ABSTRACT

In the recent days, wide range of research has been carried out on visual enhancement of under images in submarine and military operations to discover submerged structural designing and sea floor exploration. But, diving in the deep ocean for a long time has increased the difficulties for analysis of underwater images. Further, other factors such as scattering resulting from presence of particles inside the water and blurring effects reduce the quality of images being captured by underwater optic camera. There are several algorithms have been introduced to improve the visual quality of deep-water images. Therefore, in this project, a novel algorithm based on bidirectional Empirical Mode Decomposition (BEMD) to enhance the visual quality of the underwater images will be implemented and comparison of data with conventional enhancement technique will be illustrated. The implementation will be done using MATLAB software.

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CHAPTER 2

LITERATURE SURVEY

The earth is associate aquatic planet and the maximum amount as eightieth of its surface is roofed by water. Moreover, there is a strong interest in knowing what lies in underwater. Present days, an image of deep waters has a scope to large investigation to explore the underwater for sea floor expedition and navigation. Enthusiasm of underwater imaging includes the inspection of plants, seabed exploration, the search for wrecks up and to the exploration of natural resources. There were several issues faced by the human in the underwater, if he dives deep into the ocean and stay there for a long time to perform experimentation[1] – super script. Due to the above reasons, unmanned remote vehicles are used to sea floor exploration.

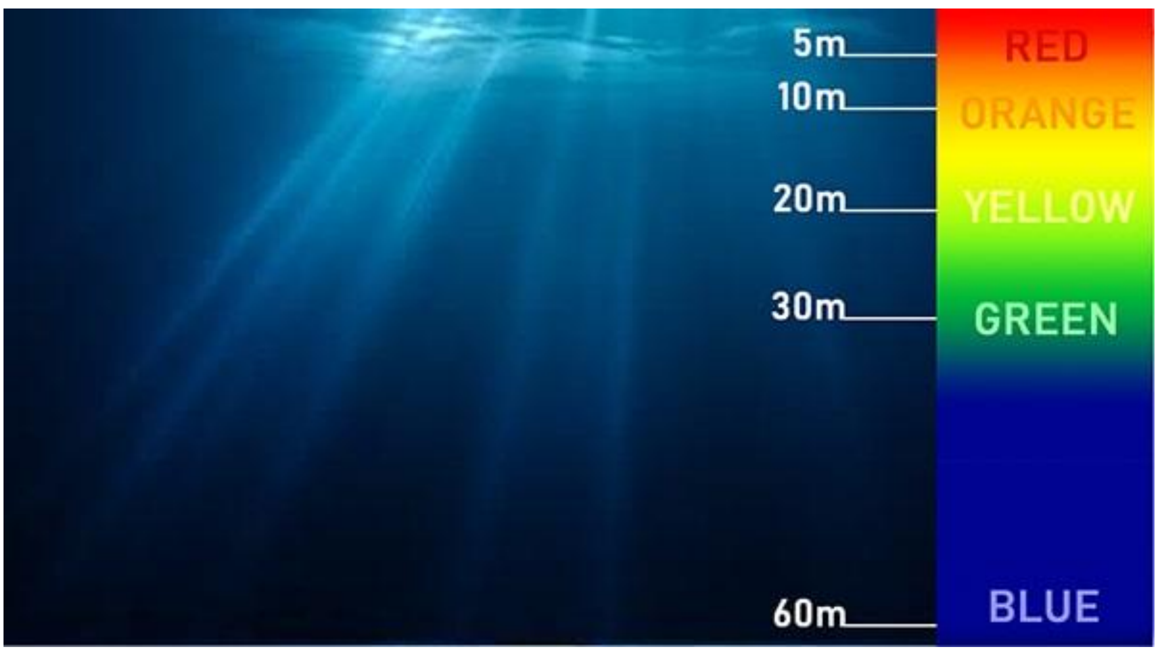

Figure 2.1 Absorption of Light Underwater

Now-a-days, underwater image possess a large research area to discover the underwater for sea floor exploration and navigation. The applications including submerged environment observing, discovering potential outcomes for connected purposes for structural designing and appraisal of coral reefs have an enormous enthusiasm for investigation range for submarine and military operations. But, the lack of ability of the human being in diving in the deep ocean for a long time has increased the difficulties for underwater analysis . Under-water Remotely Operated Vehicle(UROV) are used these days for underwater analysis. But, poor lighting condition and absorption of light inside the water causes low quality to the image taken by the UROV. There are different kinds of phenomenon to disrupt the under water image like scattering effect which is because of presence of particles inside the water, blurring effect because of poor lighting condition and vignetting effect because of lens used in underwater optic camera [1]. The main problem inside the water is the absorption of light.

One of the scattering effects is the back-scattering. It is an additive noise in the form of marine snow patterns which appear due to reflection of the light from a given natural or artificial source on the suspended particles in the direction of the camera. Adreas et.al. [2] has proposed a method which typically concentrate on local contrast equalization to balance the non-uniform lighting caused by back scattering. To denoise the underwater image in the filter domain Arfia et.al. [3] has introduced a method based on the characteristics of the EMD and wavelet technique. Aysun et.al. [4] has proposed an empirical mode decomposition method to enhance the poor quality underwater image. Fig. 1: Absorption of light by water Most of the time, due to presence of un-canonical illuminants inside the water heavy unwanted color cast occurs in the image. So images with color cast goes through lost shading differentiation and variety.Shen et.al. [5] has proposed an white balance algorithm through the average equalization and threshold to restore the unwanted color cast. Choudhary et.al. [6] has observed that the images with color cast have standard deviation is different from other color channels. So they proposed a color constancy algorithm using the statistics of image to remove the color cast. Huo et.al. [7] has proposed a white balance algorithm using extracting gray color points in images for color temperature estimation.

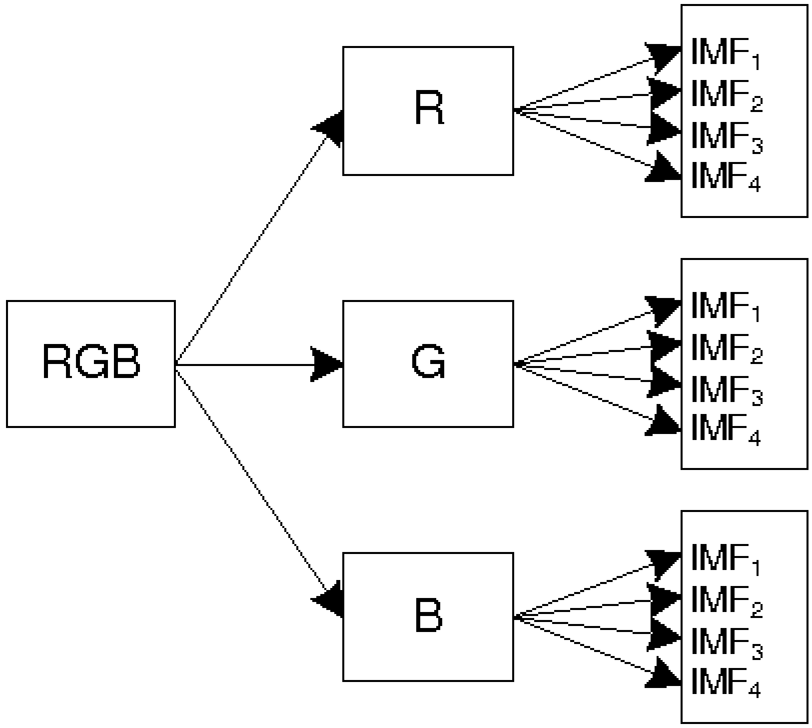

Figure 2.2 EMD Basic Block Diagram

Image enhancement is a universal technique known to restore the optical quality of images or acknowledgment of data in images for human viewers. This paper describes an algorithm where the image is processed through a white balance algorithm which eliminates the unwanted color casts. Then, an EMD technique is used to enhance the resulting image and to restore the color. The final image is compared with different conventional methods visually and statistically, and found to be one of the better enhancement algorithms.

A. Historical Development

Underwater image quality improvement approaches present a path to magnify the object recognition in underwater surrounding. A heap of research started for the upgradation of image visual quality, but a little amount of work has been carried out in this area. In the deep waters, image quality is degrading due to poor illumination conditions and the light properties differ in water compared to air.[2]. There were several parameters which decreases the quality of an image in underground waters. So in order to remove all these effects

there are several techniques has been implemented and practiced.

B. Need for Pre process

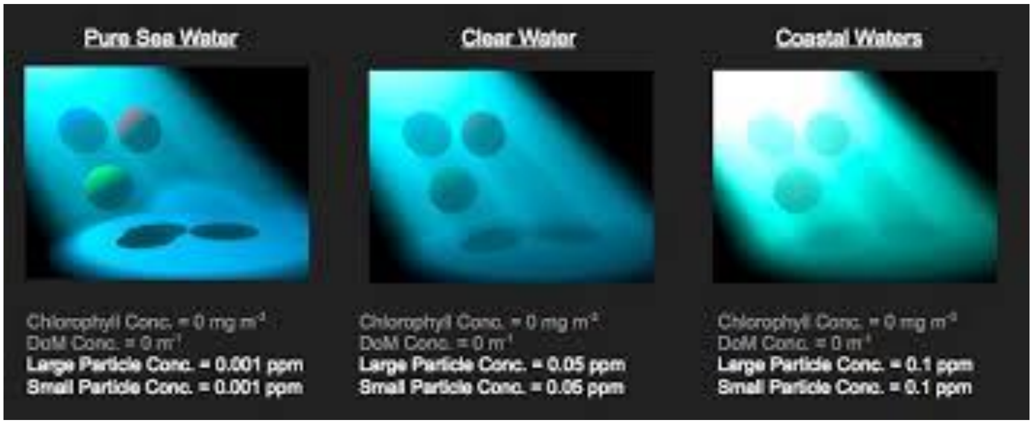

Figure 2.3 Water Scattering due to dust

Initially processing is necessary for deep water images due to their poor-quality during acquisition. Necessity for pre-processing of deep-water images [1] are discussed below:

(i) Quality of images taken from deep water is deteriorated due to light ray attributes like scattering and absorption of light.

(ii) Specificity of surroundings such as lighting inequalities, water torridness, and blue complexion is more or less influential when vehicles move.

(iii) Video or image captured from deep waters like unknown rigid scene, and the depth of the scene and low light sensitivity due to Marine snow etc.

TRADITIONAL TECHNIQUES FOR IMAGE ENHANCEMENT

There are several techniques which are used very frequently for processing the image to improve the visual quality. Some of them are as follows:

(i) Contrast Stretching

(ii) Adaptive Histogram Equalization

A. Contrast stretching

The contrast stretching is a method to transform high intense region of image into brighter and less intense region into darker by using a predefined transformation function T(r) [2]. Generally, the underwater images will have fewer grey values. There are 256 grey values. '0' indicates black and '255' indicates white. In this method the current grey value of the image is stretched towards 255 i.e., from black to white, pixel by pixel. That means the contrast of the image is stretched, so that the quality of the image is improved for better vision.

For example:

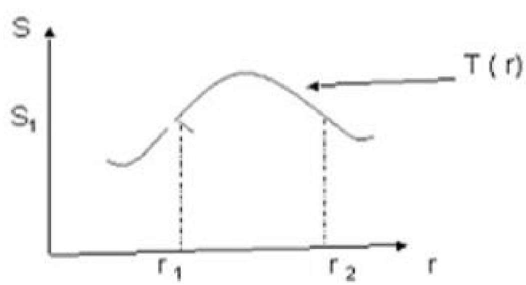

Figure 2.4 Two different gray levels look same

Here two different thresholds are considered for the entire image and the values between them are stretched to the maximum extent, so that the contrast increases. And more over by this method the entire global image contrast is enhanced.

Figure. 2.5 (a) Raw image (contrast) (b) Enhanced image

But the disadvantage here is that the transformation function is not unique. Depending on the application the suitable transformation function is chosen.

B. Adaptive histogram equalization

Adaptive histogram equalization is a PC based image processing technique which is used to improve the quality of image properties like contrast. It is similar to contrast stretching method but with a slight difference. It computes several intensities of specific Gray value, each corresponding to a distinct portion of an image, and with the help of them intensities are rearranged by applying a suitable transformation function. For example, a simple transformation function such as each pixel transformed based on the histogram of a square surrounding the pixel [3]. Existing values will be mapped to new values keeping actual number of intensities in the resulting image equal or less than the original number of intensities. The transformation function applied on the histogram is proportional to the cumulative distributive function (CDF) of pixel values in the neighbourhood. Therefore, it suits for enhancing the local details and enhancing the edge information of each region of an image.

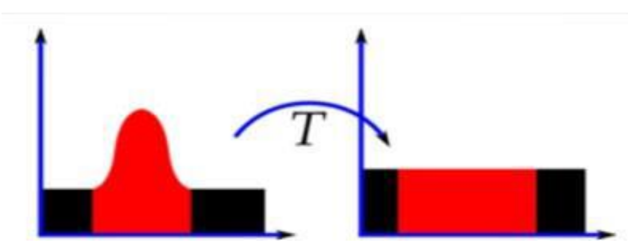

Fig.2.4 Histograms of an image before and after histogram equalization

Histogram equalization is a technique for changing the overall pixel intensities based on transformation function and contrast of an image. Histogram equalization is an effective technique which will benefit for the images with extreme contrast values. The limitation of this technique highlights the unwanted noise present in the background of an image and lead to loss in the information signal. It results in undesired effects in the resultant images [4].

Figure. 2.6 (a) Raw image (HistEq) (b) Enhanced image

Here the noise in relatively homogeneous regions of the image is amplified which results in poor SNR. And also, only the local objects of the image are enhanced and the background is left unenhanced.

Hitam et al. (2013)[2] have discussed a new method specifically developed for enhancing the underwater images called mixture Contrast Limited Adaptive Histogram Equalization (CLAHE) color model. The method operates Contrast Limited Adaptive Histogram Equalization on RGB and HSV color model and Euclidean norm is used to combine both results together. The combined results show less mean square error and high peak signal to noise ratio(PSNR) then other methods of under water image enhancing. It shows that the projected method is capable of classifying coral reefs particularly when visual cues are visible.

Shelda Mohan and T.R. Mahesh, 2013[5] has presented Particle Swarm Optimization (PSO) for tuning the enhancement parameter of Contrast Limited Adaptive Histogram Equalization relied on Local Contrast Modification (LCM). The quality of enhanced image is tested using a criteria based on edge information of the image. The planned method provides finest contrast enhancement though preserving the local data and details of the input mammogram picture. Sowmyashree et al. 2014[8] have presented a relative study of the different image enhancement methods used for enhancing images of the bodies under the water. It also describes the various properties of water due to which the underwater images images are distorted and degraded.

Setiawan et al. 2013[7] used Contrast Limited Adaptive Histogram Equalization (CLAHE) to enhance color retinal image. In this paper, they proposed new enhancement method using CLAHE in G channel to improve the color retinal image quality. The enhancement process conduct in G channel is suitable to enhance the color retinal image quality. Visual observation is used to judge the enhanced images and compare them with the original ones.

Chang et al. 2014[1] have proposed the mean-variance analysis technique that is engaged in partitioning the grey scale image into four associated images for individual image. The contrast of the palm bone X-ray radiographs is enhanced by newly proposed technique i.e. quad histogram equalization technique. Experimental results using this method illustrate that the proposed algorithm is better than the global histogram equalization (GHE) technique and brightness saving bi-histogram equalization (BBHE) technique.

Khan et al. 2012[3] has proposed Bi- and Multi-histogram equalization methods designed for contrast improvement of digital images. Multi-HE methods are projected so that natural look of image is maintained at the cost of either the brightness or its contrast. Simulation results for a number of trial images shows that the proposed method enhances the contrast even as preserving brightness and natural look of the images.

Senthilkumaran N and Thimmiaraja J 2014[6] have compared different techniques such as Global Histogram Equalization (GHE), Local histogram equalization (LHE), Brightness preserving Dynamic Histogram equalization (BPDHE) and Adaptive Histogram Equalization (AHE) by means of diverse objective quality measures for MRI brain image improvement. Quality measures used for comparison are Weber contrast, Michelson contrast, Contrast and AMBE.

Talha et al. 2013[4] have proposed Balanced Contrast Limited Adaptive Histogram Equalization (BCLAHE) for Adaptive Dynamic Range Compression (ADRC) of real time medical pictures. The proposed method scheme is tested and has given away high-quality results in terms of latency and perceptibility of tiny details. They have concluded that Balanced-CLAHE gives accurate results in improving local information than global histogram equalization.

Erturk et al.2012[9] have presented a new algorithm based on an Empirical Mode Decomposition (EMD) which is used to improve visibility of underwater images. It is indicated that the proposed method provides finer results compared to regular methods such as contrast stretching, histogram equalization. In the given approach, initially EMD is used for decomposing every spectral part of an underwater image into Intrinsic Mode Functions (IMFs). Then by combining the IMFs of spectral channels, enhanced image is constructed with variables weights in order to attain an improved image with enhanced visual features.

Galdran et al. 2014[10]proposed a Red Channel method, where colors associated to short wavelengths are recovered, as expected for underwater images, leading to a recovery of the lost contrast. The Red Channel method can be interpreted as a variant of the Dark Channel method used for images degraded by the atmosphere when exposed to haze. Experimental results are also shown.

Sasi et al. 2013[11] constructed productive color space for enhancing the contrast of myocardial perfusion images. Effects of histogram equalization and contrast limited adaptive histogram equalization are founded by the investigation. The method which gives good contrast improvement outcome is used for the appropriate color space. The color space giving better outcomes is selected experimentally. Exceptionality of this work is that contrast limited adaptive histogram equalization(CLAHE) technique is applicable to the chrominance parts of the cardiac nuclear image. It left the luminance channel unchanged which consequence an improved image as resultant in projected color space.

G.Padmavathi et al. 2010[12] have compared and evaluated three filters performance. These filters are homomorphic filter, anisotropic diffusion and wavelet denoising by average filter. All these filters are helpful in pre-processing of underwater images. Image quality is improved, noise is suppressed, edges in an image are preserved and image is smoothen by the use of these filters. Among the three filters used wavelet denoising by average filter gives required results in terms of Mean Square Error(MSE) and Peak Signal to Noise Ratio(PSNR).

Singh et al. [13] have done analysis of different underwater image enhancement techniques. The comparison between performance of contrast limited adaptive histogram equalization method, contrast stretching, and histogram equalization method is done. Mean square error(MSE) and signal to noise ratio (SNR) are used as parameters for comparing the performance of above methods. The methods were examined on different type of underwater images.

Chiang et al. 2012[15]have proposed a fresh efficient approach based on dehazing algorithm, used to enhance underwater images. This algorithm is used to compensate the attenuation inconsistency along the transmission course and to acquire the possible effect of presence of an artificial source of light into consideration. The haze occurrence and deviation in wavelength attenuation along the propagation path underwater to camera are corrected after compensating the influence of artificial light. The performance was evaluated both objectively and subjectively, of the proposed algorithm for wavelength compensation and image dehazing(WCID) by using groundtruth color patches.

Garcia et al. 2002[16] have analyzed and compared already available techniques for dealing with the problems of underwater images. These techniques mainly deal with nonuniform illumination, lowcontrast in underwater images. The analyzed methodologies consist the review of the homomorphic filtering, illumination-reflectance model, local histogram equalization and subtraction of the illumination field. Many illustrations on real data have been carried out to compare and contrast the dissimilar methods.

Iqbal et al. 2007[14] have projected an approach which is based on slide stretching. This approach has dual objectives. First objective is to balance the colour contrast of images by applying the contrast stretching of RGB color model. Second objective is to amplify the true color and resolve the problem of illumination by the use of saturation and intensity stretching of HSI color space. For enhancing the underwater images an interactive software has been proposed.

CHAPTER 3

PROPOSED SYSTEM

3.1 BLOCK DIAGRAM

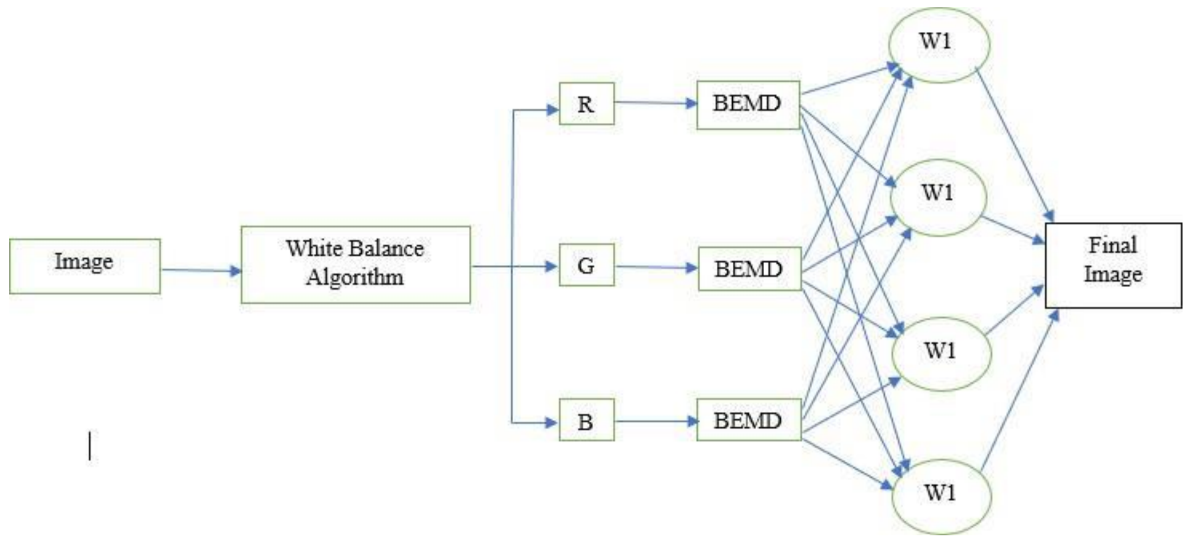

Figure 3.1 Block Diagram of BEMD

3.2 WORKING

The White Balanced Empirical Mode Decomposition is a combination of two approaches i.e., the White Balanced approach and the BEMD approach.

BALANCHING OF PHOTOMETRIC VARIATIONS:

In order to acquire image a source of illumination is required. In the deep waters the main source of illumination is sun. As the acquired image type is of RGB, in the deep waters blue color variations are more dominant due to its shorter wavelength. As the color image consists of 3 planes i.e., red, green and blue, due to improper illumination source the impact of blue color compared to red and green is more. Due to this there is a necessity to balance the color combination such that it is invariant of illumination. In order to balance those variations, assess the color of predominating light and remove the effects of that color and make the acquired image free from photometric variations. These effects are removed by applying the transformation on pixel intensities of each color plane by an average pixel intensity value of that color plane[5].

BIDIRECTIONAL EMPIRICAL MODE DECOMPOSITION:

Empirical mode decomposition is as similar to the wavelet decomposition but it decomposes the signal at different time scales [6]. The adaptive decomposition preserves the local signal attributes and assure that the signals in all IMFs are mono-component. As mono-component signals allow the calculation of physically meaningful instantaneous frequencies, any event in the signal can hence be localized on the time axis as well as the frequency axis by presenting the IMFs in frequency-time-energy distributions.

The IMFS obtained are almost perpendicular to the original signal. The necessary conditions to be satisfied by the IMFs are:

a) In each and every IMF, the no. of extremities and the zero crossings rate should be equal or may be differed by one.

b) At any point of time, for each IMF average value of the envelope computed from local maxima or local minima must be zero.

By considering the above two conditions, it came to know that IMFs are correlated to oscillatory modes in time series. Addition of all IMFs and the residual signal recovers the entire signal. The IMFs contain different frequency ranges, where the highest frequencies are usually found in the first IMF which contains the edge information with reference to image and lower frequencies in subsequent IMFs consists of spatial information of the image[7].

In the White Balanced EMD algorithm, which is shown in the *Fig.5.*, Initially the image is processed to remove the color effects caused due to improper illumination on the image source i.e., to make image free from photometric variations. From the processed input image of RGB, individual color planes are extracted. Now, each color plane is decomposed into its intrinsic mode functions using EMD method. Each IMFs are scaled with a weight and normalized [5].

After this processing, the recovered image is constructed by considering product of weights and the lower frequency IMFs. The reconstructed image is a visually enhanced image.

- **INPUT IMAGE**

  Input image is the colour image which is taken as the input for this project.

- **CHANNEL SEPARATION**

  The aim of pre-processing is an improvement of the image data that suppresses unwilling distortions or enhances some image features important for further processing, although geometric transformations of images (e.g. rotation, scaling, translation) are classified among pre-processing methods here since similar techniques are used.

- **WHITE BALANCING**

  An image transform can be applied to an image to convert it from one domain to another domain.

- **PROCESSING RGB CHANNELS**

  The feature clustering method is used to enhance the feature expression ability of image dictionary and improve the accuracy of the mapping matrix. Moreover, we calculate the image feature mapping matrix offline by using collaborative representation, which increases the image reconstruction speed. Experimental results show that the proposed Super resolution method not only improves the image reconstruction efficiency, but also reconstructs more high-frequency information, making the reconstructed image closer to the input image.

- **CONCATATION OF RGB CHANNELS**

  After the process of super resolution method in the previous step a resultant image is obtained from that image a particular part is zoomed and shown as output in this process.

- **RESULT OF OUTPUT**

  Hence, final output image is obtained.

CHAPTER 5

RESULT ANALYSIS

RESULTS:

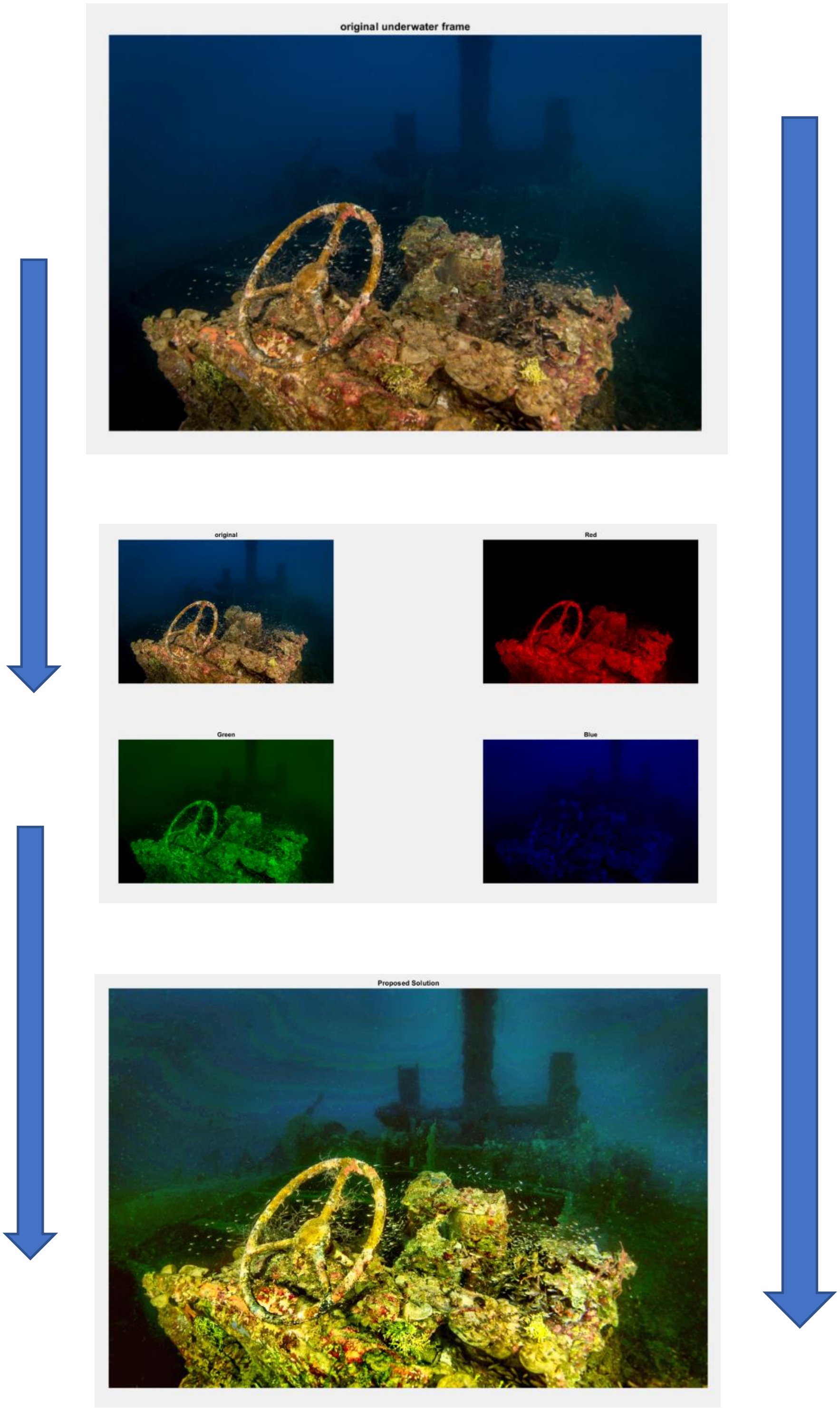

Figure 5.1 The Complete Workflow

STEP 1:

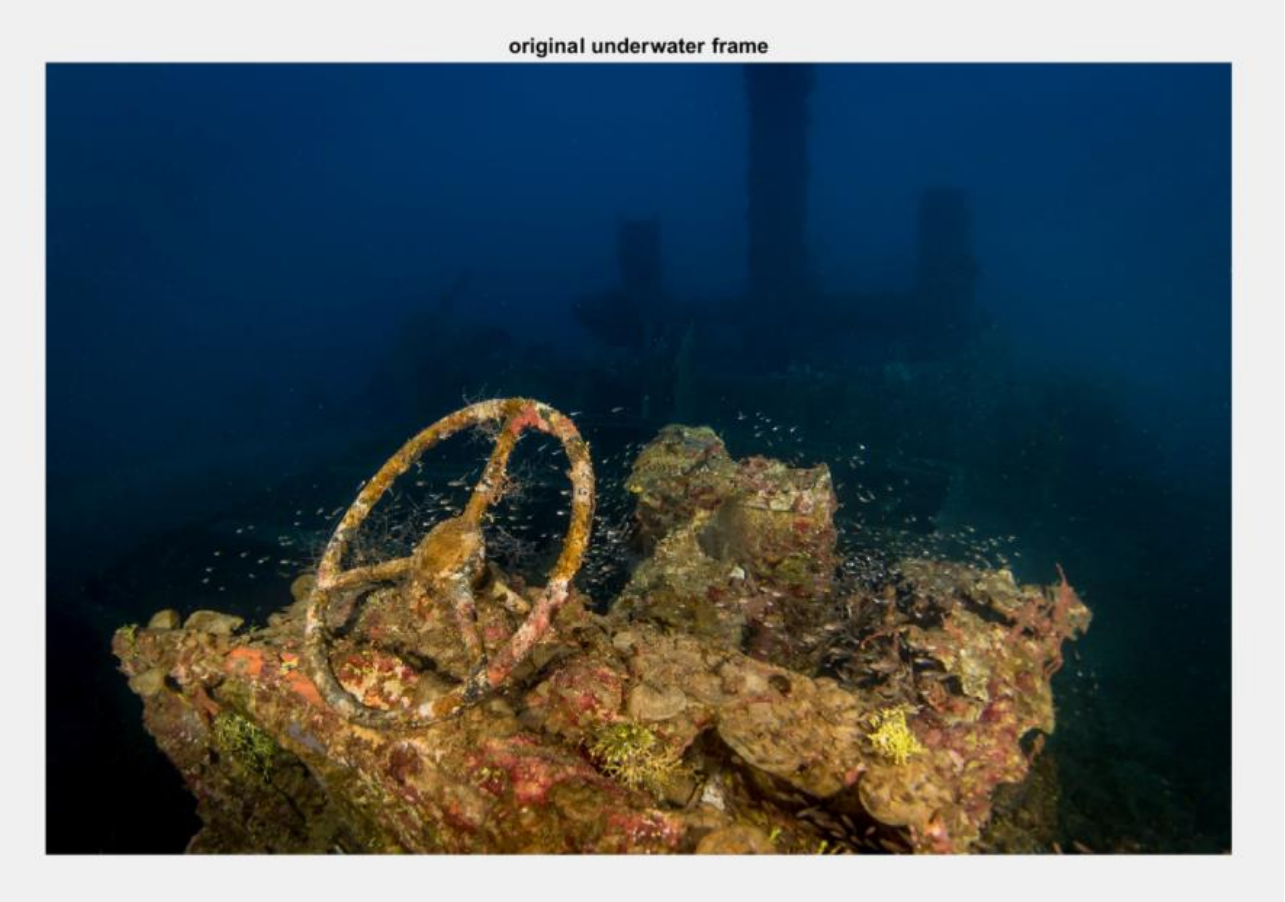

Figure 5.2 Underwater Input Image

Fig 5.2 is the input reference image from the user.

As you can see the background of the image is totally is washed out. For SLAM we need to have a clear idea of the proximity and the overall range in the input image.

Having a better input image improves the output of the SLAM program.

Improvement to be seen:

- extreme blue tint
- washed out background
- not color accurate
- low exposure
- less sharpness

STEP 2:

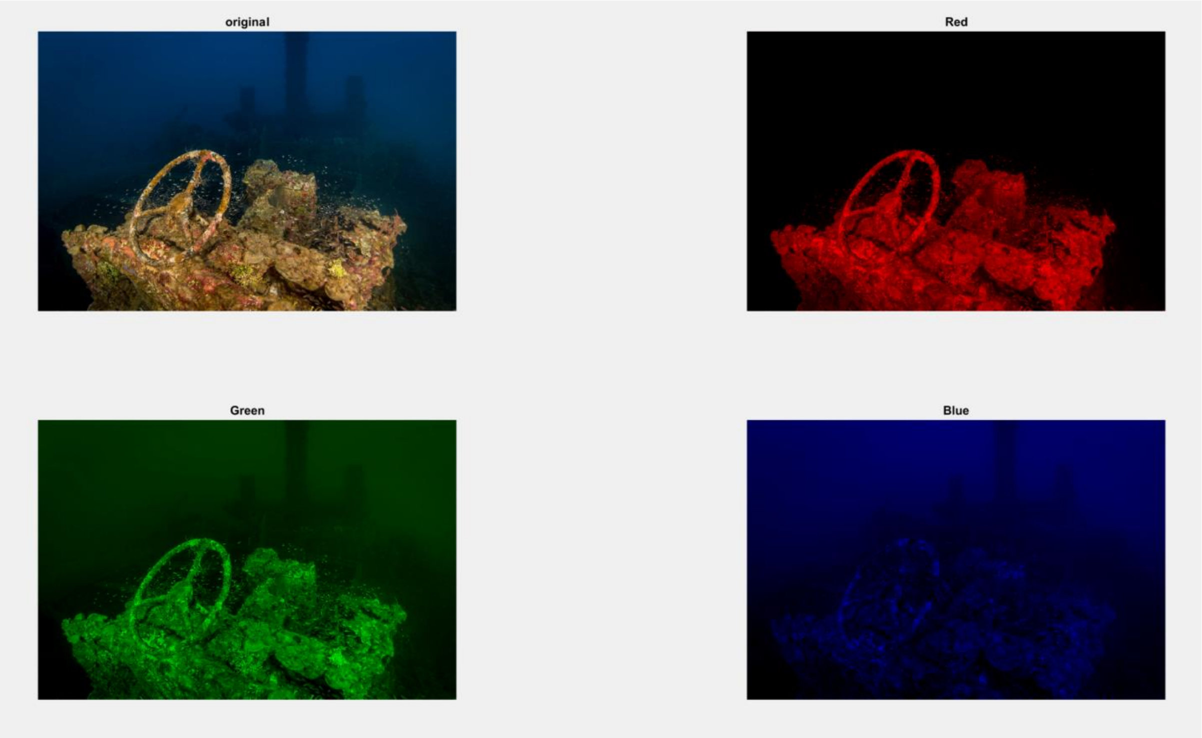

Figure 5.3 Separating all RGB Channels

An RGB colour can be understood by thinking of it as all possible colours that can be made from three coloured lights for red, green, and blue. Imagine, for example, shining three lights together onto a white wall in a dark room: one red light, one green light, and one blue light, each with dimmers. If only the red light is on, the wall will be red. If only the green light is on, the wall will look green. If the red and green lights are on together, the wall will look yellow. Dim the red light and the wall will become more of a yellow-green. Dim the green light instead, and the wall will become more orange.

Figure 5.3 is used to convert the input image into several sub-band coefficient images such as Red band, Green band and the Green band. These separate channels will be further used in the next steps.

STEP-4:

Figure 5.5 Intensity Map of Green Channel

Figure 5.6 Intensity Map of Blue Channel

Figure 5.7 Intensity Map of Red Channel

This method usually increases the global contrast of many images, especially when the usable data of the image is represented by close contrast values. Through this adjustment, the intensities can be better distributed on the histogram. This allows for areas of lower local contrast to gain a higher contrast. Histogram equalization accomplishes this by effectively spreading out the most frequent intensity values.

Adaptive histogram equalization (AHE) is a computer image processing technique used to improve contrast in images. It differs from ordinary histogram equalization in the respect that the adaptive method computes several histograms, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast and enhancing the definitions of edges in each region of an image.

Figure 5.5 consists of three images for every channel present in the RGB colour space. These three channels are separated from the input image and are processed via a BEMD method. The results of the three processed channels are shown in the above Figure.

STEP-5:

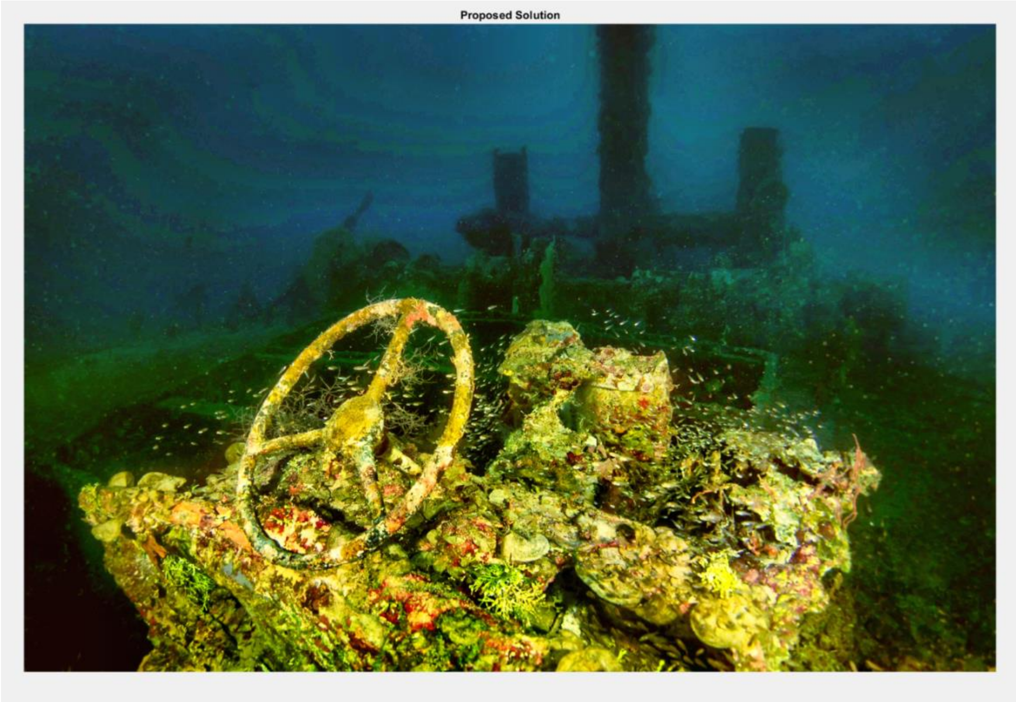

Figure 5.8 Proposed Final Output Image

To get balance the color temperature in your image. so that objects which appear white in person are rendered white in your photo. Proper camera white balance has to take into account the "color temperature" of a light source, which refers to the relative warmth or coolness of white light.

Figure 5.6 represents the Final output Image by Concatenating the individual RGB channels represented in Figure 5.5. The induvial are weighted and the final image is obtained.

CHAPTER 6

ADVANTAGES & LIMITATIONS

6.1 ADVANTAGES:

- The main advantage of this technique is that it improves the input image for the SLAM application.
- The dynamic range of the image is much better.
- It does not require one to extract and match features.
- It provides an advantage as it is costless and the existing low resolution imaging systems can still be utilized.

6.2 LIMITATIONS:

- A disadvantage of the method is that it is indiscriminate. It may increase the contrast of background noise, while decreasing the usable signal. Noise is introduced which cannot be avoided.
- Most images show a increased contrast in the green channel, that is, the images have more green tint.
- Some parts of the images due to over exposure, loose detail and information.
- After zooming the image, the zoomed part quality is reduced.

CHAPTER 7

CONCLUSION

7.1 CONCLUSION:

In the field of image processing, there are several novel techniques are proposed to enhance the visual quality of underwater images. Existing techniques improves the deep-water images to a large extent. But all these methods suffer with some poor-quality metrics. A good quality image will have high PSNR, high GLCM and low MSE. Based on these characteristics the proposed method and the conventional method are compared. The results shown that among both the techniques, White Balanced BEMD gives the better enhancement of quality parameters for underwater images.

7.2 FUTURE SCOPE:

Applying Retinex and complex image enhancement techniques to improve the results of the implementation of Simultaneous Localization and Mapping (SLAM) for Autonomous Underwater Vehicle (AUV).

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