ENHANCEMENT OF UNDERWATER IMAGES USING DCP

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Abstract: The images captured underwater normally experiences many obstacles in order to get a clear picture. Red colour will usually get disappeared under the water due to absorption as it has the highest wavelength that might leads to bluish or greenish image. Images will be blurred and poorly visible even because of the scattering effect. There exists some suspended particles inside the water which leads to the haziness in the image captured. In this paper, enhancement of images is by using a preprocessor followed by guided filter which preserves the edge factor using guidance image and later dark channel prior algorithm is used to remove the haziness and colour correction will be done which gives a clear contrasted image. The proposed technology will be carried out with the tool SPYDER (Python 3.5), Anaconda.

***Index Terms* – guided filtering, dehazing, colour correction, underwater images, dark channel prior**

I. INTRODUCTION

There exists many techniques to improve the visibility of underwater images. The physical properties of medium will be the main cause for any issues in the images captured underwater, as the red waves travels it gets lost as it has a highest wavelength [1].The wavelength of light plays a vital role in colour contrast of an image captured underwater due to the absorption of light rays by the medium.

There exists a numerous challenges to get the clear colour contrasted image underwater which leads to discover a various specific approaches in order to overcome the issues and to get a clear images that could be helpful in many fields like scientific purpose and also in the artistic photography. Initially there used to be universal image enhancement methods, some of it like histogram equalization method, adaptive histogram equalization method, contrast limited adaptive histogram equalization method and many more that was common for all kinds of enhancement of images [2].

Underwater images creates a complexity in the formation due to many distortions by its physical properties. Often the image will be blue or green dominated and even the suspended particles contributes the haziness into the image which makes even more complicated. The image suffers a lot of problems by absorption and scattering because of the medium. Now there exists a specific enhancement methods by using dehazing method which will remove the hazes present in the image and does the colour correction. Hence providing an interest in the marine image enhancement. It has many applications in oceanic engineering [3] which usually suffers for taking a good visible quality pictures underwater.

In this paper, dark channel prior is used which makes easy to estimate the depth based on the haze present in the images. More the depth more will be the presence of hazes. The preprocessing will be carried out and later filtering will be done using guided filtering algorithm that preserves the edge factors using the guidance of another image that is the input image itself. The dark channel prior algorithm removes the haze efficiently. The DCP algorithm has four main steps to remove the haze present in the image, which allows to estimate the depth of the sea where the image has been captured. Red channel correction will also be done under this in order to restore the colour that has been faded away due to the wavelength of certain channels like red channels wherever it is necessary. This approach provides a greater significance in the enhancement of images captured underwater because of its haze removal approach and the edge preserving factor that plays a main role in the underwater images. Hence this paper presents a successful approach to get a clear enhanced image.

II. RELATED WORKS

Earlier works has one of the techniques known as wavelength compensation and image dehazing (WCID) technique. In this WCID technique, wavelength plays a main role, with the help of depth estimation of object and lens. Foreground and background segmentation will be done. It is known that natural light is preferable and if any unnatural or false effect of light is there then that will be removed and remunerates by finding. Then scene radius from the distance downwards D along D+R. with the help of remaining energy range of different colour channels in background light the deepness of water is found out in the scene. Colour balance will be obtained with respect to the fading factor of light colour change by compensating it. The image dehazing algorithm is corrected objectively and objectively which indeed gives a haze free image [4].

To get the better quality of image that has been suffering from fading of red channel inside the water, RGB algorithm is introduced succeeding by HSI saturation and intensity stretch. Two colour models are used here. In the beginning, balancing of green channels into the blue channels will be done and then converts it into HSI where the intensity parameters can be obtained which keeps away the problem of lighting. Vast range of colour are obtained from saturation and intensity and HSI model provides greater colour range. Blue I constricted by saturation and intensity to be mean from light blue to dark blue. A contrast variation to get a better quality of image [5].

A related work has a technique known as dark prior channel along with the HSV filtering and soft matting. As usual there exists number of faded factor information and that will be obtained by the HSV filtering. Transmission, restoration of image will be estimated by dark channel prior and to get the wider range RGB to HSV conversion will be done to get to know the enhanced image details [6].

Removal of noise plays an important role in any image enhancement. A function called noise level function is initiated that measure and takes off the noise in an image. NLF removes in a single image with the help of a model called piecewise smooth image model. Image brightness is showed a function of noise in noise level function. The pixel value projection on the RGB value in each segment leads to the eviction of noise. Segmentation of image is carried out into piecewise areas be regarded as brightness measurement and Gaussian conditional random field (GCRF) is initiated to obtain clear image from the attenuated input image [7].

A technique called colour attenuation prior technique is launched derived on brightness and saturation variations of pixels in an image that is completely hazy, where the range of haze is showed off by it and finds a linear model with the benefits of edge preserving. Depth estimation has more importance in any type of image enhancement. In this method, measuring of depth that is depth mapping will be done and the radiance will be got easily. A better efficient effects will be obtained from this method. The radiance of hazy image can be obtained by linear model parameters effectively [8].

An enhancing method known as retinex based enhancing method is launched that encompass colour correction strategy at the beginning, to get the details of an image, variational framework for retinex is used. Enhancement of reflectance and illumination is done at the final stage. By merging all this, an enhanced image is acquired and is fabricated better with the correction of colour to get a better quality. With the different degrees of polarization image it would be better to apply with and to get a clear image [9].

III. PROBLEMS IN UNDERWATER IMAGES

There exists a number of challenges in getting a clear image underwater. The two major issues are scattering and absorption. Scattering usually occurs due to the reflection and dereflection of light on the lens which usually leads to blurriness and colour imbalance that tends to poor visibility of images. Absorption is mainly due to wavelength variation. The red has higher wavelength that goes off faster and blue remains as it has lower wavelength that creates imbalance in colour. Suspended particles causes hazes that makes images blurred and unclear. Figure 1 shows a pictorial representation of the problems underwater.

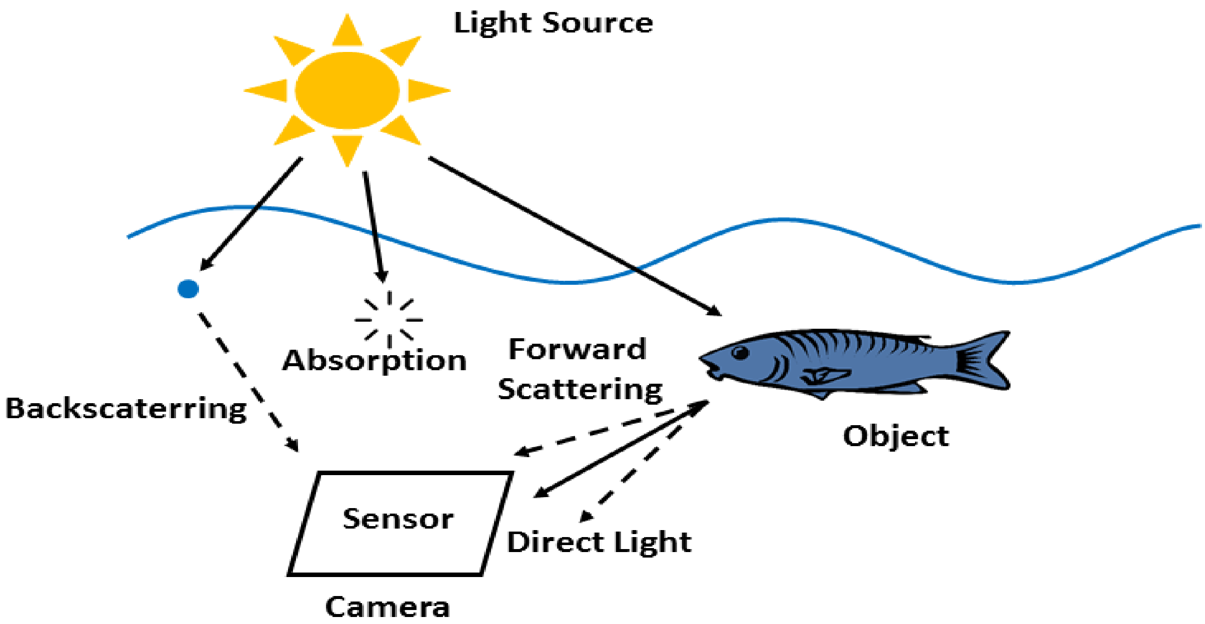

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Fig 1: Propagation of light underwater

IV. PROPOSED METHODOLOGY

Underwater images undergoes blurriness and colour imbalance due to the scattering and absorption of light. The images captured underwater will be pre-processed initially using the fast box filtering which basically averages the surrounding pixel. It divides the image into horizontal and vertical directions and adjoins to replace it. Guided filtering will be then used for edge preserving and effective for blur regions. Guided filtering uses input image itself as the guidance image with box filtered image. Later the filtered image will undergo dehazing processes using dark channel prior algorithm which will be carried out using the steps – atmospheric light estimation, transmission map estimation, transmission map refinement and image reconstruction. Thereby giving the clear haze free and noise free image compared to the input image. Figure 2 shows the block diagram of the proposed methodology.

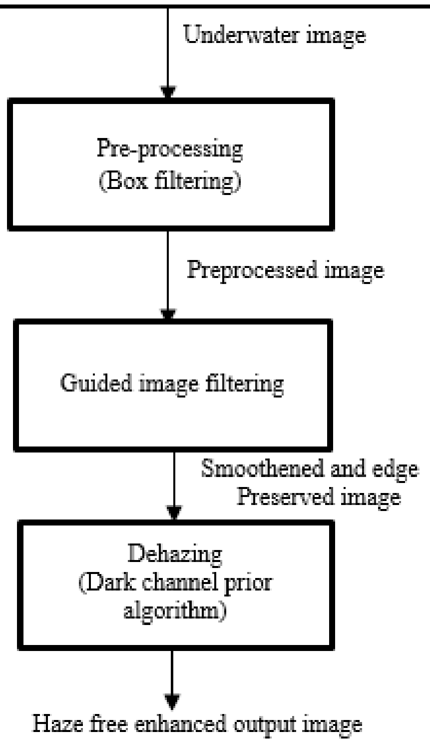

Fig 2: Block diagram of proposed methodology

Fast box filtering is implemented to average the pixel values. It performs number of times to get the average value and hence accelerating the guided filtering. It process by selecting a narrow window, the summation is computed as

$$R(x, y) = R(x-1, y) + I(x + r, y) - I(x - r - 1, y) \quad (1)$$

$$C(x, y) = C(x, y-1) + R(x, y + r) - R(x, y - r - 1) \quad (2)$$

Where I(x, y) is the value of pixel in an input image. Radius of window be the r and R will be the intensity summation in 1× (2r+1) narrow window and C be the intensity accumulation in the rectangular window (2r + 1) (2r + 1). Then the normalization must be carried out to get the output image.

$$O(x, y) = \frac{1}{(2r+1)^2} C(x, y) \quad (3)$$

Then the box filtered image will undergo guided filtering to preserve the edges. If the input image is p, guidance image is I and q be the output image. The guided filter is derived as,

$$q_i = a_k I_i + b_k \quad (4)$$

Where I is the pixel index and k be the local square window index. When the minimization of error in reconstruction in the middle of p and q is computed as,

$$a_k = \frac{\frac{1}{|\omega|}\sum_{i \in \omega_k} I_i p_i - \mu_k p'_k}{\sigma_k^2 + \epsilon} \quad (5)$$

$$b_k = p'_k - a_k \mu_k \quad (6)$$

Where μ_k and σ_k be the mean and variance of I and there exists a parameter ϵ which controls the smoothness degree. The guided filter output is derived as,

$$q_i = a'_i I_i + b'_i \quad (7)$$

Where a'_i and b'_i be the mean of 'a' and 'b' respectively. Finally the dark channel prior algorithm is used in order to get a haze free image. Dark channel is initially defined as,

$$J^{dark}(x) = \min_{y \in \Omega(x)} \left(\min_{c \in \{r,g,b\}} J^c(y) \right) \quad (8)$$

Initially it estimates the light in atmosphere and that is as follows,

$$A = I\left(argmax_x (I^{dark}(x)) \right) \quad (9)$$

With the estimation of light, transmission map estimation will be done where if the haze is taken off completely it might look so unnatural and hence some of it is retained and refined as follows,

$$t'(x) = a'_x t''(x) + b'_x \quad (10)$$

Where a_x and b_x represents the mean of all coefficients at pixel x. Reconstruction of image will be done where it includes some colour correction and after finding all the atmospheric light and transmission map refinement, dehazed image is given as follows with the parameter t_0 that keeps away the denominator with low value.

$$J(x) = \frac{I(x) - A}{\max(t'(x), t_0)} + A \quad (11)$$

V. RESULTS

The enhancement of underwater images is necessary and the proposed method is implemented and has got the successful results using the tool Spyder 3.5 and the obtained results are as follows which gives a clear colour corrected and haze removed image which is more clear and enhanced output image. The figure 3 and figure 5 represents the raw underwater image, figure 4 and figure 6 represents the enhanced output image.

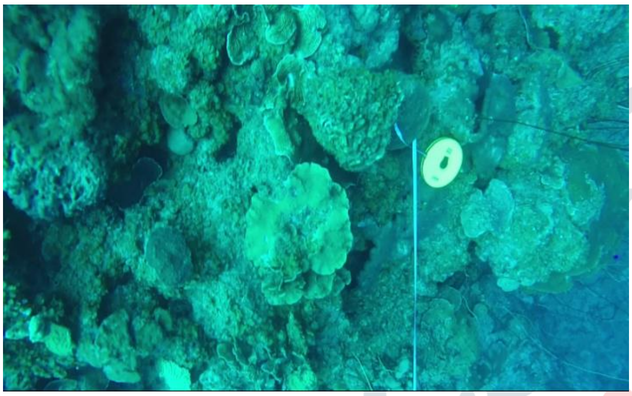

Fig 3: Input image

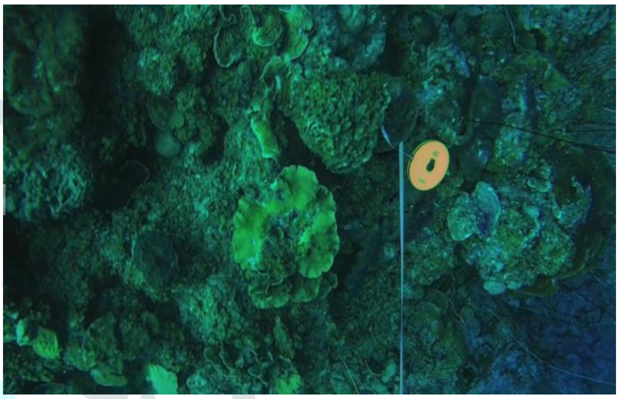

Fig 4: Enhanced output image

Fig 5: Input image

Fig 6: Enhanced output image

VI. CONCLUSION

In this paper, we have used an image enhancement technique that effectively enhances the underwater images which suffers from blurriness, colour imbalance and hazes due to many suspended particles. The input image will be initially preprocessed using box filtering that average the pixel and accelerates the guided filtering. Guided filtering is used to get the edge preserving factors and it uses a guidance image to process the image. Here in this approach input image after preprocessing is taken as guidance image. Guidance image smoothens the image and preserves edge factors. Dark channel prior algorithm is implemented that removes the hazes present in the image using four steps like atmospheric light estimation, transmission map estimation, transmission map refinement and reconstruction of image. Finally yielding a clear haze free image efficiently.

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