Removal of Artificial Light Source and Image Dehazing in Underwater Images Using WCID Algorithm

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***Abstract*— In underwater photography the two major sources of distortions that lowers the visibility and contrast are the light scattering and colour change. Light scattering is caused by light incident on objects reflected multiple times by particles present in the water before reaching the camera. Colour change occurs due to the attenuation encountered by the light travelling in the water with different wavelengths. An artificial light source is provided for avoiding the insufficient lighting in underwater photography, that causes overcompensation in underwater images. The existing underwater enhancement techniques cannot handle light scattering and color change distortions suffered by underwater images, and the possible presence of artificial lighting simultaneously. So a new method is developed to enhance the underwater images using Wavelength Compensation and Dehazing (WCID) algorithm.**

Keywords*— Image dehazing; light scattering; wavelength compensation; artificial light source.

I. INTRODUCTION

In underwater photographic system, the light transmitted from a subject is absorbed and scattered in the medium before it reaches the camera. This is due to the presence of fine suspended particles such as sand, minerals and plankton that exist in lakes, oceans and rivers.This process causes degraded photographs and often lack visual vividness and appeal. In underwater photography the two major sources of distortions are light scattering and colour change. Light scattering occurs when individual photons of light are reflected or diverted when they encounter suspended particles in the water. Colour change corresponds to the varying degrees of attenuation for different wavelength.

Fig. 1 Hazed underwater image

The presence of artificial light source add a luminance in the foreground area of the underwater image and often causes overcompensatiion. In Low Complexity Wavelength Compensation and Image Dehazing Algorithm [1,2] a novel approach is developed to enhance underwater images, by compensating the attenuation discrepancy along the propagation path, and the influence of the possible presence of an artificial light source is taken into consideration.

II. EXISTING METHODS

Conventionally, the processing of underwater images focuses solely on compensating either light scattering or color change distortion. Techniques targeting on removal of light scattering distortion includes image dehazing to restore the clarity of the underwater images [4,10]. Color-change correction techniques estimate underwater environmental parameters by performing color registration with consideration of light attenuation [11,8], employing histogram equalization in both RGB and HSI color spaces to balance the luminance distributions of color [3,6,9], and dynamically mixing the illumination of an object in a distance-dependent way by using a controllable multicolor light source to compensate color loss [7]. A systematic approach is needed to take all the factors concerning light scattering, color change, and possible presence of artificial light source into consideration. With the Low complexity wavelength compensation and image dehazing algorithm, expensive optical instruments or stereo image pairs are no longer required [2] and this algorithm requires less computational resources and complexity is reduced when compared to conventional Wavelength Compensation and Image Dehazing algorithm.

This paper is organized as follows. In section II, some of the existing methods is discussed. Section III, describes the proposed method. Section III concludes the project work.

III. PROPOSED METHOD

In Low Complexity Wavelength Compensation and Image Dehazing Algorithm first the distances between scenes objects to camera is estimated by using a low complexity Dark Channel Prior Algorithm. Based on the depth map derived the foreground and background area within the image is segmented. The light intensities of foreground and background are then compared, to determine whether an artificial light source is employed during the image acquiring process.If an artificial light source is detected, the added luminance is to be eliminated. The Wavelength Compensation and Image Dehazing algorithm are utilized to remove the haze effect and colour change along the underwater propagation path.

A. Underwater photographic system

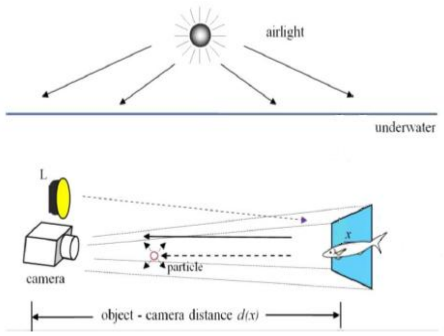

Fig.. 1The underwater photographic system

The underwater photographic system is provided with an artificial light source in addition to flash light of camera for avoiding the insufficient lighting in photographic environment. The light from both the camera and artificial light source is incident on surface points in the scene and reflected back to camera. In the propagation path between the subject and camera d(x), hazing and colour distortion occurs due to light scattering and varying degrees of attenuation encountered with different wavelength of light. The homogeneous skylight entering above into the water is the major source of illumination in an underwater environment.

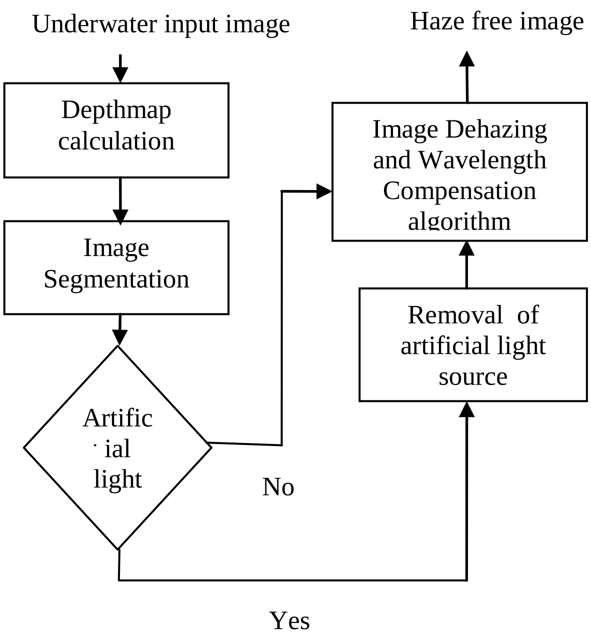

Fig. 2 Flow chart of the Low Complexity Wavelength Compensation and Image Dehazing algorithm.

B. Darkchannel prior algorithm

The dark channel prior [5], which is an existing scene depth derivation method, is based on the fact that, in most of the non background light patches on a haze free underwater image, at least one colour channel has a very low intensity at some pixels. The minimum intensity in such a patch should have a very low value, called a dark channel. Pixels with a very low value cannot be found in the local patch, which implies the existence of haze. The concentration of haze can be quantified by dark channel prior algorithm. This in turn provides the object camera distance, ie the depth map.

The underwater hazy image can be modeled by using the Radiative Transport equation,

$$I_\lambda(x) = j_\lambda(x).t_\lambda(x) + (1-t_\lambda(x)) . B_\lambda \qquad (1)$$

where $\lambda \in$ {red,green,blue}

Here 'x' is a point on the underwater scene, $I_\lambda(x)$ is the image captured by the camera, $j_\lambda(x)$ is the scene radiance at point x ie the actual amount of light source reflected from point x, $t_\lambda(x)$ is the residual energy ratio of $j_\lambda(x)$ after reflecting from point x in the underwater scene before reaching the camera. B_λ is the homogeneous background light and λ is the light wavelength. The residual energy ratio is a function of both the wavelength λ and the object camera distance d(x). The direct attenuation $j_\lambda(x) . t_\lambda(x)$ describes the decay of scene radiance in the water.

The dark channel can be calculated by using the equation,

$$\text{Darkchannel} = \min(I_\lambda(x)) \qquad (2)$$

where $\lambda \in$ {red,green,blue}

$I_\lambda(x)$ is the underwater image acquired by camera.The background light B_λ is usually assumed to be the pixel intensity with the highest brightness value in an image. The brightest pixel value among all local minima corresponds to the background light as follows,

$$B_\lambda = \max(\min(I_\lambda(x))) \qquad (3)$$

The depth map can be calculated by using the formula.

$$\text{Depth map} = 1-\min\{\text{median}(I_\lambda(x))/B_\lambda\} \qquad (4)$$

The median filter is used to reduce the block effect.

Fig. 3 Depth map

C. Image Segmentation

The foreground and background areas of the underwater image are segmented based on the depth map derived using a threshold.

Foreground if $d(x) > threshold$
Background if $d(x) <= threshold$

D. Determination of Artificial light source

The existance of an artificial light source can be determined by comparing the difference between the mean luminance of the foreground and background images. Higher mean luminance in the foreground indicates the existence of a supplementary light source.

E. Removal of artificial light source

For removing the artificial light source, first the average intensity of both the foreground and background image is calculated. Then take the difference between foreground intensity and background intensity. In the next step find the luminosity updated foreground intensity is find out by subtracting the difference intensity from the foreground intensity. Then by adding the updated foreground with the background the image free of artificial light source is obtained

Fig. 4 Artificial light source removed image

F. Compensation of Light Scattering and Color Change

After removing the artificial light source and deriving distance d(x) between an object and the camera, the haze can be removed by subtracting the in-scattering term $(1-N_{rer}^{d(x)}) \cdot B_{\lambda}$ from image perceived by the camera.

Fig. 5 Haze free and wave length compensated image

Next, the color change encountered during the object–camera path can be corrected by dividing the dehazed image by the wavelength-dependent attenuation ratio $N_{rer}^{d(x)}$.

IV. CONCLUSION

The underwater image suffers from low contrast and resolution due to poor visibility conditions, hence an object identification become typical task. The underwater image enhancement using Low Complexity Wavelength compensation algorithm is used to enhance underwater images by a dehazing algorithm, to compensate attenuation discrepancy along the propagation path, and to take the influence of the possible presence of artificial light source into consideration.

In this project the influence of the artificial light source is removed from the underwater input image. For removing the influence of artificial light source, first the depth map is derived. Based on the depth map derived the image is segmented to foreground and background images. Then the presence of artificial light source is detected by comparing the mean luminance of foreground and background images. If the luminance of foreground is greater than the background, then there exists an artificial light source. If the presence of artificial light source is detected then the influence of it is eliminated from the hazed underwater image.

The haze effect can be removed by using WCID algorithm. The low complexity is achieved by using a median filter in the dark channel prior algorithm.

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