATURE SURVEY

The technique of wavelength compensation and image dehazing (WCID) has been implied which enhances the underwater images. It estimates the depth of the object and the camera with respect to the wavelength of light and segments the foreground and background, if there is an artificial light presents then it removes the artificial light and compensates by estimating the scene range from depth D through D+R, R is the image depth range. In accordance with the residual energy ratios of various channel of colour that are present in background light the depth of the water is estimated in the image scene. The attenuation with respect to the wavelength of light colour change compensation is carried out to get the colour balance. By using the ground truth patches of colour images and YouTube videos downloaded the wavelength compensation and image dehazing algorithm is evaluated subjectively and objectively that finally gives a haze free and colour corrected image [1].

A novel linear colour attenuation prior technique is proposed which is built on the brightness and saturation differences of pixels in the hazy image which represents the amount of haze and creates a linear model which is more advantageous in edge preserving. With the proposed method, depth map can be obtained and even the radiance of the scene can be pursued easily. This method gives higher efficiency and a better dehazing effects. By obtaining the depth map using this linear model parameters, the hazy image radiance can be get back [2].

As the light travels it undergoes absorption and scattering in the water. An algorithm to overcome this has proposed which comprises of colour correction and illumination adjustment. Basically a colour enhancement method will be used and then the gamma correction will be implemented and the illumination map will be done on it to get illumination adjustments. This method shows the simpler processing complexity and a better visual performance [3].

A retinex based enhancing method is introduced which includes colour correction strategy initially, and later the variational framework for retinex to get the detail brightness and finally the reflectance and illumination are enhanced. The enhanced image will be obtained by combining these and the result is made better by colour correction to get a clear image. This approach requires various degrees of polarization images [4].

The noise level function (NLF) has introduced for estimation and removal of colour noise, which removes from a single image by using piecewise smooth image models. NLF is a function that represents the noise level as a function of image brightness. The noise will be removed by the pixel value projection onto the RGB value in every segment. The image is segmented into the piecewise regions where the mean represents the brightness estimation and the Gaussian conditional random field (GCRF) is created to get the clear image by the noisy input [5].

The underwater image enhancement leads to the better clarity of images. A technique called dark prior channel is used followed by soft matting and HSV filtering to get the faded information of an image. Dark channel prior estimates the transmission and restores the images, HSV filtering converts RGB to HSV to get the saturation. By comparing the PSNR and MSE parameters it gives much better enhanced image [6].

RGB algorithm is implied to get the better colour contrast followed by the HSI saturation and intensity stretch. Hence there is a two color models has been used here to avoid the problem of lighting and to get a better quality of images. Initially red and green channels are balanced to almost blue channel then transforms to HSI form where it get intensity parameters to avoid lighting problems the greater colour range is provided by HSI model by the colour element control of image where the wider range of colour are from saturation and intensity. Blue is restricted by saturation and intensity to represent from light blue to dark blue. Using this the contrast can be varied and a contrast stretching algorithm is used to get the good contrast of image [7].

Pre-processing filtering is needed to restore the image underwater. An automatic parameter free algorithm is proposed which enables the correctness of non-uniform illumination and removes noise and gets a good colour contrast. It first removes the moiré effect in an image and then it resizes to squared image later converts RGB to YCbCr followed by denoising and intensity adjustment which will be again converted back to the RGB that will be equalized [8].

III. PROBLEMS IN UNDERWATER IMAGES

Scattering and colour change due to absorption are the two main problems in the underwater images. Scattering leads to poor visibility and low quality of contrast in the underwater images. Before the light incidents on the camera it gets reflected a number of times and also gets dereflected which is known as scattering. Forward scattering leads to the blurriness of the image where background scattering leads to the contrast variation.

Absorption usually occurs because of the different wavelengths present. There present a more blue colour in the images captured underwater due to the lower wavelength that can travel deep inside whereas the higher wavelength of red channel fades off and that leads to the colour imbalance. Hazes will be present in underwater images due to the suspended particles that are there in the underwater environment. These challenges can be overcome by using a lot of various techniques to enhance the images captured underwater.

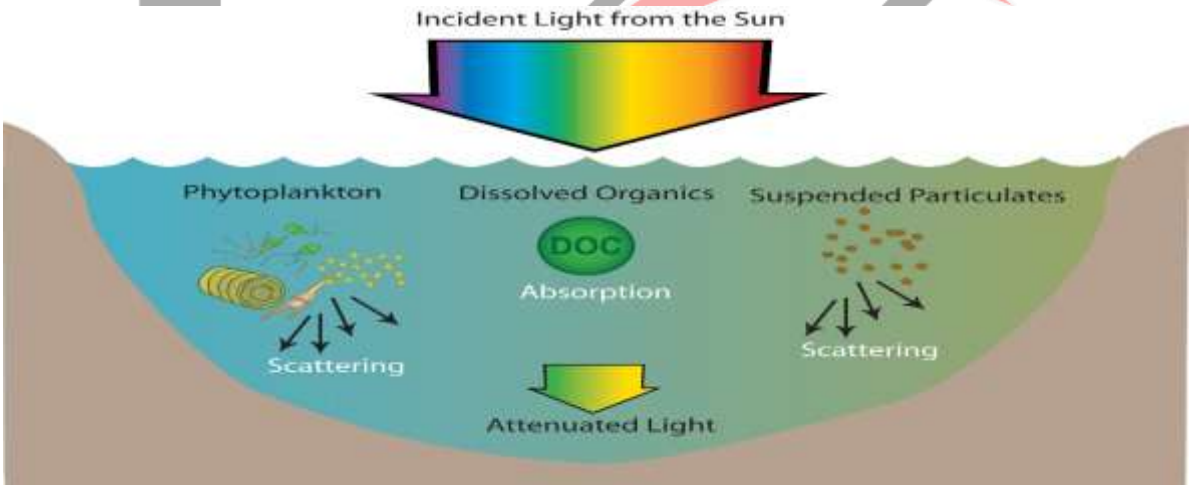

Fig 1: light propagation underwater

IV. TECHNIQUES FOR IMAGE ENHANCEMENT

A. WCID Technique

The technique wavelength compensation and image dehazing is used for enhancing the underwater images. In this technique, initially the depth of the scene D(x) is estimated by using the dark channel prior, later the segmentation of image will be made into foreground and background areas based on the depth. A comparison will be made with the intensity of light of background and foreground to know if there is any artificial light is present and if it's there it will be removed. Then a dehazing algorithm and wavelength compensation are used to eliminate the haze in the image and the colour imbalance.

Fig 2: Showing the WCID technique

B. Colour attenuation prior technique

The colour attenuation prior technique is used for removal of haze from a hazy image. A linear model will be formed to estimate the parameters. In specific an atmospheric scattering model is used in image processing, a colour attenuation prior plays a main role in haze removal, hazy regions can be recognized when the brightness is high and the saturation is lower which makes easier to remove the haze. It is easier to get to know the concentration of the haze in the image by estimating the difference in the brightness and saturation. A main advantage of this technique is that it preserves the edge features. After estimating the atmospheric light A and depth of the scene d, a haze free image can obtained.

C. Integral colour model technique

This technique has two folds, primarily contrast stretching of RGB algorithm is pertained to get the contrast of colour in an image, then the saturation and intensity stretching of HSI is applied to get lighting problem solved and higher to real colour. The colour element will be limited by the saturation whereas the range from light blue to dark blue is limited by the intensity. Hence by controlling the value the contrast of image can be controlled in underwater image. Contrast stretching make use of pixel values. It balances the red and green channels almost to the blue. Later the RGB is converted into HSI colour mode to get the real colour by saturation and intensity stretching.

D. Illumination adjustment method

A new technology called colour correction and illumination adjustment is proposed to get a good quality of an underwater image. As the name indicates it has two parts- colour correction and illumination adjustment. A retinex model based method will be used in the illumination adjustment method. In the colour correction method, the mean and variance of RGB channels will be calculated separately and then normalized where the three channels average will be the same. After the correction of colour, the RGB image will be converted into HSV space to adjust the illumination based on the retinex model. An illumination map estimation will be carried put first followed by correction of illumination map to get the clear image. This method is efficient in obtaining the genuine colour and the natural appearance.

E. Histogram based techniques

There are many techniques based on the histogram to enhance the colour contrast, turbulence underwater and the blurriness of the underwater images. Some of the techniques based on the histogram are histogram equalization and adaptive histogram equalization.

i. Histogram equalization

Histogram is a famous enhancement technique. With the probability distribution function (PDF) and cumulative distribution function (CDF), histogram equalization is carried out along stretching and equalization by the range of intensity. It deals with both continuous and discrete case. By extending the intensity values on the dynamic range HE enhances the contrast of image which is carried out with the help of transformation function T(r).

ii. Adaptive histogram equalization

Adaptive histogram equalization (AHE) is based on the local area enhancement. It segments the pixels into particular rectangular areas and defines the region then the intensity values of that regions are used to find out the mapping function of histogram equalization. Then that is substituted to the pixel in processed region. After mapping processing of each pixel the resultant image is obtained.

V. CONCLUSION

In this paper, several techniques have been reviewed in order to sort out the problems occur in underwater images. Acquiring a clear image in underwater environment is challenging and difficult. The significant obstruction for processing the images captured underwater is the visibility of color due to the light propagation. The technique WCID is useful in getting the information about the depth, which compares the intensity of background and foreground to process the image. Colour attenuation prior techniques achieves better in removal of haze in the image. Integral colour model and illumination adjustment method is useful in getting the natural

appearance comparatively. Thus, comparing all the techniques the noise can still be reduced effectively and that can be improved to achieve at its best.

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