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Enhancement of Underwater Images: A Review

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Abstract- Underwater image pre-processing is absolutely necessary due to the quality of images captured under water. When capture such images, quality of images degrade due to many factors like ripples in water, lack of availability of light, organic matter dissolved in water etc and also such images are captured from a very small distance , so the images must be pre processed before applying any kind of operation on these images. Different filtering techniques are available in the literature for pre-processing of underwater images. The filters used normally improve the image quality, suppress the noise, preserves the edges in an image, enhance and smoothen the image. In this paper comparative analysis of various Filters for such underwater images is presented.

Keywords:- Underwater image preprocessing, Homomorphic Filter, Anisotropic Filter,Wavelet filter.

1.INTRODUCTION

Underwater image enhancement techniques provide a way to improve the object identification in underwater environment. Underwater sea images needs to be preprocessed due to lower quality of sea water images. When such images are captured, quality degrades due to many factors like ripples in water, lack of availability of light and organic matter dissolved in water etc.Due to theses factors such images needs to be captured from a very small distance , so the quality of underwater images suffers.Thats why these kind of images must processed before applying any kind of operation on these images. To denoise an image without affecting the image quality and edges in an image, edge preserving filters are used [2]. When an underwater image is captured, pre-processing is necessarily done to correct and adjust the image for further study and processing.Basic image processing steps are as follows:

a.) Image acquistion
b.) Pre-processing
c.) Discretization/Digitization
d.) Image Enhancement and Restoration
e.) Image segmentation
f.) Feature extraction
g.) Image representation
h.) Image interpretation

Pre-Processing is an important step in image processing technique.

Recently, many researchers have developed pre processing techniques for underwater images using image enhancement methods.

Prabhakar C.J. et. al. [1] studied an image based preprocessing technique to enhance the quality of the underwater images. The technique comprises a combination of four filters such as homomorphic filtering, wavelet denoising, bilateral filtering and contrast equalization. These filters are applied sequentially on degraded underwater images. The literature survey reveals that image based preprocessing algorithms uses standard filter techniques with various combinations. For smoothing the image, the image based preprocessing algorithms uses the anisotropic filter. The main drawback of the anisotropic filter is that iterative in nature and computation time is high compared to bilateral filter. In addition to other three filters, we employ a bilateral filter for smoothing the image. The technique using quantitative based criteria such as a gradient magnitude histogram and Peak Signal to Noise Ratio (PSNR). Further, the results has been qualitatively evaluated based on edge detection results.

G.Padmavathi et. al. [2] studied that the under water images suffering from quality degradation due to transmission 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. The filters used normally improve the image quality, suppress the noise, preserves the edges in an image, enhance and smoothen the image. Therefore three famous filters namely, homomorphic filter, anisotropic diffusion and wavelet denoising by average filter used for under water image pre-processing. The speckle reduction by anisotropic filter improves the image quality, suppressed the noise, preserves the edges in an image, enhance and smoothen the image .The mean square error value which must be low for an image and peak signal to noise ratio which must be high in an image .Though the wavelet filter shows high and low for PSNR and MSE.

Isabelle Quidu et. al. [3] proposed that underwater images suffer from limited range, non uniform lighting, low contrast, diminished colors, important blur. Moreover many parameters can modify the optical properties of the water and underwater images show large temporal and spatial variations. So, it is necessary to pre-process those images before using usual image processing methods. The various filter composed homomorphic filtering to reduce illumination problems and to enhance the contrast, wavelet denoising and anisotropic filtering to cancel out the noise and enhance edges, contrast adjustment and color compensation to suppress the predominant color.

2. EDGE PRESERVING FILTERS FOR PREPROCESSING

In this section, we present filters, which are adopted in the proposed technique. These filters are employed sequentially on degraded images.

2.1 Homomorphic filtering

The homomorphic filtering is used to correct non-uniform illumination to enhance contrast in the image. It is a frequency filtering method. Compared to other filtering techniques, it corrects non-uniform lighting and sharpens the image.

In the Illumination-reflectance model, where image is defined as a intensity illumination and the reflectance function as follows

$F(x,y) = i(x,y) \times r(x,y)$------Eq.1

Where F(x,y) is the image sensed by instrument, i(x,y) the illumination and r(x,y) the reflectance function. On contrary, reflectance is associated with high frequency components. By multiplying these components a highpass filter can be suppress the low frequencies, i.e the non uniform illumination in the image can suppressed. The algorithm is described as follows:

1.) The illumination and reflectance components by taking the logarithm of the image give (Eq.2).

G(x,y)=ln $F(x,y)$=ln(i(x, y)×r(x, y)) = ln (i(x, y))+ ln (r(x, y)) -- -----Eq.2

2.) Computation of the Fourier transform of the log image gives (Eq.3)

G (wx, wy) = I (wx, wy) + R(wx, wy) ----------Eq.3

3.) High-pass filtering. The filter applied to the Fourier transform decreases the contribution of low frequencies (illumination) and also amplifies the contribution of mid and high frequencies (reflectance), sharpening the edges of the objects in the image given in (Eq.5)

S(wx, wy)=H(wx, wy) × I(wx, wy) + H(wx, wy) × R(wx, wy) --------Eq.4

With,

H (wx, wy) = (rH − rL)× (1 – exp (− (w2x+ w2 y2 /2w))) + rL ------ Eq.5

where rH = 2.5 and rL = 0.5 are the maximum and minimum coefficients homomorphic filtering factors these two are selected empirically.

4.) Computation of the inverse Fourier transforms is taken to reconstruct the original image. The resultant filtered image is obtained.

2.2 Anisotropic filtering

Anisotropic filtering simplifies image features to improve image segmentation. This filter smoothes the image in homogeneous area but preserves edges and enhances them. It is used to smooth textures and reduce artifacts by deleting small edges amplified by homomorphic filtering. The previous step of denoising is very important to obtain good results with anisotropic filtering. It is the association of wavelet denoising and anisotropic filtering which gives such results. Anisotropic algorithm is usually used as long as result is not satisfactory.

Perona and Malik anisotropic diffusion is the edge sensitive extension of the average filter. Anisotropic diffusion can be applied to radar and medical ultrasound images, underwater images.

2.3 Wavelet filtering

Wavelet filter is also used to suppress the noise i.e the Gaussian noise are naturally present in the camera images and other type of instrument images.

While transferring the images Gaussian noise can be added.This wavelet denoising gives very good results compared to other denoising methods because, unlike other methods, it does not assume that the coefficients are independent. Thresholding is a simple non-linear technique, which operates on one wavelet coefficient at a time. In its most basic form, each coefficient is thresholded by comparing against threshold, if the coefficient is smaller than threshold, set to zero; otherwise it is kept or modified. Replacing the small noisy coefficients by zero and inverse wavelet transform on the result may lead to reconstruction with the essential signal characteristics and with the less noise. A simple denoising algorithm that uses the wavelet transform consist of the following three steps,

(1)Calculate the wavelet transform of the noisy signal

(2)Modify the noisy detail wavelet coefficients according to some rule

(3)Compute the inverse transform using the modified coefficients.

3. CONCLUSION

In this paper, we proposed a preprocessing technique for enhancing the quality of degraded underwater images. The three edge preserving filters taken for study are homomorphic filter, anisotropic filter, wavelet denoising by average filter. Underwater image suffers from transmission properties of water, the transmission of limited range of light, disturbance of lightening, low contrast and blurring of image, diminishing color during capturing of image.

The speckle reduction by anisotropic filter improves the image quality, suppressed the noise, preserves the edges in an image, enhance and smoothen the image. Homomorphic filtering is used to correct non-uniform illumination and to enhance contrasts in the image. It's a frequency filtering technique. Wavelet filter is also used to suppress the noise i.e the Gaussian noise are naturally present in the camera images and other type of instrument images.

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