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Implementation of an Improved Algorithm for Underwater Image Enhancement and Denoising

Ms. Pooja A. Jaiswal[1], Prof. Vishal B. Padole[2]

Electronics & Telecommunication Engg Dept, P.R. Patil College of Engineering& Technology, Amravati, India[1]

Professor, Electronics& Telecommunication Engg Dept, P.R. Patil College of Engineering& Technology, Amravati, India [2]

Abstract: For under water images, denoising and image enhancement is essential. Underwater exploration of the seafloor is used for various scientific reasons such as assessing the biological environment, exploring mineral, and for conducting underwater living organism's analysis. As the images underwater suffers from the different degree of distortion. Underwater images are affected by the light scattering and colour change, so most of times images that we captured are blur. Due to light scattering incident light get reflected and deflected multiple times by particle present in the water which degrade the visibility and contrast of the underwater images. The underwater images have poor image quality. First it uses some pre-processing methodology which is to be done before wavelet threshold de-nosing. Then it will use webers law for image enhancement along with wavelet transform then we get some adaptive output and the images that we recovered are more enhanced as well as it reduce the noise level.

Keywords: Underwater images, Enhancement, Denoising, and Wavelet transform Webers law.

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. Many researches have adopted technique to restore or enhance underwater images. There are different algorithms in many computer languages incorporated with such vision system to give a clear view of the deep sea environment. Under water 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 is 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 uses an algorithm which is used for image enhancement and denoising purpose. The image denoising of underwater images is done by wavelet transform and enhancement is done bywebers 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 multi resolution 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. The decomposition of signal makes full use of high frequency information of each of the multidimensional can add image details and get a better 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. The proposed method uses wavelet transform and webers law for further image processing.

2. LITERATURE REVIEW

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 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.

Some preprocessing methodology proposed by Varinderjit kaur, Arpinder Singh and Ajay Kumar Dogra[2] on defining a general mathematical and experimental methodology to compare and classify classical image denoising algorithms and, second, to propose a nonlocal means (NL-means) algorithm addressing the preservation of structure in a digital image. The mathematical analysis is based on the analysis of the "method noise," defined as

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the difference between a digital image and its denoised version.

Algorithm is presented by John Y. Chiang and Ying-Ching Chen.[3] based on the WCID which helps in effectively restoring image color balance and remove haze. As per the researches, no existing techniques can handle light scattering and color change distortions suffered by underwater images simultaneously. The experimental results demonstrate superior haze removing and color balancing capabilities.

Underwater image pre-processing is absolutely necessary due to the quality of images captured under water. Basically, under water images suffer from quality degradation due to retransmission of limited range of light, low contrast and blurred image due to quality of light and diminishing color. When an underwater image is captured, pre-processing is necessarily done to correct and adjust the image for further study and processing. Dr.G. Padmavathi, Dr. P. Subashini, Mr. M. Muthu Kumar and Suresh Kumar Thakur[4] worked on Different filtering techniques .The filters used normally improve the image quality, suppress the noise, preserves the edges in an image, enhance and smoothen the image. Therefore an attempt has been made to compare and evaluate the performance of three famous filters namely, homomorphic filter, anisotropic diffusion and wavelet denoising by average filter used for under water image pre-processing. Out of the three filters, wavelet denoising by average filter gives desirable results in terms of Mean Square Error and Peak Signal to Noise Ratio (PSNR). However the elapsed time of the three filters is also studied to identify the suitable filters that process the image quickly by preserving the image quality.

Image enhancement done by Mukesh C. Motwan, Mukesh C. Gadiya , Rakhi C. Motwani[5] described different methodologies for noise reduction (or denoising) giving an insight as to which algorithm should be used to find the most reliable estimate of the original image data given its degraded version. As Image denoising still remains a challenge for researchers because noise removal introduces artifacts and causes blurring of the images. Noise modeling in images is greatly affected by capturing instruments, data transmission media, image quantization and discrete sources of radiation. Different algorithms are used depending on the noise model. Most of the natural images are assumed to have additive random noise which is modeled as a Gaussian. Speckle noise is observed in ultrasound images whereas Rician noise affects MRI images. The scope is to focus on noise removal techniques for natural images.

3. FLOW DIAGRAM OF PROPOSED WORK

Here proposed work uses some prepossessing methodology which is shown in figure (a).

For restoring image from denoising it use wavelet transform and for getting more enhanced image it make the use of law called webers law.

Here it will use MATLAB as simulation experiment tool.

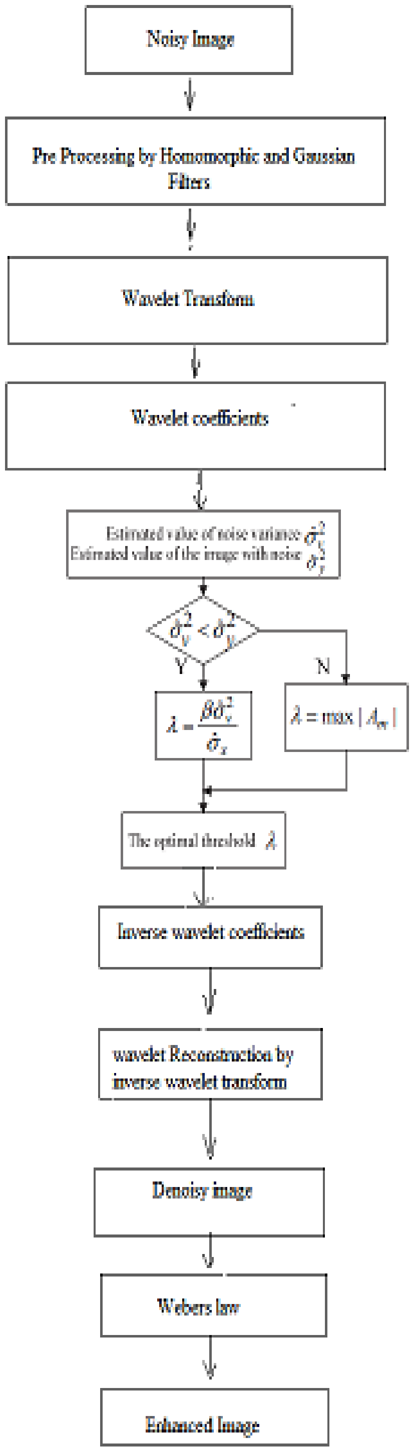

Fig (a) Block Diagram of proposed work

Underwater Images- Firstly we will use constructed underwater images. Then we will apply some preprocessing methodologies.

Preprocessing- For getting better denoising image some preprocessing should be done before wavelet threshold denoising. The preprocessing is done by two ways. Very first we will use Homomorphic filtering technology to eliminate the non-uniform illumination and balance constrast. In the second case we will apply the Gaussian low pass filtering for smoothing the image.

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The following reasons specify why the preprocessing is necessary for underwater images.

i. Underwater image degradation is due to specific transmission properties of light in the water like absorption and scattering.
ii. Specificity of environment like light changing, water turbidness, and blue hue is more or less predominant when vehicles move.
iii. Specificity of video captures like unknown rigid scene and unknown color or low light sensitivity due to Marine snow.

The preprocessing is required for underwater images due to poor capture image quality. In this preprocessing is done by homorphic filtering and Gaussian filtering.

Preprocessing by homorphic fitering:
The homorphic filtering is used for sharpening the edges of image and also used to balance contrast. This is done by separating the illumination and reflectance component. The illumination component of an image is generally characterized by slow spatial variation. The reflectance component of an image tends to vary abruptly. These characteristics lead to associating the low frequencies of the Fourier transform of the natural log of an image with illumination and high frequencies with reflectance. Even though these assumptions are approximation at best, a good deal of control can be gained over the illumination and reflectance components with a homomorphic filter. For homomorphic filter to be effective it needs to affect the low- and high frequency components of the Fourier transforming different way. To compress the dynamic range of an image, the low frequency components thought to be attenuated to some degree. Then we choose filter component and use it further In this way the preprocessing by using homomorphic filtering is done.

Preprocessing by Gaussian filtering:
The Gaussian smoothing operator is a 2D convolution operatorthat is used to `blur' images and remove detail and noise. In this sense it is similar to the mean filter, but it uses a different kernel that represents the shape of a Gaussian (`bellshaped') hump. The idea of Gaussian smoothing is to use this 2D distribution as a `pointspread' function, and this is achieved by convolution. Since the image is stored as a collection of discrete pixels we need to produce a discrete approximation to the Gaussian function before we can perform the convolution. In theory, the Gaussian distribution is nonzero everywhere, which would require an infinitely large convolution kernel.Once a suitable kernel has been calculated, then the Gaussian smoothing can be performed using standard convolution method.

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.

Webers Law- Morphology is a technique of image processing based on shape and form of objects and it works on webers law. Morphological methods apply a structuring element to an input image, creating an output image at the same size. The value of each pixel in the input image is based on a comparison of the corresponding pixel in the input image with its neighbors. By choosing the size and shape of the neighbor, you can construct a morphological operation that is sensitive to specific shapes in the input image.

Enhanced Image- At the end we get enhanced image by the morphological operations that can first be defined on gray scale images where the source image is planar (single-channel). The definition can then be expanded to full-colour images.

Implementation
Firstly we will use constructed underwater images. Then we will apply some preprocessing methodologies which uses two filtering techniques homorphic and Gaussian filtering. For wavelet denoising it is essential to calculate some optimal threshold which is given by,

$$\lambda_{MBS} = \begin{cases} \dfrac{\beta \hat{\sigma}_v^2}{\hat{\sigma}_x^2} & \text{if} \quad \hat{\sigma}_v^2 > \hat{\sigma}_y^2 \\ \max|A_m| & \text{otherwise} \end{cases}$$

Here Am are the coefficients of wavelet in every scale

Where,

$$\beta = \sqrt{\frac{\log M}{2 \times j}}$$

M is the total of coefficients of wavelet, j is the wavelet decomposition level present is the sub band coefficients, $\hat{\sigma}y^2$ is the variance of the degraded image after wavelet transform $\hat{\sigma}x^2$ is variance of the original image after wavelet transform, and $\hat{\sigma}v^2$ denotes the variance of the noise components after wavelet transform.After inverse wavelet transform we get modified wavelet coefficients. Now simulation results into denoisy image.

Image enhancement law: Webers law

The webers law is given as follows,

C = Lmax – Lmin/Lmin

C – Contrast of the image, Lmax- Luminance of the image and Lmin– Luminance of the Surroundings

If L = Lmin and ΔL = Lmax – Lminthen from this we can write
C = ΔL/L

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On the other hand in a methodology to compute the background parameter was proposed. The Methodology consists in calculating the average between the smallest and largest regional minima. However, the main disadvantage of this proposal is that the image background is not detected in a local way. As a result, the contrast is not correctly enhanced in images with poor lighting, since considerable changes occur in the image background due to abrupt changes in luminance. In this paper, an approximation to Weber's law is considered by taking the luminance L as the grey level intensity of a function (image) Equation (a) indicates that D(log L) is proportional to C ; therefore Weber's law can be expressed as

$$C = k \log L + b \qquad L > 0 \ (1)$$

This law has a logarithmic relation. This technique is applied to image processing to enhance the image effectively. Where 'C' is the contrast, 'k' and 'b' are constants, 'b' being the background parameter and 'k' being the scaling factor for enhancement. Weber's law can be best understood from the following example. Consider a photo taken in a dark room. The obtained photo actually consists of 2 different things. One is what we visually perceive in that image and the other is what is actually present in that image. Weber's law simply states that the relation between these two is logarithmic. In our case, an approximation to Weber's law is considered by taking the luminance L as the grey level intensity of a function (image); in this way, expression (1) is written as

$$C = k \log f + b \qquad f > 0$$

4. SIMULATION RESULTS

Fig (a)Noisy under water image

Fig (b) Image after Homomorphic Filtering

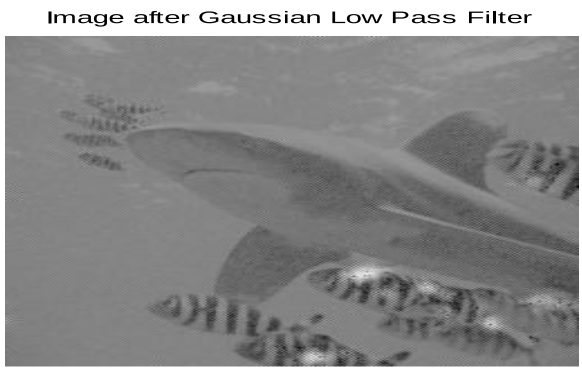

Fig (c) Image after Gaussian low pass filtering

Fig (d) Image after wavelet transform

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Enhance Denoised Image

Fig (e) Image after applying Webers Law

In order to verify the algorithm we do simulation experiment. We make use of MATLAB as experiment tool. In the first step Homomorphic filtering is used to correct non uniform illuminationand to enhance the contrast in the image, In second step Gaussian filtering is used to smooth the image in homogenious areas. Then we apply wavelet transform which results into noisy image. By using webers law we get enhanced under water image. Results are shown by Figures above.

CONCLUSION

The preprocessing is required for underwater images due to poor capture image quality. By applying the homomorphic filtering technology we eliminated the non uniform illumination and balance contrast and by Gaussian low pass filtering we get the smoothing image. The proposed algorithm combining adaptive threshold with adaptive output of the threshold function will not only remove noise but also gives a better visual effect. By applying the proposed approach, we can produce promissing results. Due to the advantage of its low entropy multi resolution characteristic removing the correlation as well as choosing base flexibility wavelet de-nosing method more and more attracts people attention

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BIOGRAPHIES

Miss Pooja A. Jaiswal M.E. pursuing from P.R. Patil College of Engineering and Technology S.G.B.A.U. Amravati and B.E. from Sant Gadge Baba Amravati University. I have published two International Papers.

Vishal B. Padole Obtained M-Tech Degree, from Government college of Engineering Amravati. And BE from Amravati University, Amravati. Currently he is pursuing PhD from Sant Gadge baba Amravati University, Amravati. He published 6 international papers and one national paper. He has been engaged in teaching, for period of about 6 years and He is working as an Assistant Professor in P. R. Patil College of Engineering and technology Amravati. His Area of research is image processing and signal processing.