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# Underwater Images Denoising and Enhancement Using Contrast Limited Adaptive Histogram Equalization (CLAHE) Method-A Review.

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**ABSTRACT:** The images observed from the underwater are usually of low quality because of the scattering of lights, ripples in water and the organic matters resolved in the water. So the preprocessing becomes an important necessity for the images obtained from under water before subjected to the future operations. The various degree of distortions suffered from by the underwater images could be preprocessed by applying the denoising and the image enhancement techniques. The Review addressing the techniques available in enhancing and denoising the underwater images is presented in the paper.

**KEYWORDS:** Preprocessing, Image Denoising, Image Enhancement, Filtering, Contrast Stretching, Under Water Images.

## I. INTRODUCTION

The preprocessing techniques such as the image enhancement and the denoising applied to the images are the methods that take in the low quality images as the input to make it clearer and perceptible and improving the information content of the image as well as modifying its visual impact. The features of the images are intensified applying the image enhancement methods [1-2].

The image enhancement techniques subdues the noise, protects the edges of the images followed by enhancing and smoothing of the image to make them more useful for the further analysis or the study [3-4].

The review in the paper concentrates techniques to improve the poor quality images obtained from the river beds and the oceans. The images form the under waters are usually collected by the people interested in oceanography while floating on water , scuba diving , by diving from a submarine or a boat, and programmed cameras that travel deep inside the water to observe the creatures living inside the deep water beds or the trench's [5-8]

In the water surface the light spreads and gets observed un-uniformly, deep inside the water only the low wavelength of the natural light will be observed by the water with only blue only blue and green light being visible. The light propagates in the water using the absorption and the scattering, influencing the complete performance of the imaging system that is in the underwater. The images taken gets blurred due to the forward scattering and the backward scattering causes the contrast problem in the images resulting in uneven illumination, with the low contrast and the poor quality of images [9-12]

So the images acquired form the underwater are projected through certain image processing steps before subjected to the further computation or the research work. The Figure.1 below provides the stages of the image processing to regain the quality of the underwater images.

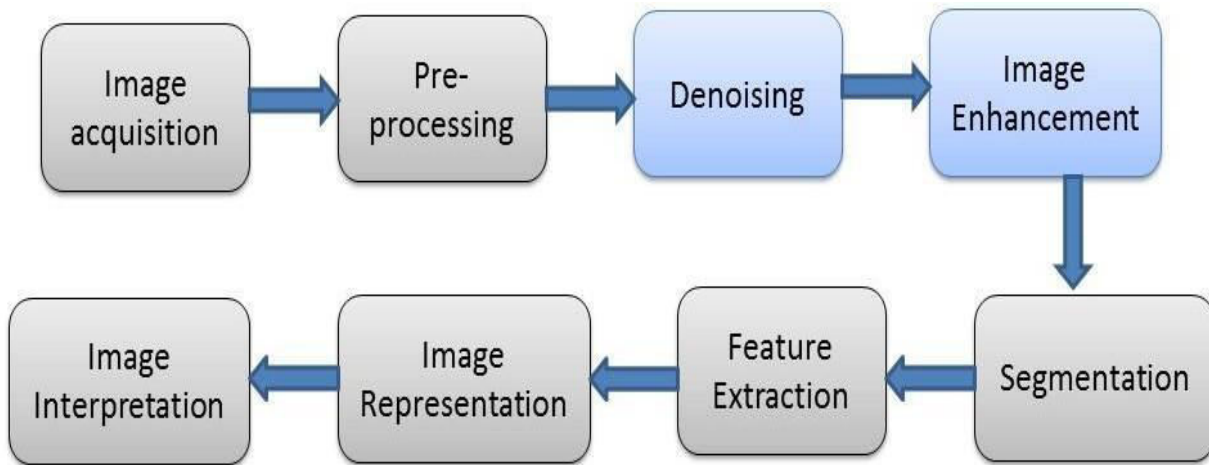


Figure.1 Stages of the Image Processing

The image processing involves many stages such as the, image acquisition is done using either the underwater cameras or the underwater imaging system, the images acquired are preprocessed initially to balance the contrast and the illumination in the images followed by the next two stages to improve the quality of the images, further the segmentation simplifies the representation of the images to make it easier to analyze, the feature extraction isolates the desired portions of the images, The representing and the interpreting of the images would be done gathering the location , size, shape, color, texture pattern, height and the association of the image[13-17].

The review in the paper mainly concentrate only on the denoising and the image enhancement methods utilized in the improving the quality of the underwater images. The paper proceeds with the obstacle found under water reducing the quality of the images, in section 2 followed by the over view of the image enhancement techniques utilized in improving the quality of the images acquired from the underwater in the section 3, and the conclusion in the section 4.

### III. THE REASON DEGRADING THE UNDERWATER IMAGES QUALITY

The quality of the images in the underwater are affected due to many reasons some of them are the absorption and scattering of light, mist caused by the light reflected from the surface, varying degrees of the attenuation caused by the different wavelength of light, dominance of the bluish tone, the organic matters that are dissolved in the water etc. These reasons result with the contrast loss and the color deviation in the images acquired underwater. The table.1 below provides the reasons and the causes that degrade the low of the images gathered from under water.

Reason	Causes
Lightening	The Primary obstacle faced by the underwater photographer is the loss of color and contrast when submerged to significant depth.
The imaging Aids Used	In many cases waterproof camera don't capture underwater images. The enlargement of lenses rises by refraction. This feature serves as an advantage to photographer to obtain very small cases.
Flashes and ripples in water	The use of reflection is often regarded as most difficult aspect of underwater photography.
Image splitting	Split images are popular in scuba magazines.
Lack of training	Underwater ducking training providers helps the diver to improve technique.

Table.1 Reasons Degrading the Underwater Image Quality



**IV. IMAGE ENHANCEMENT AND DENOISING TECHNIQUES**

The enhancement of the images basically includes multitudes of processes such as contrast stretching, pseudo coloring, noise clipping and filtering. The techniques obtained for improving the quality just intensifies the selected range of the features to provide a clear visibility. The section provides few common denoising and the image enhancement techniques utilized in improving the quality of the images that were acquired from the underwater, they section elaborates few filtering techniques applied in enhancing the images followed by few common denoising algorithms that reduces the distortions found in the content of the images. The table.2 below provides few common methodologies used in the improving the quality of the images obtained under water.

Image Enhancement technique.	Procedure	Attributes
Contrast Stretching	It is also called normalization, improves the contrast of an image by improving the range of intensity.	It can only apply a linear scaling function to image .
Empirical mode decomposition	It is exceptionally direct, it carries out operation over the arrangements of data until a stable portion is reached.	Versatile, based on local movement of objects. The original image is broke into intrinsic mode functions and residues.
Homomorphic Filtering	It is frequency filtering technique, it is used to fix non uniform lightening to reinforce contrast from the impressions.	The filter can eliminate the non-uniform illumination present in the image
Anisotropic Filtering	It smoothens the picture in homogenous range, conserving the edges and later upgrading them.	Disentangles picture components to enhance picture division
Histogram equalization	This is simple and forward technique for modifying image intensities and contrast of image using histogram.	Histogram Equalization is helpful in pictures with background and frontal areas that are both dim.

Contrast Limited Adaptive histogram equalization(CLAHE).	This is generalization of adaptive histogram equalization, with this technique the image is broken up into tiles based upon its histogram and transfer function, which is derived from interpolation between the manipulated histogram of the neighboring sub region.	Limit noise enhancement unlike histogram equalization.
Integrated Color model	Does Color harmonization, improving contrast of RGB color, space and adjust the HIS model.	Enhances the true color diminishing the uneven illumination.

Table. 2 Image Enhancement Techniques

The images acquired from under waters hold very poor picture quality because of the nature of the light, as the light entering into the water gets scattered in various directions. The various color wavelengths of the light reaches the various depths of the water only the wavelength with the blue reaches the deep inside the water and this is the reason why the underwater images remain blue and green when captured. This also results with certain noise level affecting the image quality. The Gaussian noise is common noise found with the factors that are unstable in the imaging system, the salt and the pepper noise indicates the small and a large scale values on selected pixels or region, fixed mode noise occurs due to the presence of the imperfections in the devices found in the systems. So in order to tackle them the review present few denoising techniques available to reduce the noise levels in the pictures in the table.3 below



Denoising Algorithms	Descriptions
The median filter	The median filter is nonlinear signal processing method which can overcome the image details caused by linear filtering under certain conditions and effective for filtering pulse noise and image scanning noise.
Average Filter	It is categorized into three types as average filter, geometric average filter and harmonic average filter.
Adaptive wiener filter	The adaptive wiener filter van adjust the current filter parameters that can obtained empirically which make it adapt to the statical properties of time varying signal noise.
Wavelet Denoising.	The basic method of wavelet denoising are the wavelet transform modulus maxima denoising, the wavelet transform interscale correlation denoising, the nonlinear wavelet threshold denoising.

Table.3 Denoising Algorithms

The image enhancement and the denoising techniques elaborated in the paper aid in the image based applications, to restore the originality of the images acquired from the underwater.

## V. CONCLUSION

The paper presents the review of the underwater image enhancement and the denoising techniques presenting the reasons behind the quality degradation of the underwater images followed by the techniques to enhance and denoising the pictures observed. In future the paper is to subject the techniques reviewed in analyzing image enhancement achieved in restoring the damaged archeological artifacts.

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