

# A Study on Underwater Image Enhancement Techniques

Bharat Kumar. M <sup>1</sup> , SK .Y Muneer Ahamed <sup>2</sup>

1, 2 B. Tech Students, Dept of Electronics and Communication Engineering  
Eswar college of Engineering

Kesanupalli, Andhra Pradesh, India  
MUNWAR ALI SHAIK <sup>3</sup>

3, Assistant Professor, Dept of Electronics and Communication Engineering  
Eswar college of Engineering  
Kesanupalli, Andhra Pradesh, India

**Abstract**—Underwater image processing is one of the challenging field in Digital Image processing because of the physical properties of underwater environment. Underwater image processing is used in a wide variety of research areas such as detection of man made objects, marine biology, ocean resources exploration, mine detection etc. However, Underwater images suffers from three major problems: Color distortion, fuzz and under exposure due to scattering and absorption of light in underwater environment. This paper mainly focus on brief study of different underwater image enhancement techniques available. Finally we summarize the performance analysis of underwater image enhancement methods .

**Index Terms**—Color balancing, Image enhancement, Underwater images, Histogram equalization, Contrast stretching..

## I. INTRODUCTION

Underwater environment contain numerous abundant resources such as amazing land scapes , fishes and marine animals. Underwater imaging becomes one of the interesting research area[1]. However the underwater imaging is entirely different from normal imaging because of the physical properties offer by underwater environment. Basically the quality of underwater images are mainly affected by factors such as low contrast, poor visibility due to absorption and scattering effects by underwater medium[2-4]. Usually the visibility of underwater images decreases fast after a distance of 5m under the water[5].As the light penetrate the water the attenuation process effects the wavelength spectrum due to these the appearance and intensity of colored surface affected. Since the scattering attenuates more the longer wavelength than the shorter one. Fig.1[5] shows the diminishing of underwater color. As shown the red color which is longer in wavelength is absorbed by water first at depth of 5m followed by the colors orange, yellow, green and blue. As a result the

underwater image appears blue-green. In order to restore the contrast and intensity of underwater image the blue-green appearance of the image must be removed. This tends to the need of underwater image enhancement methods. Hence underwater image processing becomes one of the important and interesting area of Digital Image processing and attracts many researchers to do research in this domain. Selection of particular underwater image enhancement technique is always depends on degree of the image degraded and underwater properties. Many research papers are published on underwater image enhancement. In this paper we studied the advances in underwater image enhancement techniques.

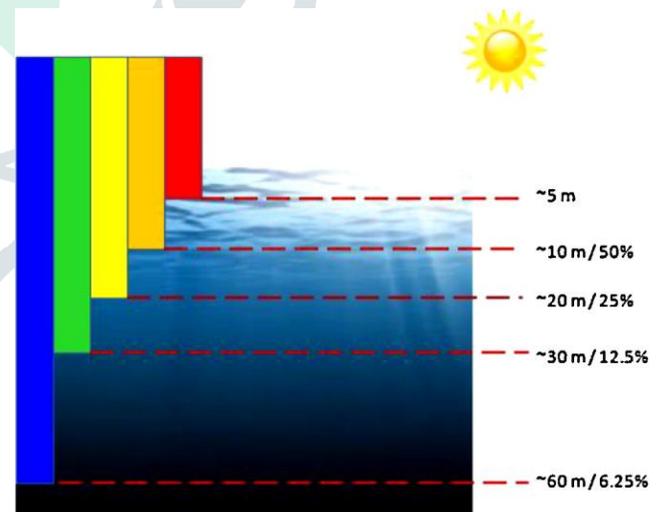


Fig. 1. Illustration of underwater color diminishing [5].

We, Summarize a review on different underwater image enhancement techniques which can help scholars to understand the principles and different algorithms of underwater image processing. The rest of the paper is organized as follows,

Section-II Literature review, we discuss experimental results of different under water image enhancement techniques in Section-III, we conclude our discussions in Section-IV.

## II. LITERATURE REVIEW

Underwater Image processing include image dehazing and image enhancement methods. In this paper we discuss underwater image enhancement methods. Image enhancement methods improves contrast of underwater images. In past years many researchers have published numerous papers on underwater image enhancement methods. Among them one of the very basic and popular image enhancement method is Histogram equalization(HE). HE works by equalizing the histogram of image through intensity range by means of cumulative distribution function (CDF) and probability distribution function (PDF). S.M.Pizer et al [6] proposed the adaptive histogram equalization method (AHE). It is a contrast enhancement method sensitive to spatial information of image. This technique alter the intensity values of image to maintain constant intensity histogram by the use of (CDF) of pixel intensities. An extension to HE , A.M.Reza [7] proposed Contrast limited adaptive histogram equalization (CLAHE) to prevent the over amplification of noise by contrast limiting. In 2002, R. Eustice , O. Pizarro [8] proposed an method which is extension for the Mat lab image processing tool box for mosaicing algorithms and optical image processing. The following are the methods proposed by Eustice et al [8] for the implementation of Mat lab image processing tool box (1) Contrast limited adaptive histogram specification (CLAHS) to handle non-uniform inherent lightning in underwater environment; (2) Fourier method for translation recovery, scale, rotation to provide robustness towards image regions which are dissimilar; (3) Local correlation; (4) Multi-resolution pyramidal blending. CLAHS is an extension Contrast limited adaptive histogram equalization (CLAHE). Many traditional white balancing algorithms are available for underwater image enhancement. Among those methods, The MAX-RGB [9] white balancing algorithm assumes that the maximum response in each color channel is caused by white patch and estimates the color of Light by using the maximum response of the different color channels. The gray world [10] algorithm assumes that the average reflectance in the image scene is achromatic , based on the assumption it estimates the illuminant color distribution by averaging each color channel independently .

In 2004 Finlayson [11] proposed shades of grey method . In this method it assumed that the average edge difference in

the image scene is achromatic and calculates the illuminant color distribution by applying the minkowski p-norm on the zero order pixel structure. In 2007, Van de Weijer [12] proposed Grey-edge white balancing algorithm as an extension of shades of grey method .In this method it assumes that the average edge difference in a scene to be achromatic and estimates the illuminant color distribution by applying the minkowski p-norm on derivative structure of image channels. C.O.Ancuti in 2017 proposed Color balance and fusion method [13] for underwater image enhancement it produce better results compared to many traditional enhancement methods. He demonstrated an effective enhancement method that does not require any hardware or knowledge about the underwater environment.

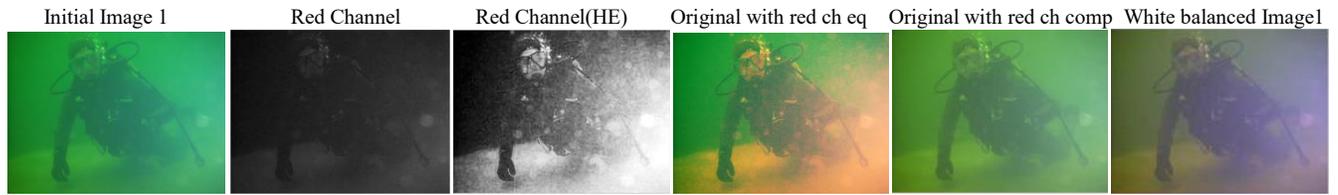
C.O.Ancuti method overcome the drawbacks of many traditional white balancing algorithms by considering the following observations. He explained that the traditional gray world [10] algorithm achieves good visual appeal for reasonably distorted underwater images but not for highly approach of underwater white balance to compensate color cast caused by the absorption of colors at water depth Mainly in our paper we study only the Color balance method proposed by C.O.Ancuti [13] . it explained a new.

distorted underwater images. It fail to remove the bluish color shift. C.O.Ancuti concludes that the loss of red channel information in image must be compensated by the following principles.

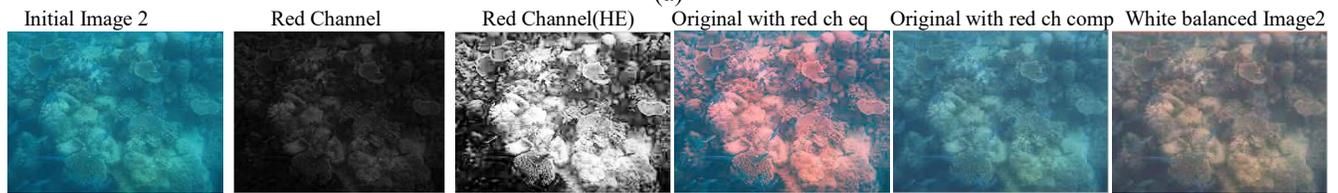
1. The red light due to long wavelength is lost first when travelling in clean water
2. The red light compensation can be achieved by adding a fraction of green channel to red
3. The red channel compensation should be proportional to the difference between mean of green and red values
4. Finally the white balanced image is achieved by applying gray-world [10] algorithm to the compensated image

## III. UNDERWATER IMAGE ENHANCEMENT TECHNIQUES

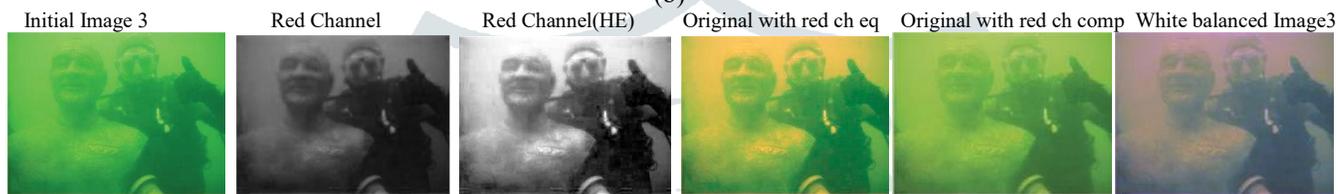
In this section we discuss about the experimental results of various Underwater image enhancement techniques discussed in the previous section . First we discuss the C.O.Ancuti white balancing method and then the remaining methods .



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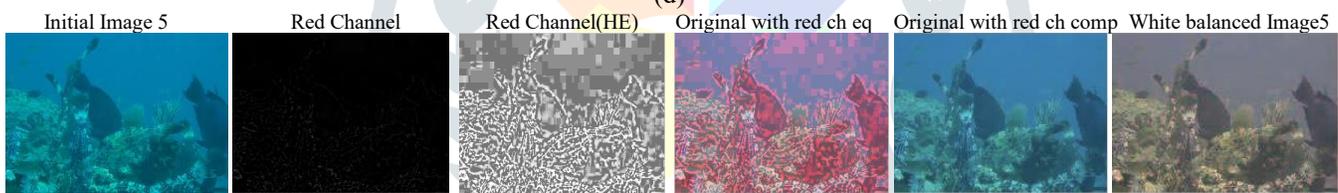
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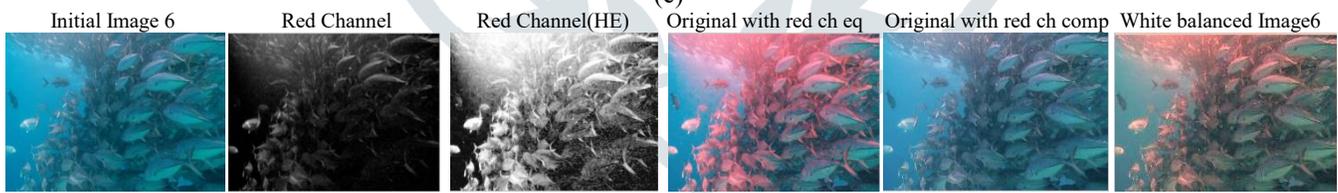
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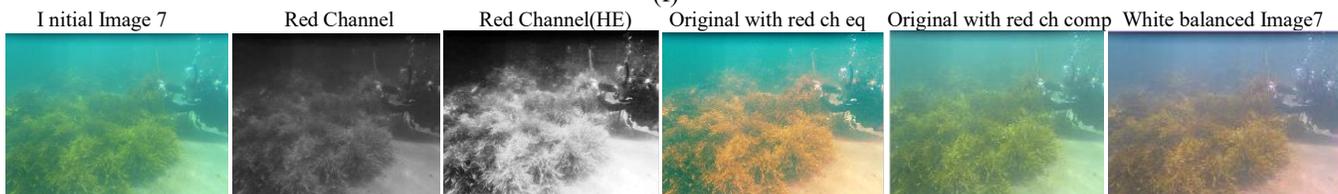
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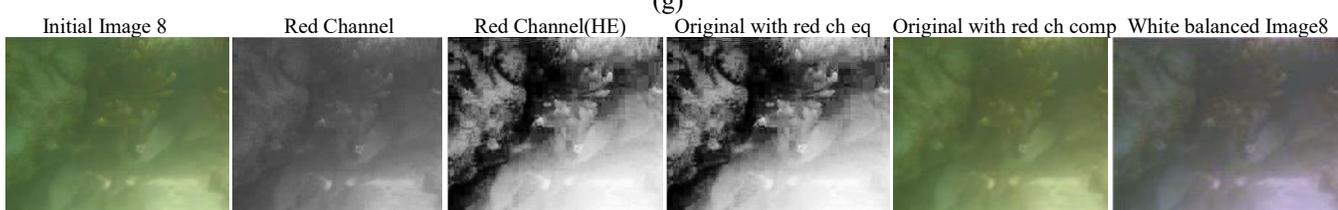
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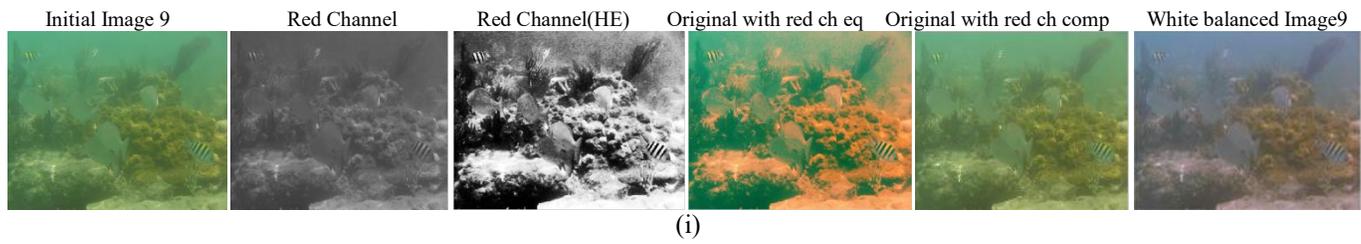
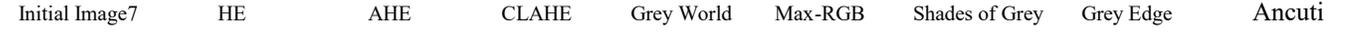
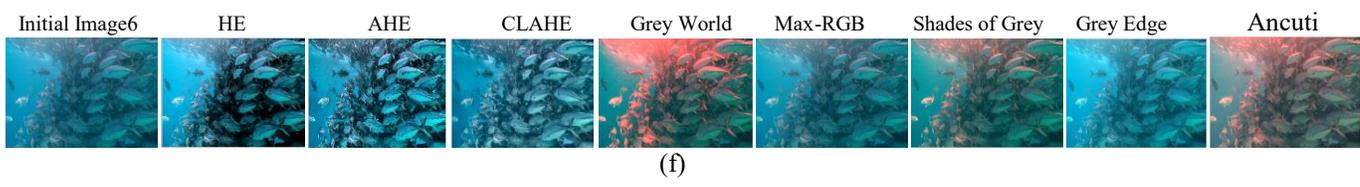
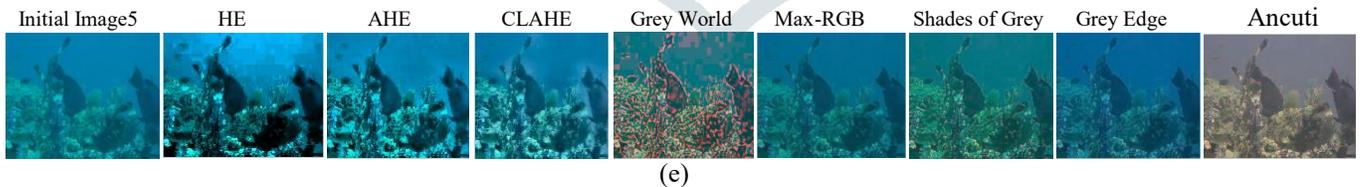
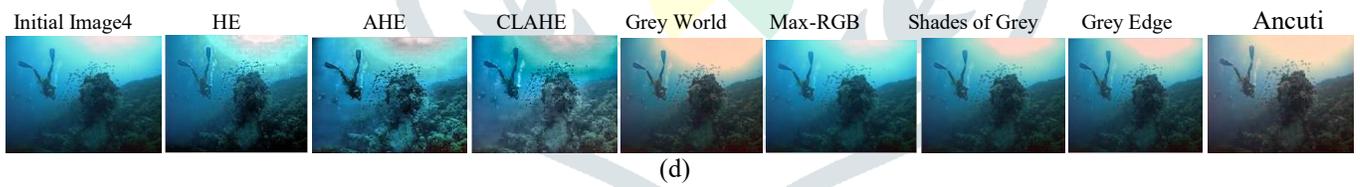
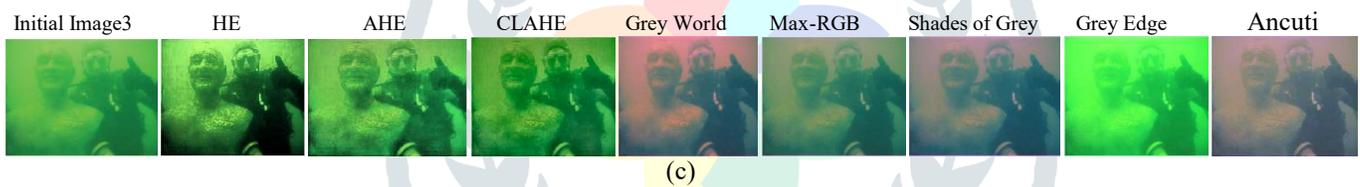
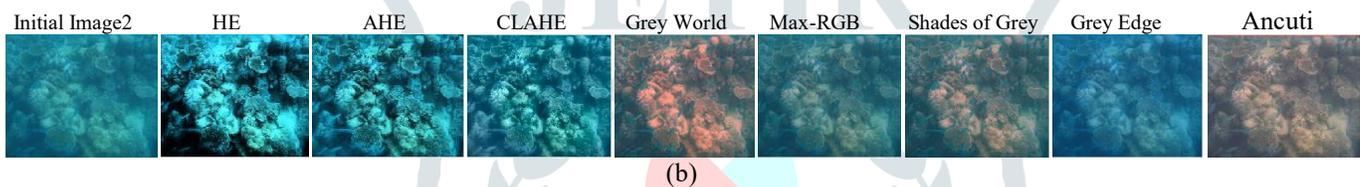


Fig. 2 . (a-i) Results of Color balance method for Underwater Image Enhancement method on different images [13]

Comparative results of different Underwater image enhancement techniques



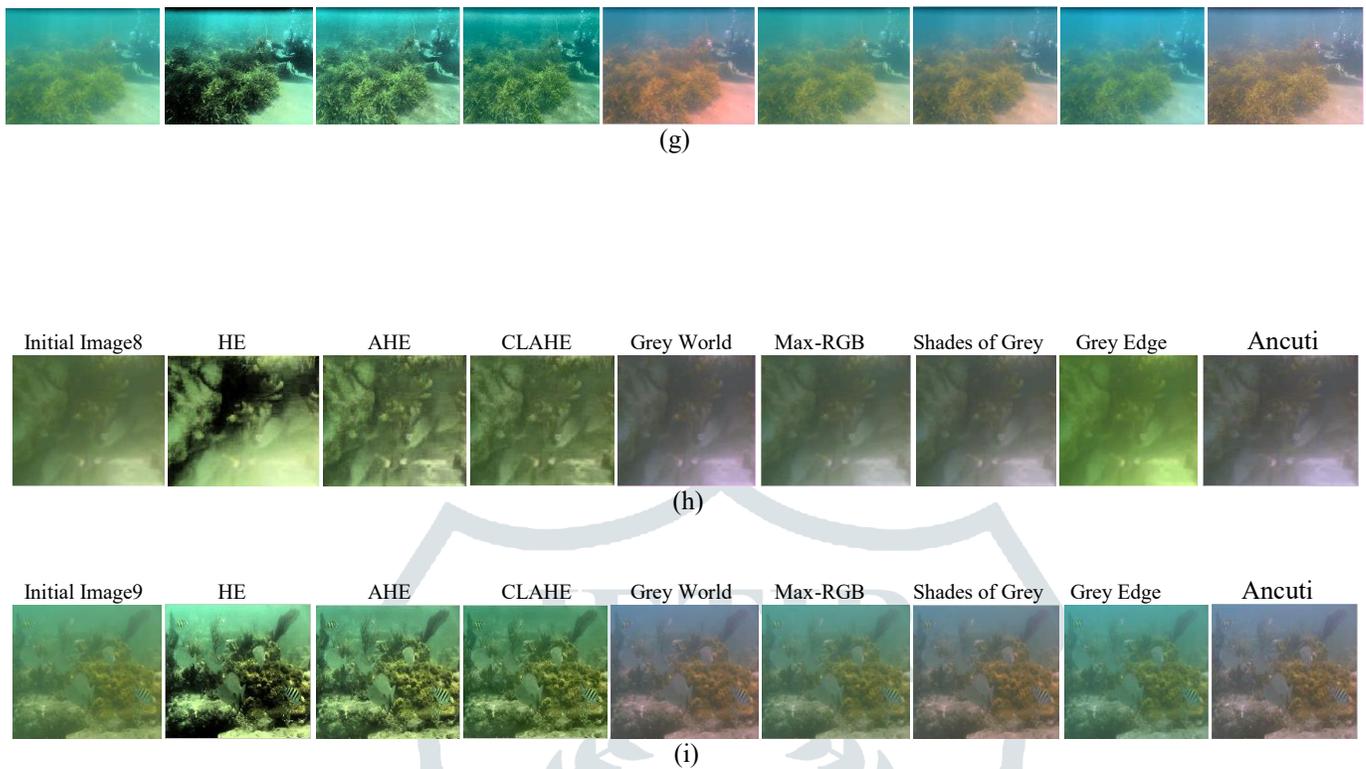


Fig. 3 . (a-i) Comparative Results of various Underwater image Enhancement techniques on different underwater images

TABLE I  
OVERVIEW OF UNDERWATER IMAGE ENHANCEMENT METHODS

S.no	Method	Advantages	Drawbacks
1	HE	Simple and enhance contrasts of an image.	If gray values are physically far apart from each other in the Image, then this method is not suitable.
2	AHE[6]	Straight Forward method	Over enhancement of noise in homogeneous areas of image
3	CLAHE[7]	Eliminates over amplification of noise in image	Has limitations regarding pixel mapping in boarder and corner regions
4	Grey World[10]	Computationally less Expensive	Less reliable
5	Shades of Grey[11]	Better contrast than Grey World	computational cost is more
6	Ancuti[13]	Performance is good	Artificial light is Ignored

IV CONCLUSION:

In this Work Different Underwater image Enhancement techniques are studied and applied on different Underwater images. We summarize an overview of different underwater image enhancement techniques and results. We hope that this survey will be helpful for researchers who do research and to understand the significance and numerous applications in underwater image processing. We predict that this paper on underwater image processing will provide a great contribution to help researchers for better explore underwater environments in the future.

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**Sk. Munwar Ali** received the M.Tech. in Digital Electronics and Communication systems from Eswar college of Engineering, Kesanupalli, Andhra Pradesh, India in 2014.

He is currently an Assistant Professor in Department of Electronics and Communication ,Eswar college of Engineering, Narasaraopet . he has authored/coauthored over 8 scientific papers in international jour-nals and conference proceedings

His current research interests include Digital Image and Signal processing



Guru Bharat Malepati, is presently studying Final year B.Tech ECE in Eswar college of Engineering,Kesanupalli,Narasaraopet. His research interests include Digital Image Processing



**Sk. Muneer Ahamed** is presently studying Final year B.Tech ECE in Eswar college of Engineering,Kesanupalli,Narasaraopet. His research interests include Digital Image Processing