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Improving Interpretability of an Underwater using Undecimated Wavelet Transform

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Abstract - *Image processing is one of the rising fields in the present scenario. In this, enhancing underwater imaging is a challenging task. Identifying the living and non-living things in underwater is a complicated task in the present era. Generally these images are of low contrast where the visibility of objects is not clear because of the poor quality. As the depth of the water increases the problem of identifying the objects becomes much more complex. The problems vary according to the type of water, depth, distance between the camera and object. This paper deals with improving interpretability of an underwater image using undecimated wavelet transform by working on the white balance and color correction. This process involves few steps. In the first step, histogram equalization is performed on the underwater image for contrast adjustment. In the second step, white balancing is performed in order to enhance the dark regions in an underwater image. In the next step, the outputs from step1 and step2 are fused using undecimated wavelet transform.*

***Key Words*: Undecimated wavelet transform, white balance, color correction**

1. INTRODUCTION

Earth is an aquatic planet. 70 percent of its area is covered by water. It is crucial to get the clear images in order to work on underwater images. As the air environment deals with problems like dust particles, natural light, reflection, distance between object and camera issues, underwater environment also faces same problems [1]. The quality of images depends on depth of the water, density of the water and distance between the object and the camera.

The visible spectrum plays a crucial role in underwater images. Light scattering effect and color change effect are the problems in the underwater image. The image visibility and quality is good if the water is transparent and pellucid. The water becomes denser due to planktons, sand and minerals as the depth of the water increases. When the object is being captured, the camera light gets deflected and reflected by different particles in the underwater environment. Some portion of the camera light is absorbed by the particles. Initially, this scattering effects results in low contrast with reduced visibility of image. Next, the color change effect depends on the wavelength of light travel in the water. The color which is having highest wavelength will penetrate short distance in the water [2]. As per VIBGYOR (Violet-Indigo-Blue-Green-Yellow-Orange-Red), red color is having highest wavelength, so it penetrates shorter distance. Blue color has the shortest wavelength, so it penetrates very long in the deep sea water. That is the reason why ocean water looks blue in color. Practically, in underwater conditions, the objects at a distance of more than 10 meters are almost indistinguishable. There have been several attempts to restore and enhance the visibility of such degraded images. Figure.1 shows the penetration of light in under water.

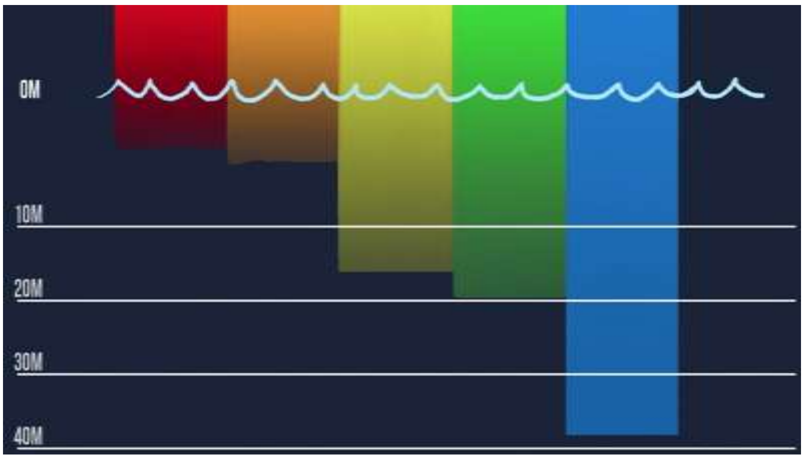

Fig.1. Penetration of light in underwater environment

II. LITERATURE SURVEY

Enhancement of image is the pre-processing step to improve the information or quality of the image. This method can be applied to the color image, grayscale image, underwater image, satellite image, etc. Underwater images can be improved using image enhancement techniques like Histogram Equalization, Dark-channel prior method, Wavelength Compensation & image de-hazing (WCID).

Dark channel prior:

Dark channel prior method is used to solve the light scattering problem for the degraded image[3]. The problem arises when the scene of the object is similar to the background light. So this method is not preferable for underwater image enhancement.

Wavelength Compensation and Image Dehazing (WCID):

In this technique, dehazing algorithm is combined with the wavelength compensation [4]. The dark prior model is used to estimate the distance between camera and the objects. Dehazing algorithm is used to remove the color scattering. Next photography scene depth is estimated from the energy of each wavelength in the background of an image. Restoring the distortion from color cast is performed by reverse compensation. Wavelength compensation and image dehazing algorithm (WCID) overcomes all the problems related to color change effect and light scattering.

Unsupervised Color Correction Method (UCM)

Unsupervised Color Correction Method (UCM) is based on color balancing and contrast correction of HIS (Hue Saturation and Intensity) color model and RGB color model [5]. This model provides color balance in an image. It improves the illumination with an increase in actual color by removing the color cast.

III. PROPOSED METHOD

In this paper a new technique is proposed to enhance the underwater image quality. In this method stationary wavelet transform is used to recover the details of the objects under water. This process involves three vital steps. They are

1. White Balancing

White balancing reduces the bluish and reddish tint by adjusting the color components and it removes the unfeasible color casts, so that objects appear white in the picture as shown in Fig.2. Color temperature should take into account when dealing with the white balancing of an image. Color temperature refers to the coolness or warmth of white light. White balancing is done by using mean filtering [6]. It is one of the effective methods for under water images.

Fig.2. Image before and after white balancing

2. Color correction

Generally, images are degraded due to poor contrast and brightness. Color correction is done by adjusting the contrast adjustment with the help of histogram equalization [7].Fig.3 shows the color correction of an image.

Fig.3. Image before and after color correction

3. Image Fusion using undecimated wavelet transform

In machine vision, single image doesn't contain all the information. So it is preferable to fuse to images. Image fusion is a process of combining two or more images into a single image for extracting the important features of each single image [8],[9]. Image fusion is done in two ways. They are transform fusion and spatial fusion. In this paper spatial fusion is performed. Types of spatial fusion are

3.1. Simple Averaging

1. The pixel values of two images is taken and added.

2. Average is obtained by dividing this sum by 2.

3. $H(x, y) = [U(x, y) + V(x, y)]/2$……………………………………………..Eq.(1)

Where U(x,y) and V(x,y) are the input images. i.e.., U(x,y) is a white balanced image and V(x,y) is a color corrected image.

4. The obtained average value is assigned to the corresponding pixel of the output image

5. This process is repeated for all the pixel values.

3.2. Select Maximum

1. The focus of the image depends on the pixel values. If the pixel values are of higher values then the focus is more.
2. In this algorithm, the in-focus regions are choosen using the higher pixel values which results in highly focused image.
3. The greatest pixel value is assigned to the corresponding pixel.

Undecimated Wavelet Transform

Stationary wavelet transform is also known as un-decimated discrete wavelet transform. It is similar to the discrete wavelet transform. This is done by suppressing the down sampling and up sampling in the inverse transform.

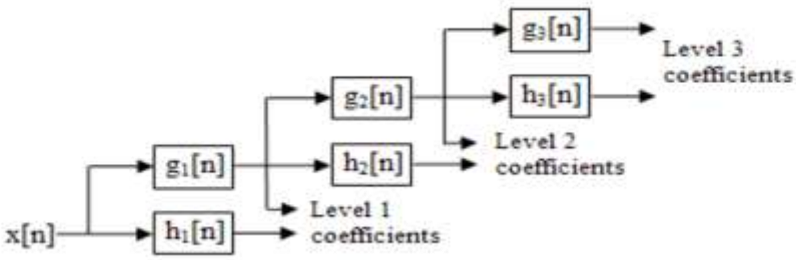

Fig.4. Obtaining coefficients using Stationary wavelet transform

ALGORITHM

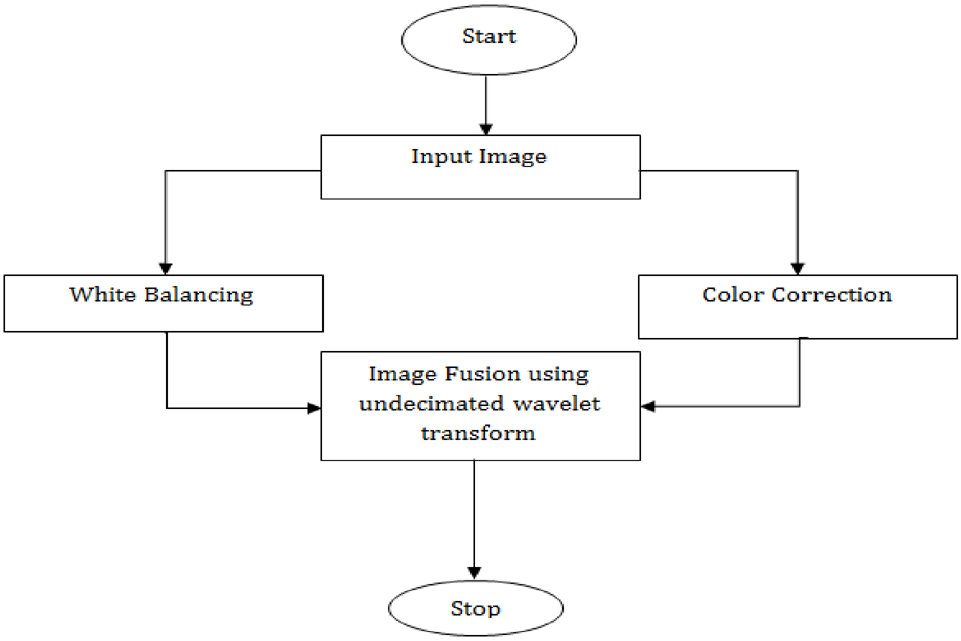

Image fusion is done using many transforms like discrete wavelet transform and Pyramid Transform. Multi-scale transforms use discrete wavelet transform or pyramid transform for representing the source image at multi-scale. The disadvantage of pyramid transform includes lack of flexibility and blocking effects [10]. To overcome these problems, DWT approach is considered. But, discrete wavelet transform (DWT) suffers from poor directionality and lack of shift invariance. To avoid these disadvantages a Dual Tree Complex Wavelet Transform (DTCWT) is proposed [11]. But it is more expensive, computationally intensive and approximately shift invariant.

IV. Simulation Results

In this paper, the performance of proposed method is compared with the wavelength decomposition and image dehazing algorithm. Initially input image is taken and histogram of RGB planes is obtained as shown in Fig.5 and then the input image is subjected to white balancing and histogram of RGB planes is obtained as shown in Fig.6. In the next step, color correction is performed for input image and histogram of RGB planes is measured as described in Fig.7. Image fusion is performed using stationary wavelet transform which is shown in Fig.8.

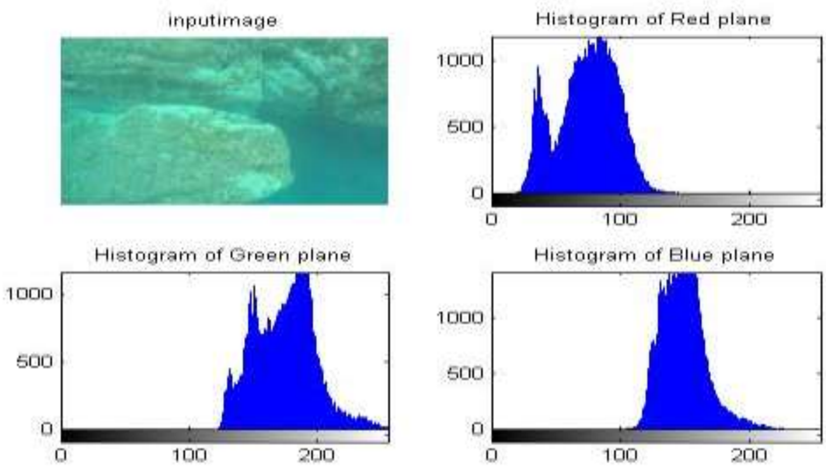

Fig.5. Input image and its histogram

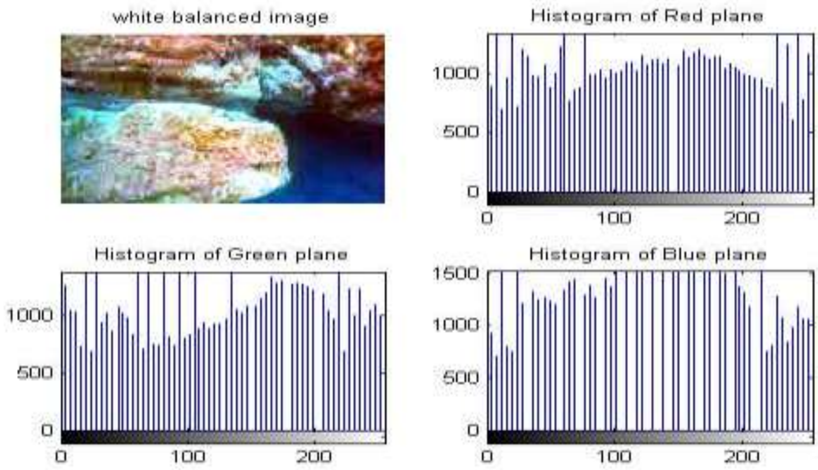

Fig.6. White Balanced image and its histogram

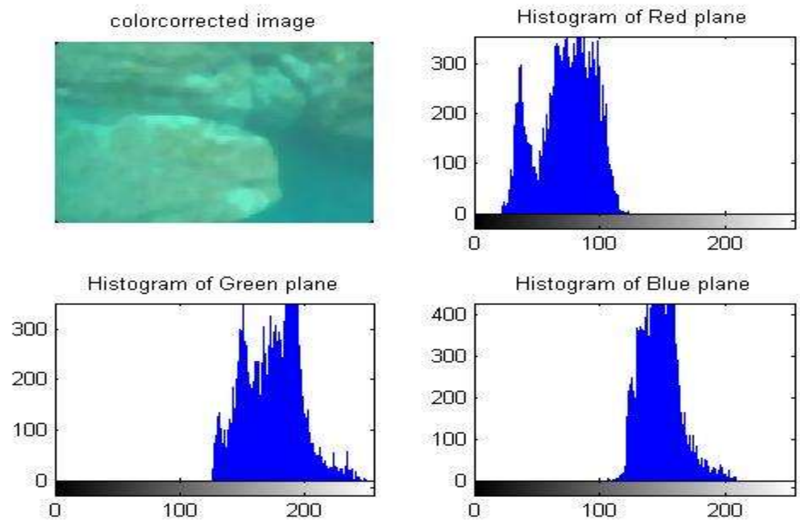

Fig.7. Color corrected image and its histogram

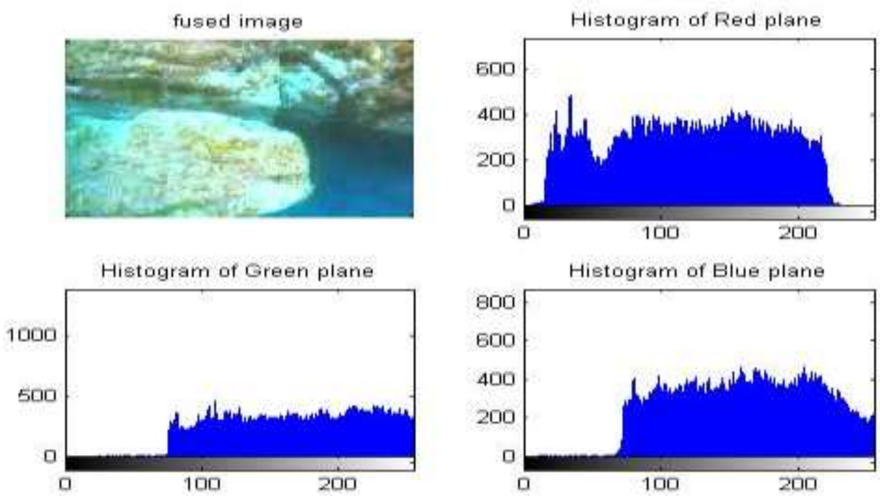

Fig.8. Fused image and its histogram

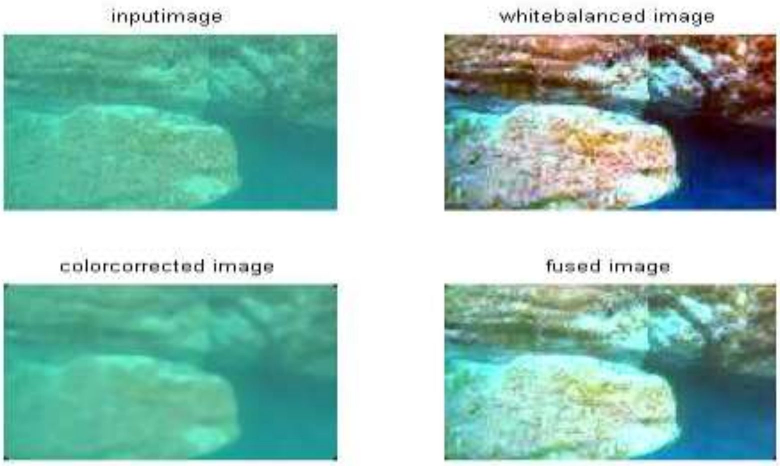

Fig.9. Enhancing the underwater image using stationary wavelet transform

Table.1. Comparison of different methods

Method	PSNR(dB)
UCM	13.62
CLAHE	15.34
WCID	18.72
Proposed Method(SWT)	20.82

V. Conclusion

In this paper, the enhancement of underwater image is done using Stationary wavelet transform (SWT). This technique restored the degraded underwater image very effectively. The tint in the degraded image is reduced by white balancing which uses mean filtering. The contrast of image is increased by color correction using histogram equalization. The proposed SWT method is compared with the previous methods like UCM, CLAHE and WCID. The PSNR criteria is measured and from table.1. It is clear that the proposed method performs better than previous methods.

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