International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 11, November-2014

Reconstruction and Restoration of Underwater Image : Study and Realization

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Abstract— **An image processing is a technique in which the data from an image are digitized in order to create an enhanced image. Underwater photography presents unique challenges due to the properties of water and its effect on light. Absorption of light in water is different as with in air. Therefore, it is important to understand the ramifications of this fact and what you can do to compensate and capture good images underwater. Restoration of an underwater object from an image distorted by moving water waves is a challenging task. In this paper we will discuss how light changes as it enters the water. We will also discuss the techniques to reduce unwanted scatter in photographs and how to restore colour. This paper proposes dehazing algorithm to balance light scattering and removes artificial light by using depth map. Next water depth is estimated by background color. Color change compensation is done by residual energy ratio. A new approach is presented in this paper. We make use of a special technique called wavelength compensation and dehazing technique simultaneously to analyze the raw image sequences and recover the phase information of the true object. We test our approach on both pretended and data of real world, separately. Such technique has wide applications to areas such as ocean study and submarine observation.**

Keywords- Underwater image, color change, light scattering, wavelength compensation, image dehazing.

I. INTRODUCTION

Light scattering and color change are two major sources of distortion for underwater photography Water is a substance which is 800 times denser than air. As light enters the water, it comes in contact with the water molecules and suspended particles to cause light loss, changes in color, diffusion, contrast loss and other effects. The way light changes under water is responsible for the typical under water 'atmosphere'. Underwater imaging is one of the challenging tasks in the field of image processing and computer vision. Unlike shooting on land, available light (the sun) alone will normally not provide the right light to produce the colorful images. Underwater light is affected by deepness, subject distance, atmospheric and surface condition. Usually, underwater images suffer from non consistent lighting, low contrast, less color, and indistinct due to attenuation leading to reduction in the strength of a signal, occurring with any type of signal, whether digital or analog. Over the last few years, many researchers have generated various image enhancement and restoration algorithms for enhancing the quality of images captured in underwater environments. The purpose of digital imaging is divided into 5 groups. They are: 1.Visualization 2. Image sharpening and restoration 3. Image retrieval 4. Measurement of pattern 5. Image Recognition. The three general phases that all types of data have to undergo while using digital technique are former processing, enhancement and display, information extraction.Conventionally,the processing of underwater images focuses solely on compensating either light scattering or color change distortion. An organized approach is needed to take all the factors concerning scattering of light, colour change, and probable presence of synthetic light source into consideration. Artificial light is removed by using depth map. Once the depth map i.e the distances between the objects and the camera is estimated then the foreground and background within a scene are segmented. The light intensities of front and background scene are checked to determine the artificial light.

II. DEPTH MAP

Dark-channel prior ,a scene-depth derivation method, is used first to calculate the distances of the scene objects to the camera. First an image is kept in an array. Next it is compared to the image of the other camera by taking square regions of pixels and comparing the intensity between the two cameras images. Third the depth of a given pixel region is calculated and kept in an array. Finally this array of depths is changed into color for maximum clarity, with bright colors being closer and dull colors being more far. Complete and well lit objects are the best to find the distance. Large blocks of solid color will produce black or nearly indiscriminate results.

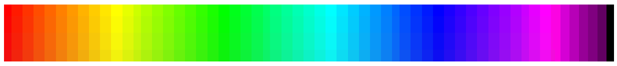


Fig 1.Colors from close to far

Calculate Depth

Now the depth value (between 0 and 255) is converted to a color to better show how far away the object is. Red is the closest in color list to black as the furthest. The real depths these colors symbolize is dependent upon your cameras and their distance from each other. The algorithm for wavelength compensation and image dehazing (WCID) proposed in this paper combines techniques of WCID to remove distortions caused by light scattering and color change.

III. LIGHT SCATTERING AND COLOR CHANGE

Haze is caused by suspended particles such as sand, minerals and plankton that exist in lakes, oceans, and rivers. As light got reflected from objects propagates toward the camera, a portion of the light meets these suspended particles. This in turn absorbs and scatters the light beam, as illustrated in Fig. 1.Techniques targeting on removal of light scattering distortion include I. Exploiting the polarization effects to compensate for visibility degradation ii. Using image dehazing to restore the clarity of the underwater images and iii. Combining point spread functions and a modulation transfer function to reduce the blurring effect. Although the above mentioned approaches can enhance scene contrast and increase visibility, distortion caused by the disparity in wavelength attenuation, i.e. color change, remains intact. On the other hand, color-change correction techniques estimate underwater environmental parameters by performing color registration with consideration of light attenuation i. Employing histogram equalization in both RGB and HSI color spaces to balance the luminance distributions of color ii. Wavelenght Compensation Method and iii. dynamically mixing the illumination of an object in a distance-dependent way by using a controllable multicolor light source to compensate color loss. Despite the improved color balance, these methods are ineffective in removing the image blurriness caused by light scattering. A systematic approach is needed to take all the factors concerning light dispersion, color modification, and possible occurrence of synthetic light source into consideration.

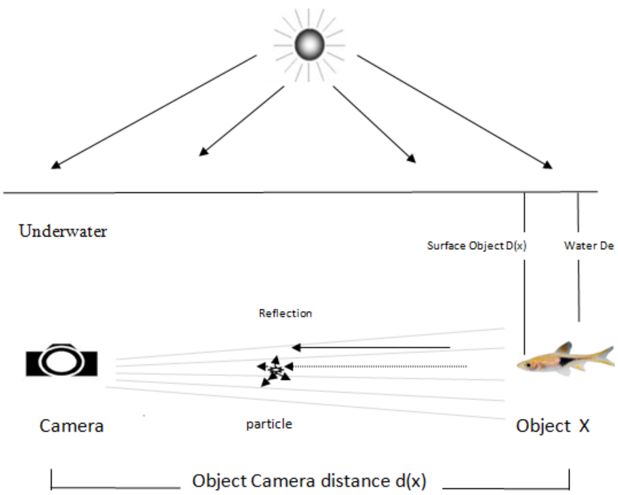


Fig 2. Light Scattering Natural light enters from air to an underwater scene point X . The light reflected propagates distance d(x) to the camera interacts with particles causing reflection and deflection.

IV. LIGHT AND COLOR LOSS

Water is approximately 800 times denser than air, and this density absorbs light - quickly. Not only does this result in dull, monotone colors, but it also reduces contrast and image sharpness. New underwater photographers often get disturbed from the blue / gray hue of their images - a direct result of the properties of water and the affect of light absorption. This is really a very common problem and there are several approaches to reintroducing color and clarity to your images.

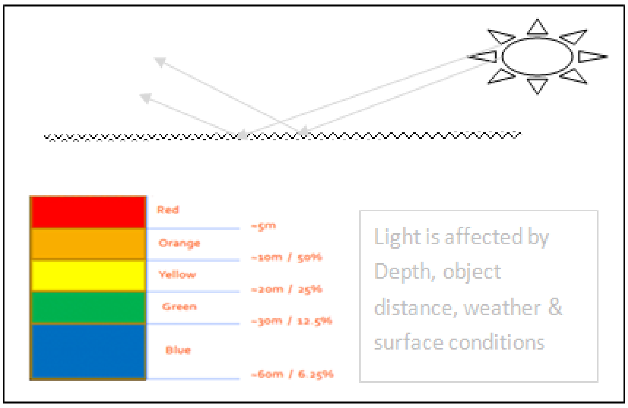


Fig.3. Light Loss

Exact frequencies of ambient light get absorbed at diverse depths, from the longest wavelength to shortest. Red almost disappears at about 5 meters, trailed by orange at 10 meters, yellow at about 20 meters, green at 30 meters and eventually even blue at about 60 meters.

Color Loss Water particles interact with light by absorbing certain wave lengths. Firstly the reds and oranges disappear, later the colour yellows, greens and purples and last the blue. Loss ofcolour red is dramatic and is already noticeable at 50cm. At 5 metres depth some 90% has got disappeared. Since the loss of colour varies critically with distance, it is required to make corrections by applying colour correction filters. Their use is explained later on and their effect is quite substantial..The picture shows that it is the total light path that matter.

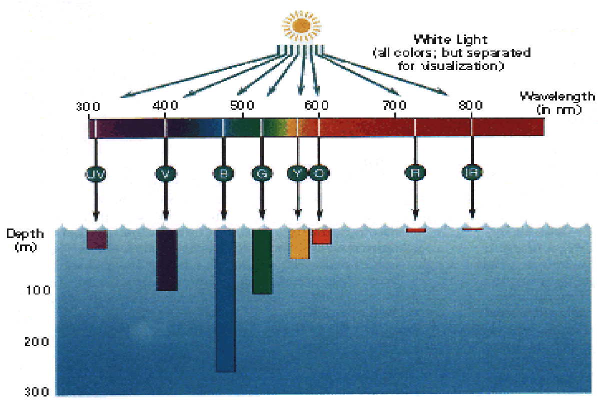


Fig 4. Loss of Color with respect to depth of water

V. EXPERIMENTS

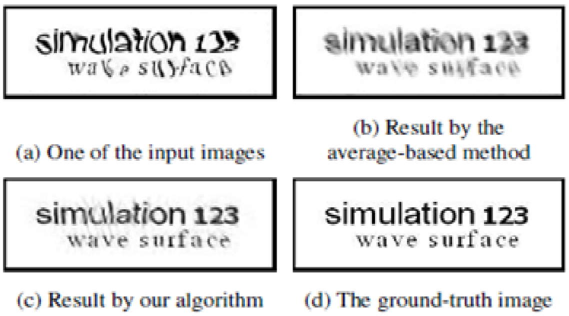


Fig 5. The Simulation Results

We would be testing our algorithm on both simulated and real-world data. Expected results would show that our algorithm is promising. Simulation (a) One of the input images (b) Result by the average-based method (c) Result by our algorithm (d) The ground-truth image. The image reconstructed by the algorithm is expected to be much sharper than the output estimated by the average-based method .

VI. OUR APPROACH

Our study will be focused on wavelength compensation and dehazing analysis; the auto level adjustment and manual adjustment to enhance the underwater habitat images. The proposed WCID algorithm proceeds in a direction inverse to the underwater image formation path discussed above as depicted in Fig. First, consider the possible presence and influence of the artificial light source. Next, remove the light scattering and color change that occurred along the course of propagation from the object to the camera. Finally, compensate the inequalities of wavelength attenuation for traversing the water depth to the top of the image and fine-tune the energy loss by deriving a more precise depth value for every point within an image.

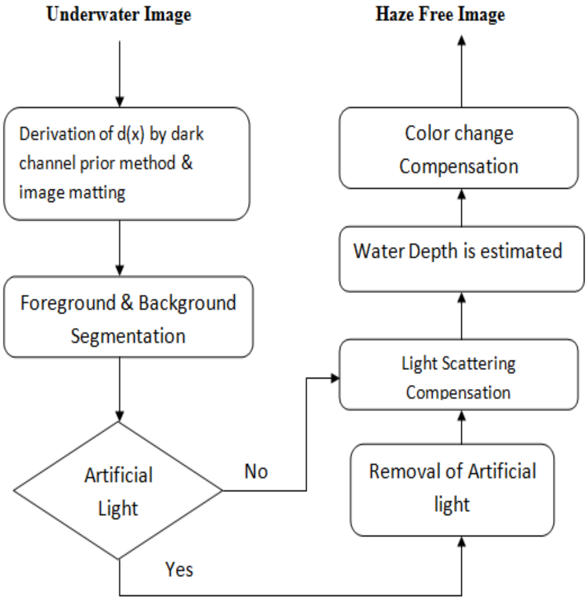
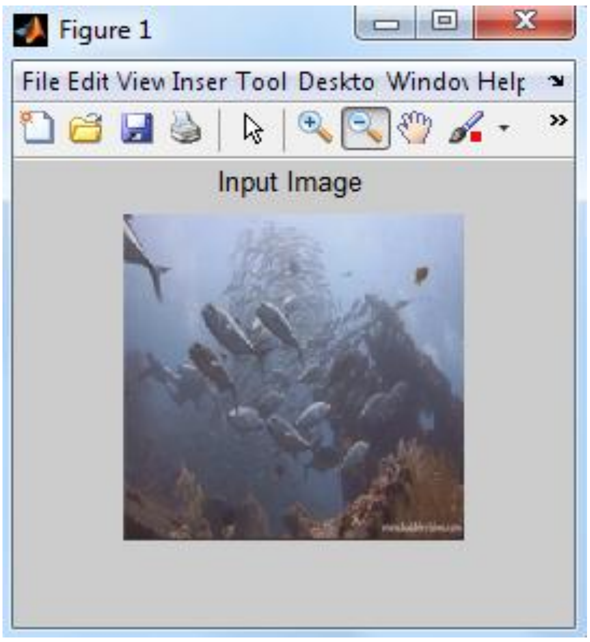
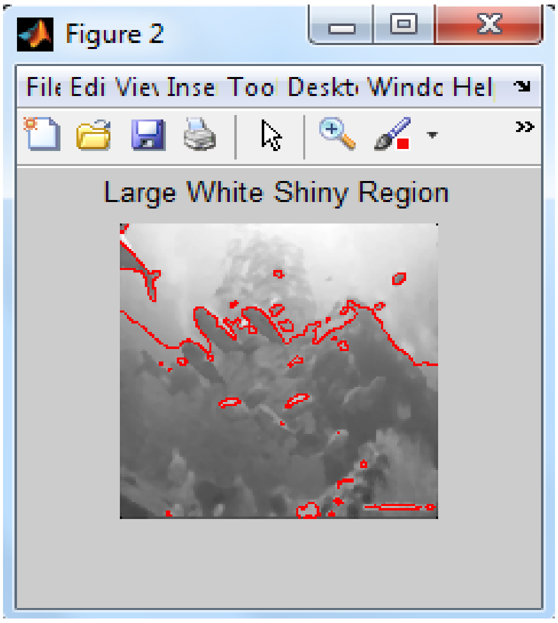


FIG 6. FLOWCHART OF WCID ALGORITHM

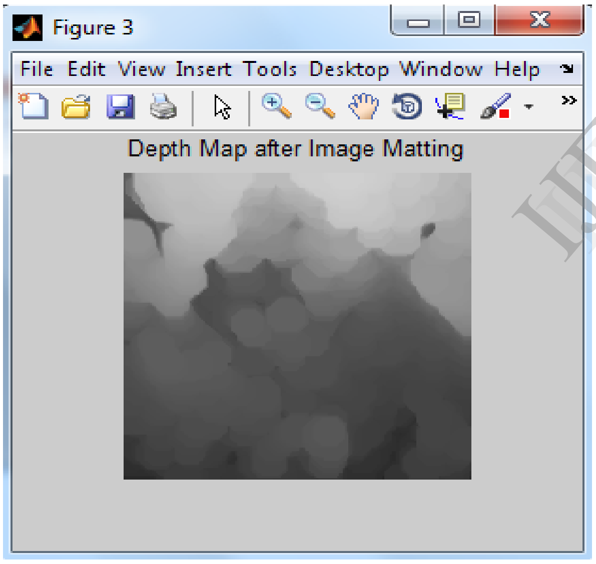
VII. EXPECTED OUTCOME

Fig 1. In the expected outcome is the actual input being applied.it is clear from the input that the image is full of haze and it has lost its brightness i.e it has lost its original color.

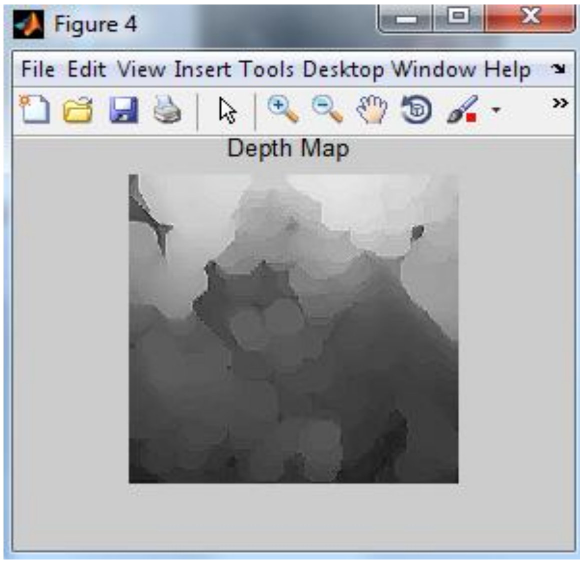


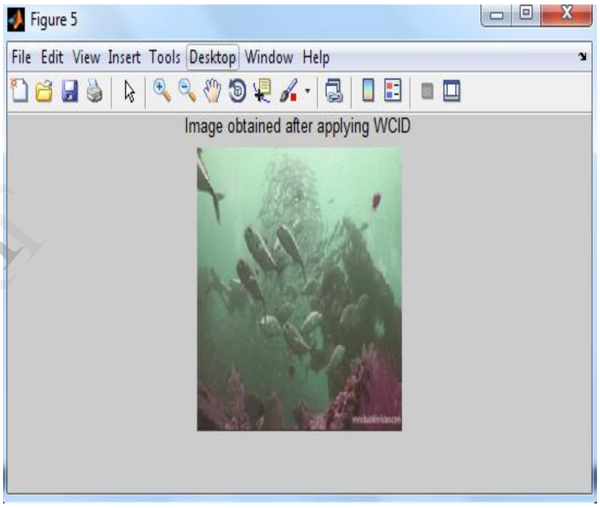


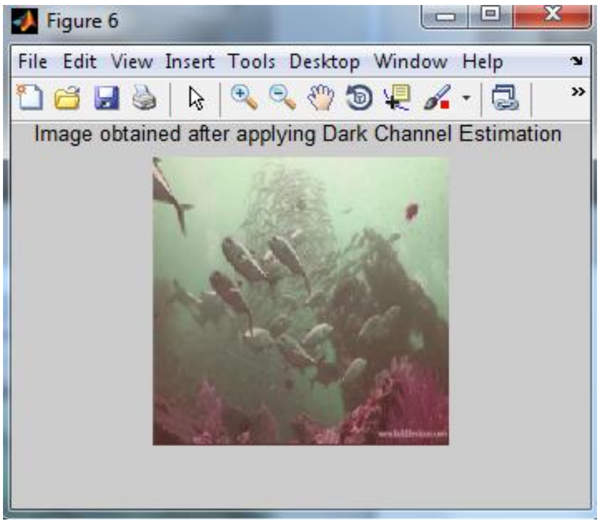
Once the distance between the object and the camera is calculated the front and the back scene in an image are segmented as shown in Fig. 2



Once the distance between object and camera is calculated and image segmentation is done depth map is calculated and image matting is done as shown in Fig. 3. Dark Channel prior an existing scene depth method is used to calculate the depth map as in the Fig.4.







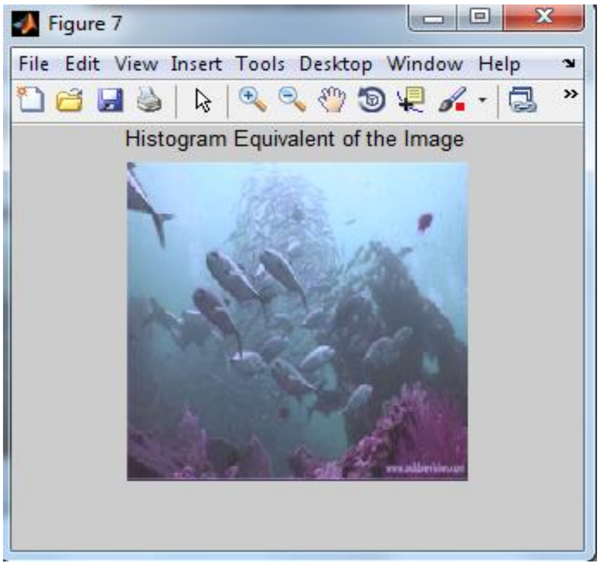


Fig 5, Fig. 6 and Fig. 7 shows different methods to enhance the underwater iamge. It could be clearly seen from the output that the output generated by WCID method is far more better as compared to Dark Channel Estimation and Histogram Equivalent method. The image obtained with Histogram method is somewhat gray incolor whereas with dark Channel Estimation Method has lost its color.

CONCLUSION

The WCID algorithm proposed in this paper can effectively restore image color balance and remove haze. To the best of our knowledge, no existing techniques can handle light scattering and color change distortions suffered by underwater images simultaneously. The experimental results demonstrate superior haze removing and color balancing capabilities of the proposed WCID over traditional dehazing and histogram equalization methods. We propose an original idea to reconstruct a submerged object distorted by moving water surface. The Wavelength compensation and dehazing technique is employed to recover the phase of the true object. Although experiments demonstrate that our approach is promising, there exist some limits. One boundary is that our algorithm needs a large computer memory and heavy computation. Another limit is the recursive phase recovery method with only a subset of the phase information. This may lessen the resolution of the output. To overcome such limits is the next step in our research exist some limits. One boundary is that our algorithm needs a large computer memory and heavy computation. Another limit is the recursive phase recovery method with only a subset of the phase information. This may lessen the resolution of the output. To overcome such limits is the next step in our research

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