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Underwater Image Restoration using Wavelet Transform

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Abstract: The objective of our project is to develop an efficient technique for low contrast under water images. A new algorithm is implemented for improving the quality of underwater images. The emerging area of research is based on Underwater images. The underwater images suffer degradation due to scattering and absorption. The degradation in image quality may be attributed to absorption and backscattering of light by suspended underwater particles. As the depth increases, different colors are absorbed by the surrounding medium depending on the wavelengths. Since underwater images have a strong dominant color, their colorfulness and contrast are often degraded. In our project we will implement a restoration technique to improve the quality of poor contrast images using Discrete Cosine transformation with suitable filtering technique. The software for developing our project is MATLAB. The proposed method provides sharper and brighter visual quality than conventional image enhancement methods.

Key words: *PSNR, MSE, Underwater, Denoising, wavelet transform, adaptive threshold, etc.*

1. INTRODUCTION

The image denoising as well as image enhancement are still challenges. Recently proposed method are not that much suitable for enhanced and denoisy images. On the other hand due to the development of exploring the ocean by autonomous underwater vehicles & unmanned underwater images is major issue. Capturing clear image underwater is actually difficult task. In past years the sonar base has been widely used for detection and recognition of images under water. Many researches have adopted technique to restore or enhance underwater images. The recorded history of underwater exploration started in the year 1856 using manned submersibles with closed transparent window attached to the underwater vehicles. .

The primary motivation to this was military. Now the study is conducted not only for the military, civilian use but also to satisfy the men's curiosity about deep sea world. Image processing contributed to underwater vision system during 90's.Recently, there are different algorithms in many computer languages incorporated with such vision system to give a clear view of the deep sea environment. Compared with sonar and acoustic imaging, even though they can be used in high range applications, optical imaging camera can provide high resolution images at low cost. Underwater images have lot of degradations while comparing to the natural photographs .These degradations have lots of dependencies in the depth of water column, under water ecology and artificial. Light that are used to illuminate the scene. In the water level surface the sunlight will spread and get absorbed non-uniformly. As we go to depth of several hundred meters, the low wavelength of natural light will be absorbed by water and only blue or green will be visible.. The proposed work is used for enhancing and characterization of the underwater images is by wavelet transform and webers law. Most algorithms or technic have not attained desired level of image denoising and image enhancement. Depending on the assumption of algorithm all shows outstanding performance but fails in general which removes the image fine structure. The wavelet gives a superior performance in image denoising due to its properties such as scarcity and multiresolution structure. This methodology will focused on the enhancement algorithm that uses signal underwater optical images. Very first proposed work will apply some preprocessing methodology for noisy and blur images.

In order to remove the denoising of the image it will use wavelet transform and for image enhancement it will make the use of webers law. The decomposition of signal makes full use of high frequency information of each of the multidimensional can add image details and get a better enhanced and denoisy image.

The light propagation in the water is caused due to absorption and scattering. The light in water can influence the overall performance of underwater imaging system. Blurring of the image is caused due to the forward scattering and the contrast of the images is caused due to the back scattering. The scattering of the light in water causes uneven illumination, low contrast and poor quality of the image. All these problems can be overcome by applying wavelet transform method to image de-noising. It is important to select threshold and the output of the threshold function when using wavelet threshold for image de-nosing. However, the traditional selection fixed threshold method is not reasonable. Considering the problems, the paper puts forward the method that combining adaptive threshold selection with adaptive output of the threshold function. The proposed method overcomes the limitations of traditional threshold selection and increases the peak signal to noise ratio (PSNR) of the image and obtain better de-noising effect.

2. LITERATURE SURVEY

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 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

2. PROBLEM STATEMENT

In the existing System, the processing is done on the underwater images, which is able to enhance the color and brightness of the image, but they are not efficient to remove noise correctly. Many important features get diminished from the image, which makes object identification a difficult task.The Objective is to improve underwater image by using de-noising techniques, the processing of underwater image is necessary because the quality these image leads some serious problems when compared to images from a clearer environment. Numbers of methods are there to cure these underwater images by using different filtering. Techniques which are also available in the literature for processing and enhancement of underwater images, The proposed system is an initiative to solve the above problem. The system is motivated from the literature survey of the wavelet transformation technique. In this system preprocessing is done on the underwater image using filtering technique, which makes the image look more prominent .After preprocessing adaptive wavelet transformation is applied. So that more accurate denoised outputs is achieved. The system is able to solve all or some of the objectives that are defined below:

- Remove noise,
- Improve the PSNR,
- Reduction of time and manual efforts,
- Better the visual effect by improving dark regions, global contrast significantly.

3. RELATED WORK

This section presents related literature concerning underwater image processing techniques.

For the problem of underwater image de-noising, a new method based on adaptive wavelet combining adaptive threshold selection with adaptive output of the threshold function is proposed. Considering the underwater image with low SNR, contrast imbalance, and poor image quality, first some pre-processing should be done before wavelet threshold de-nosing. Then, adopted adaptive wavelet combining adaptive threshold selection with adaptive output of the threshold function for the image de-noising. Finally the simulation results show that the proposed method not only removes noise effectively, improves image output peak signal-to-noise ratio (PSNR), but also yields superior vision quality and embodies the superiority of wavelet de-noising [1].

A new vectorial underwater image quality metric, dubbed the CQ that integrates the power spectrum. Unlike existing objective underwater image quality metrics, the proposed metric consists of a discriminator C based on the slope of the log-contrast power spectrum that is able to distinguish between marine habitats when a large number of images of different environments are to be processed, and a patch-based metric Q to predict the objective quality of underwater images. Experimental results illustrate that the proposed CQ metric is able to recognize underwater images with similar sharpness and correlates better with enhancement results compared to other methods, and also meet realtime requirements [2].

Light scattering is caused by light incident on objects reflected and deflected multiple times by particles present in the water before reaching the camera. This in turn lowers the visibility and contrast of the image captured. Color change corresponds to the varying degrees of attenuation encountered by light traveling in the water with different wavelengths, rendering ambient underwater environments dominated by a bluish tone. No existing underwater processing techniques can handle light scattering and color change distortions suffered by underwater images, and the possible presence of artificial lighting simultaneously, a novel systematic approach to enhance underwater images by a dehazing algorithm, to compensate the attenuation discrepancy along the propagation path, and to take the influence of the possible presence of an artifical light source into consideration [3].

Within the last decades, improving the quality of an underwater image has received considerable attention due to poor visibility of the image which is caused by physical properties of the water medium. This paper presents a new method called mixture Contrast Limited Adaptive Histogram Equalization (CLAHE) color models that specifically developed for underwater image enhancement. The method operates CLAHE on RGB and HSV color models and both results are combined together using Euclidean norm. Experimental results show that the proposed approach significantly improves the visual quality of underwater images by enhancing contrast, as well as reducing noise and artifacts [5].

4. PROPOSED WORK

In order to achieve better de-noising effect, some pre-processing should be done before wavelet threshold de-nosing. The pre-processing contains two steps, the first step is to use Homomorphic filtering technology to eliminate the nonuniform illumination and balance contrast. This step can realize the purpose to reduce the illumination changes, sharpen the edge details, preserve details and eliminate the noise in the image.

The second step is to apply Gaussian low-pass filtering for smoothing image. It is used to smooth textures and reduce artifact by deleting small image features amplified by Homomorphic filtering. Low-pass filtering is the essence of the image smoothing, which let the low frequency parts of signal access and tackle the high frequency parts of signal. Due to the image edge in high frequency parts, so it often results a certain destruction to detail in the image smoothly operation. The method of Gaussian low-pass filtering can avoid the effects. Using the representation of a Gaussian low-pass filtering.

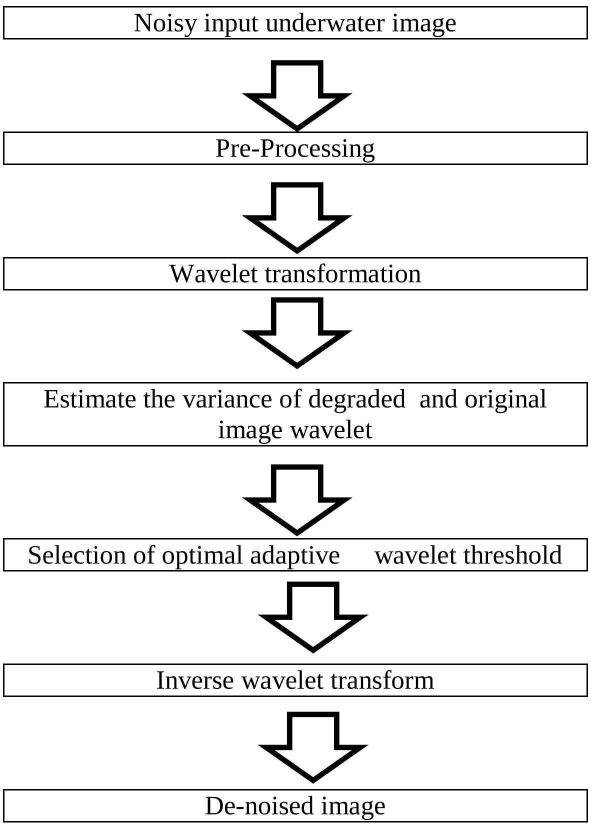


Fig 1.Proposed work algorithm

A) Classifying image data

An image is represented as a two-dimensional array of coefficients, each coefficient representing the brightness level in that point. When looking from a higher perspective, no one can't differentiate between coefficients as more important ones, and lesser important ones. Most natural images have smooth color variations, with the fine details being represented as sharp edges in between the smooth variations. Technically, the smooth variations in color can be termed as low frequency variations and the sharp variations as high frequency variations. The low frequency components (smooth variations) constitute the base of an image, and the high frequency components (the edges which give the detail) add upon them to refine the image, thereby giving a detailed image. Hence, the smooth variations are demanding more importance than the details. Separating the smooth variations and details of the image can be done in many ways. One such way is the decomposition of the image using a Discrete Wavelet Transform (DWT).

B) The Inverse DWT of an image

Just as a forward transform to used to separate the image data into various classes of importance, a reverse transform is used to reassemble the various classes of data into a reconstructed image. A pair of high pass and low pass filters is used here also. This filter pair is called the Synthesis Filter pair. The filtering procedure is just the opposite - it starts from the topmost level, apply the filters column wise first and then row wise, and proceed to the next level, till it reach the first level.

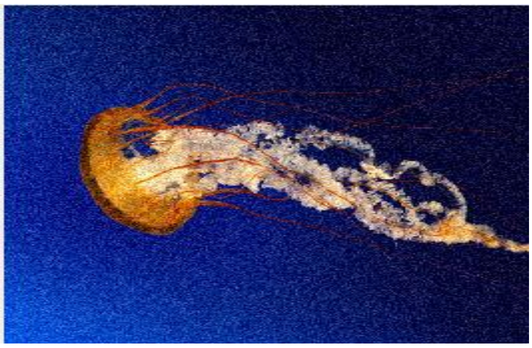
C) Adaptive wavelet thresholding

During the wavelet de-nosing, the most important steps are the choices of an appropriate threshold and effective threshold function, which have direct impacts on the performance of a wavelet de-nosing algorithm. The key of the wavelet threshold de-noising is the relation between wavelet coefficient and threshold. The choice of the threshold determines the coefficient of the wavelet reconstruction. So the selection of adaptive wavelet threshold will help to achieve better de-noising effect.

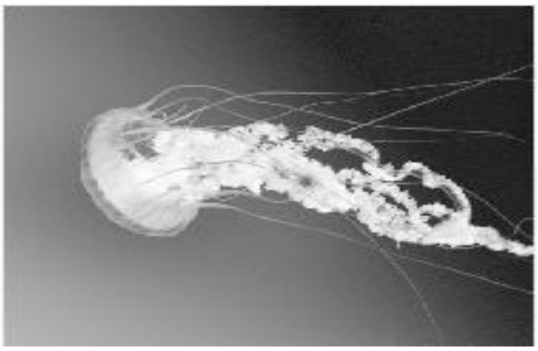
D) De-noising algorithms that use the wavelet transformation consist of three steps:

i. Calculate the wavelet transform of the noisy signal,
ii. Modify the noisy wavelet coefficient according to adaptive thresholding,
iii. Compute the inverse transform using the modified coefficients.
E) Wavelet Domain Advantages:
Why we prefer De-noising in wavelet domain, because it has many advantage, like:
i. Wavelet based de-noising provides multi resolution hierarchical characteristics. Hence an image can be de-noised at different levels of resolution and can be sequentially processed from low resolution to high resolution.

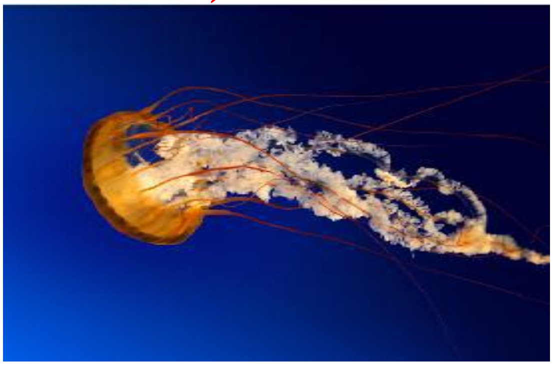
ii. High robustness as compared to common signal processing.



(a) Original image



(b) Image gaussian image



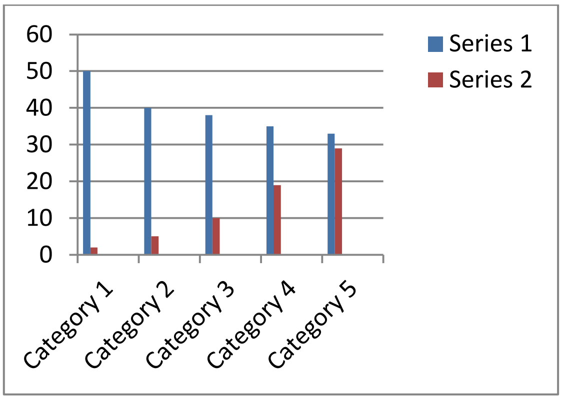
(c) wavelet transformation

Fig 2.Simulation results on jellyfish

Wavelet Transform

As proposed work uses Wavelet transforms which represent signals with a high degree of sparsity. This is the principle behind a non-linear wavelet based signal estimation technique known as wavelet denoising. In this paper we explore wavelet denoising of images. In this, a method to enhance contrast is proposed; the methodology consists in solving an optimization problem that maximizes the average local contrast of an image. The optimization formulation includes a perceptual constraint derived directly from human threshold contrast sensitivity function.

Table No. 1 Show the performance of framework on different noise level i.e. from 0 to 20, respective PSNR and MSE values are calculated with respect to noise variance. These values are generated on Jellyfish image.



Series1 = PSNR
Series 2 = MSE

Figure 2 PSNR/MSE calculations on Jellyfish image.

The above figure presents the bar graph of PSNR/MSE values which are calculated on Jellyfish image

5. CONCLUSION

The proposed work will effectively restore the image from denoising as well as it will gives more enhanced image. The difficulty associated with obtaining visibility of objects at long or short distance in underwater scenes presents a challenge to the image processing community. Even if numerous approaches for image enhancement are available, they are mainly limited to ordinary images and few approaches have been specifically developed for underwater images.The proposed algorithm combining adaptive threshold with adaptive output of the threshold function not only remove noise,

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improve the PSNR, but also get a better visual effect. By applying the proposed approach, we can produce promising results. Future work will include further evaluation of the proposed approach.

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