TECHNIQUES FOR ENHANCEMENT AND DENOISING OF UNDERWATER IMAGES: A REVIEW

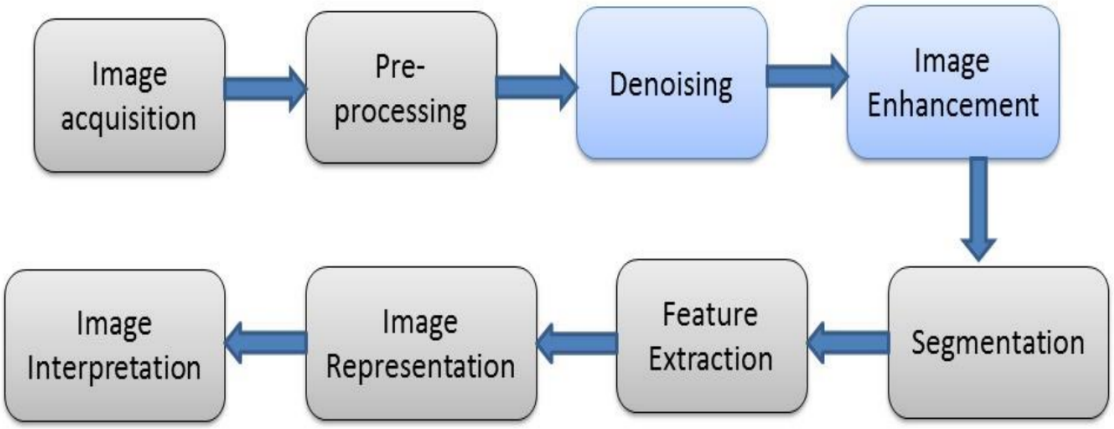

Figure.1 Stages of the Image Processing

Reasons for quality degradation of underwater images:

- Absorption and scattering of light
- Mist caused by the light reflected from the surface
- Varying degrees of attenuation caused by the different wavelength of light
- Dominance of bluish tone
- Organic matters dissolved in the water
- Flashes and ripples in water

Image Enhancing Techniques	Procedure	Attributes
Contrast stretching	It is also called as normalization Improves the contrast in an image by `stretching' the range of intensity values it contains to span a desired range of values.	It can only apply a linear scaling function to the image pixel values The enhancement is less harsh
Empirical Mode Decomposition	It is exceptionally direct It carries out the sifter operations over the arrangements of the data until finally a stable portion is reached. Disintegrates whole signal into intrinsic mode functions and residues	Versatile Based on the local movement of the objects The original images is broken into multitudes of intrinsic mode functions and residues
Homomorphic filtering	This is a frequency filtering technique It is utilized to fix non-uniform lighting to reinforce contrast from the impression. It is the most utilized system on the grounds that it redresses non-uniform lighting and sharpens the picture	The filter can reduce the non uniform illumination present in the image.
Anisotropic Filtering	It smoothens the pictures in the homogeneous range , conserving the edges and later upgrading them Diminishes relics by erasing little edges enhanced by homomorphic filtering	Disentangles picture components to enhance picture division

Wavelet Denoising By Average Filter	Wavelet denoising is used to stifle the noise	This wavelet denoising gives great results contrasted with other denoising routines because, unlike other methods, it does not assume that the coefficients are independent. Undoubtedly wavelet coefficients in normal pictures have enormous conditions. Besides the reckoning time is short
Red channel method	In this method, colors associated to short wavelengths are recovered, as expected for underwater images, leading to a recovery of the lost contrast	Estimates the color picks the pixels at the maximum depth , estimates water light transmission , does color correction
Histogram equalization	This is a simple and straightforward technique. For modifying image intensities and contrast of image in image processing using the image's histogram	Histogram equalization is helpful in pictures with backgrounds and frontal areas that are both bright or both dim. Produces unrealistic effects in the output images.
Contrast Limited Adaptive Histogram Equalization	It is generalization of adaptive histogram equalization. With this technique the image is broken up into tiles. The gray scale is calculated for each of these tiles, based upon its histogram and transform function, which is derived from the interpolation between the manipulated histograms of the neighboring sub-regions.	Limits noise enhancement unlike the Adaptive Histogram Equalization.
Integrated color model	Does color harmonizing , improving the contrast of the RGB colors space and adjustment in the HIS model	Enhances the True color diminishing the un even illumination

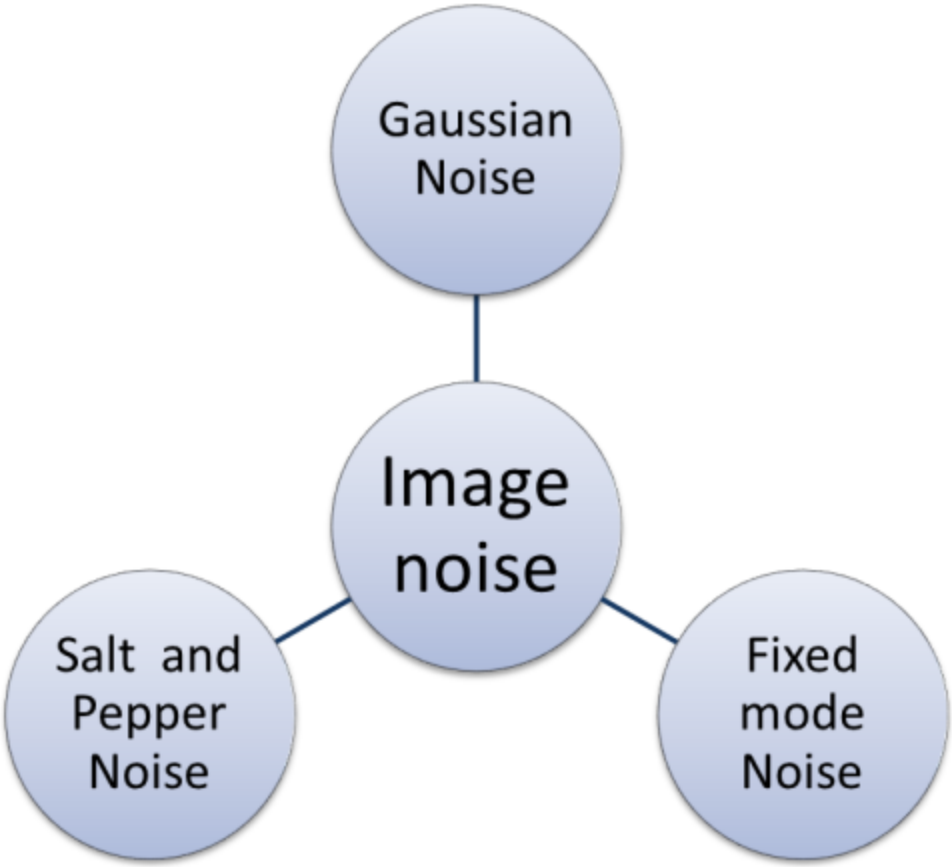

Figure.2 Classification of Image noise

Denoising Algorithms	Descriptions
The Median Filter	The Median Filtering is a nonlinear signal processing method which can overcome the image detail blur caused by linear filtering under certain conditions and effective for filtering pulse noise and image scanning noise. The median filter not only removes noise but also protects the edges of the image which can obtain a more satisfactory recovery effect. It's convenient that the Statistical Properties of Images is not necessary. However, the Median Filtering is not suitable for processing the image with a lot of points, lines, spire details
Average filter	It is categorized into three types as Average filter and the geometric average filter, harmonic averaging filter.
The Adaptive Wiener Filter	The Adaptive Filter can adjust the current filter parameters by the filter parameters that can be obtained empirically which make it adapt to the statistical properties of unknown or time-varying of signals and noise. The smoothing effect of the filter is small when the local variance is large and stronger when the local variance is small. The ultimate goal of the Adaptive Wiener Filter is to minimize Mean Square Error of the restoring as well as the original image.
Wavelet denoising	The basic methods of wavelet denoising are: The wavelet transform modulus maxima denoising; The wavelet transform inter-scale correlation denoising; The nonlinear wavelet threshold denoising.

Table.3 Denoising Algorithms

[Image denosing in underwater acoustic noise using discrete wavelet transform with different noise level estimation]

Figure 3 shows the data flow diagram of the image denoising process.

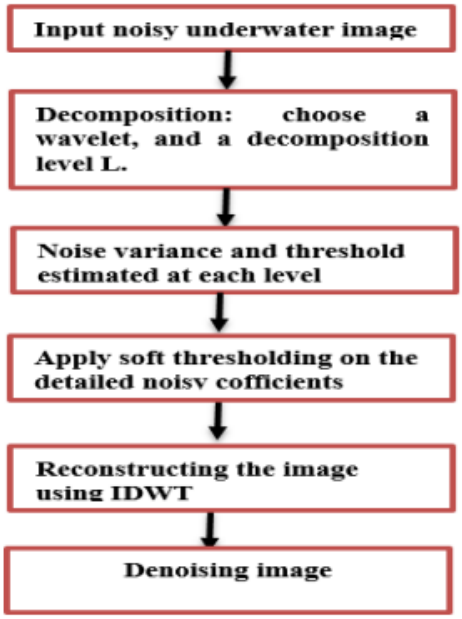

Figure.3 Data flow diagram of image denoising using Level-Dependent Estimation Discrete Wavelet Transform.

[(PDF) Study on Underwater Image Denoising Algorithm Based on Wavelet Transform]

Wavelet threshold

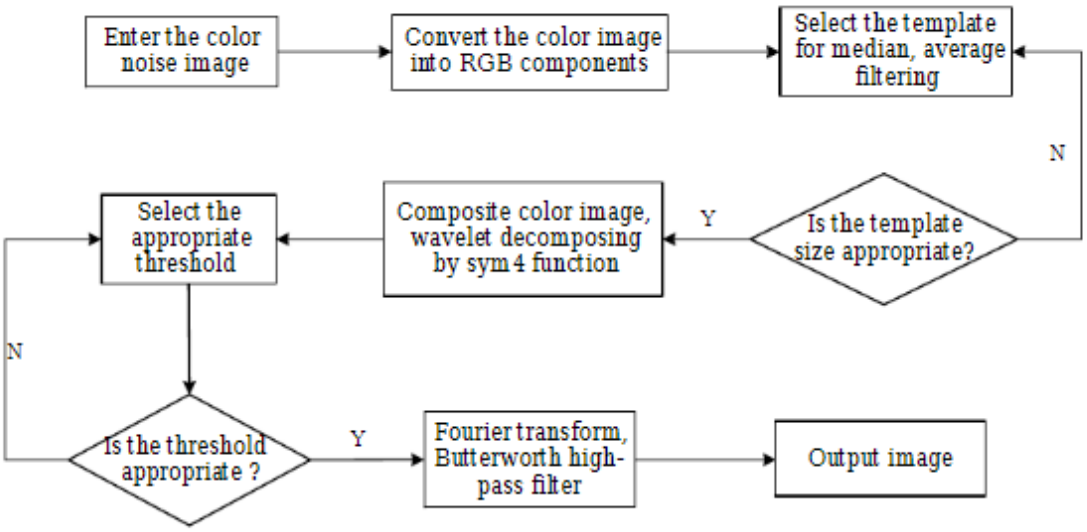

Figure 3 The flow chart of the hybrid noise filtering algorithm

[Underwater Image Processing: State of the Art of Restoration and Image Enhancement Methods]

https://pure.port.ac.uk/ws/portalfiles/portal/25542070/underwater_review_pp.pdf

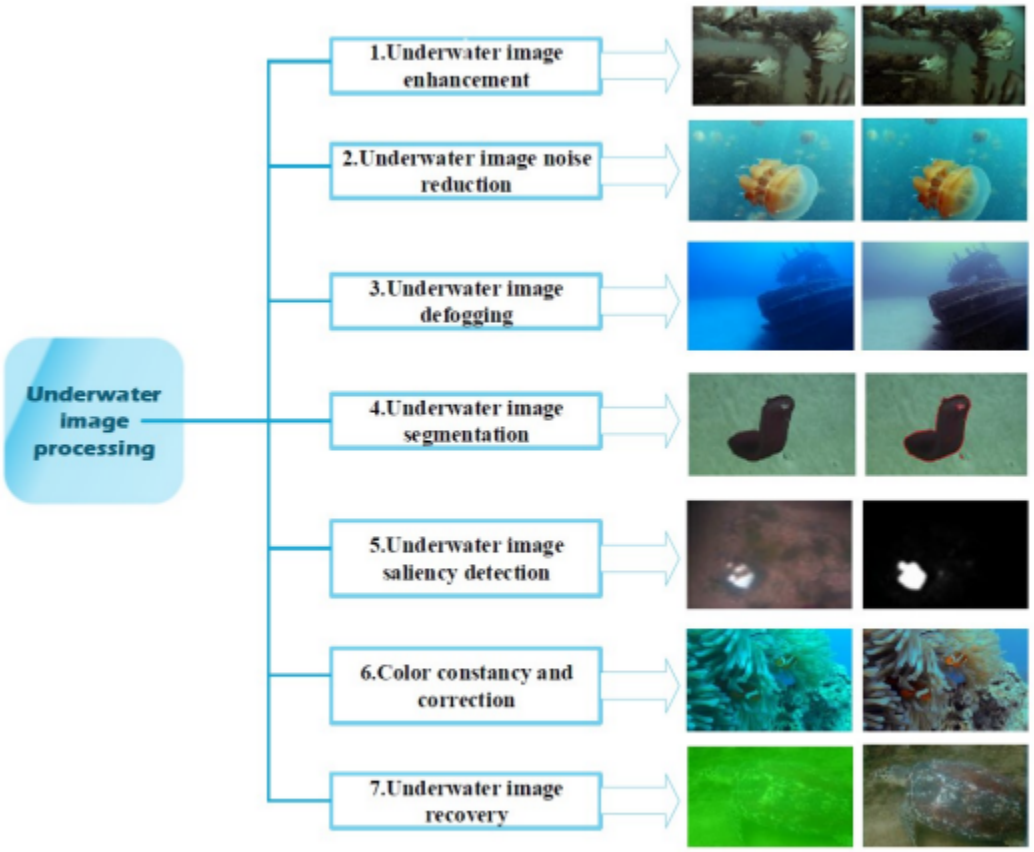

Fig. 1. Diagram of underwater image processing (UIP) and analysis.

Underwater image processing modules:

1. image enhancement
2. Image denoising
3. Image defogging
4. Image dehazing
5. Image segmentation
6. Image saliency detection
7. Color constancy and correction
8. Image recovery
9. Contrast enhancement

10. Object detection (optional)