ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

IJARCCE

International Journal of Advanced Research in Computer and Communication Engineering

SITES

Smart And Innovative Technologies In Engineering And Sciences

Gyan Ganga College of Technology

Vol. 5, Special Issue 3, November 2016

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 these factors such images needs to be captured from a very small distance , so the quality of underwater images suffers. That's why these kinds 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. In this paper, the contrast quality of digital image that scanned using transmission and reflection mode is evaluated based on mean and standard deviation of the image. Furthermore, the quality of digital image is enhancement based on spatial technique using contrast stretching, histogram equalization (HE), adaptive histogram equalization (AHE), and contrast limited adaptive histogram equalization (CLAHE). Evaluation of the preference image quality is performed based on an objective criterion.

2. LITERATURE REVIEW

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,

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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.

Gaurav Garg and Poonam Sharma An Analysis of Contrast Enhancement using Activation function [4].This paper studies various activation functions such as sigmoid function, Ramp function, Hyperbolic Tangent Function and many function are used for contrast image enhancement. Activation function is mostly used in neural networks. These activation functions are successfully studied over bright and dark region.

Dr Vijay Dhir and Sanjeev kumar Review of various Contrast Image Enhancement Technique [5].This paper studies various contrast image enhancement technique. This various technique will going improve the contrast of an image so that image will look good. There are so many contrast image enhancement technique that we will going to study in this paper they are Convolution Mask ,Linear Contrast Stretching , Histogram equalization, Adaptive Histogram Equalization and Enhancement by Point Processing. The main aim of this paper is preserve input mean brightness of an image when contrast image enhancement procedure is done on that image. Jaspreet Kaur and Amita Choudhary Comparision of Sevral Contrast Stretching method on Acute Leukemia Image [6].This paper focuses on various contrast stretching methods such as local ,global ,partial, bright and dark contrast stretching methods. The comparison of all this method studied in this paper to find out which one is best to enhance and study acute leukemia image in better way.

Archana Singh and Neeraj Kumar A Comprehensive method for Contrast Image Enhancement based on Local and Global Contrast and Local standard Deviation [7].This paper studies global and local method for Contrast image Enhancement .This paper study this two method in which researcher found that this two are not sufficient to enhance an image when image has some contrast area and it is not possible to perform any type of transformation on it. This paper proposed and study a novel method to remove the divided by zero condition that arises due to local standard deviation of that contrast area to enhance the image in more suitable way.

Prasad Nagelli,Venkath Reddy, BTR Naresh Reddy Blurred Image Enhancement using Contrast Stretching ,Local Edge Detection and blind decovolution [9].This paper is research work to avoid the problem which will occur in blurred image .Blurred image is a common problem observed in the situation when object is in motion or when we will going to shoot a video. Three method are presented here in this paper to avoid the problem of blurred image. Contrast stretching process is used to deblurred image. Local edge detection method is applied on original as well as blurred image. Both the image edges are fused to obtain sharp edges

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.

3. EXISTING TECHNIQUES

3.1 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

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

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).

$$G(x,y)=\ln(\ ,\ )=\ln(i(x, y)\times r(x, y)) = \ln (i(x, y))+\ln (r(x, y))$$

-----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

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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)

$$S(wx, wy)=H(wx, wy)\times I(wx, wy) + H(wx, wy)\times R(wx, wy) \text{ --------Eq.4 With,}$$

$$H(wx, wy) = (rH - rL)\times (1 - \exp(-(w2x + w2\ y2\ /2w))) + rL \quad \text{------ Eq.5}$$

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.

3.2 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.

3.3 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.

3.4 Adaptive histogram equalization

Because of the medium scattering and light distortion, underwater images suffer from poor visibility. It is obviously that the histograms of most underwater images have a narrow dynamic range in their RGB channels, which means to a low contrast feature of the images. To overcome this, global histogram equalization method has been used to enhance images for a long time. But it presents unsatisfied performance in underwater images since the underwater images always contain special optical properties that make the image features become too complex to be described by global parameters [9].

Considering this situation, we adopted the Contrast Limited Adaptive Histogram Equalization (CLAHE) [12] to enhance the image contrast of the underwater image after dehazing step, which could avoid the overflow of highlight parts of the image and solve the problem of excessive magnified image noise. Unlike ordinary histogram equalization algorithm, by the calculation of local histogram of the images CLAHE algorithm definitely suits for underwater images whose distribution of brightness usually changes in different parts of the scenery, leading to an improvement for the local contrast and the visibility of details for underwater images that could be seen in the following experimental parts by objective comparison of different methods.

4. SYSTEM MODEL

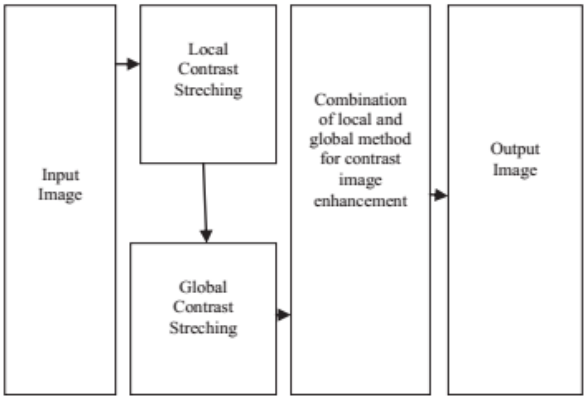

Figure 1: Basic System Architecture

5. 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.

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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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