Advance Underwater Image Reconstruction using Un-sharp Masking and AFSMF: A Review

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Abstract: An underwater image can be distorted due to light scattering and color change. It caused to one color dominating an image. As we know that the refractive index of water is high in comparison to air, therefore when light is come on water, it gets refracted. Therefore, underwater images have the deficiency of limited range visibility, low contrast, blurring, color diminished and noise. One way to improve the image quality is known as image enhancement. This paper presents a comparative study of the different techniques of image enhancement used for enhancing underwater image. Along with the comparisons the paper also presents a new approach for image enhancement using Un-sharp Masking and the enhanced images are characterized by a reduced noised level using Adaptive Fuzzy Switching Median Filter. Finally a new enhanced underwater image can be obtained by applying proposed method.

Keywords: Color change, light scattering, underwater image, ASMF, Un-sharp Masking.

I. INTRODUCTION

Image processing is a form of signal processing in which an image is taken as input and the output is either an image or a set of characteristics or parameters related to the image [1]. The tinniest substance of an image is known as pixel, also known as picture element. The activity of image processing is done pixel by pixel. The Method for improving the image quality is called Image Enhancement.

Image enhancement refines the visibility of one aspect or component of an image. It is called the sharpening of image features such as boundaries, or contrast to make a graphic display [1]. The main use of this process is to display & analysis. This will not cause increment in inherent information content in the data. This consists of noise reduction, sharpening, gray level & contrast manipulation, filtering, interpolation and magnification, pseudo coloring, and so on. Image enhancement consist qualitative subjective approach to produce a more visually pleasing image. They do not depend on any physical model for the image formation. These approaches are usually simpler and faster than deconvolution methods. The existing research shows that underwater images raise new challenges and impose significant problems due to light absorption and scattering effects of the light and inherent structure less environment [2]. Exploring, understanding and investigating underwater activities of images are gaining importance for the last few years. Scientists are keen to explore the mysterious underwater world. However, this field is still lacking in image processing analysis techniques and methods that could be used Researchers have tried to employ various different enhancement techniques.

Very little analysis has been performed on underwater images. The amount of light is reduced when we go deeper into the water and hence colors drop off one by one depending on their wavelength. Red color disappears at the depth of 3m approximately. It has been observed that the orange color is lost at the depth of 5km. At the depth of 10 m most of the yellow goes off and finally the green and purple disappear at further depth. As the blue color has the shortest wavelength it travels the longest way in water. Therefore blue and green color dominates the underwater images. Underwater images impose several problems mainly due to light absorption, light scattering, light reflection and denser medium. These difficulties caused to poor visibility of the underwater images. Absorption removes the light energy and scattering changes the direction of light path. These effects are not only due to water but also due to other components such as dissolved organic matter or small floating particles. The scattering is of two types. They are known as forward scattering and backward scattering. Forward scattering causes blurring of the image features and backward scattering reduces the contrast of the image [2]. Forward scattering is created when light passes just below the surface of an object, undergoes the diffuse shading, and scatters. Back scattering is scattering that becomes visible when the shaded object's back surface is lit, and the light scatters deeply on the object that becomes visible on the front surface. Unless a large amount of backward scattering and a very bright back light have been mentioned, back scattering is usually only visible on the edges, or particularly thin parts of backlit objects.

Fig. 1.1 An sample underwater image enhancement

Here, we introduce a novel approach that is able to enhance underwater images based on single image to overcome above mentioned problems. With respect to light reflection, Church [21] describes that the reflection of the light varies greatly depending on the structure of the sea. Another main concern is related to the water that bends the light either to make crinkle patterns or to diffuse it as shown in Figure 1. Most importantly, the quality of the water controls and influences the filtering properties of the water such as sprinkle of the dust in water [27]. According to Anthoni [22] the reflected amount of light is partly polarised horizontally and partly enters the water vertically. An important characteristic of the vertical polarisation is that it makes the object less shining and therefore helps to capture deep colours which may not be possible to capture otherwise.

Another well-known problem concerning the underwater images is related to the density of the water in the sea which is considered 800 times denser than air. Therefore, when light moves from the air to the water, it is partly reflected back and at the same time partly enters the water [7]. The amount of light that enters the water also starts reducing as we start going deeper in the sea [8]. Similarly, the water molecules also absorb certain amount of light [17]. As a result, the underwater images are getting darker and darker as the depth increases. Not only the amount of light is reduced when we go deeper but also colours drop off one by one depending on the wavelength of the colours.

The organization of this paper is as follows. Section II explains some existing techniques for image enhancing model. Section III describes the proposed model for underwater image enhancement and proposes our guided adaptive switching median filter. Section IV consist of some expected outcome. Finally, Section V concludes this paper.

II. Related Work

In this section, literature surveys of various papers that provide basic concepts and knowledge for this work have been done. On the basis of this survey we can. classify the image enhancement techniques as following.

2.1 Integrated color model (ICM)

The integrated color model is mainly based on color balancing by contrast correction is RGB model and color correction in HSI model. RGB is the red, green and blue model. This model has better human perception than the HSI model. The HSI model is the hue, saturation and intensity model. Firstly the color cast is reduced by equalizing all the color values. Secondly an enhancement to the contrast correction is applied to stretch the histogram values in red color [2]. This is performed for green and blue color. Thirdly the saturation and intensity components of the HSI color model is applied for contrast correction to increase the true color and to address the problem of illumination respectively.

[1] Contrast correction is performed to overcome low red color problem by stretching to the maximum side to increase the red color values. Similarly the green and blue values are stretched.

[2] Saturation and intensity parameters are used for contrast correction in the HSI model. Contrast correction is performed in saturation to improve the true color and in intensity to solve the problem of lighting.[2] Using this method, stretching is performed in both directions, maximum and minimum sides.

2.2 Histogram Equalization

Adaptive histogram equalization (AHE) is a computer image processing technique. It is used to improve the contrast in images. The ordinary histogram equalization computes several histograms. Each of them correspond to a distinct section of the image. This is used to redistribute the lightness values of the image. It is therefore suitable for improving the contrast of an image[4] .Contrast Limited AHE (CLAHE) differs from ordinary adaptive histogram equalization in its contrast limiting. In CLAHE, the contrast limiting procedure is applied to each neighbourhood from which a transformation function is derived. It was developed to prevent the over amplification of noise which adaptive histogram equalization can give rise to. It limits the amplification by clipping the histogram at a user-defined value called clip limit. The clipping level determines how much noise in the histogram should be smoothed and hence how much the contrast should be enhanced [4]

2.2.1 CLAHE on RGB Colour Model

The RGB colour model is an additive colour model. Here red, green and blue light are added together in various ways to reproduce a broad array of colours. The value of R, G, and B components is the sum of the respective sensitivity functions and the incoming light. In RGB color space, CLAHE is applied on all the three components individually and the result of full-color RGB can be obtained by combining them.

2.2.2 CLAHE on HSV colour model

HSV is a cylindrical-coordinate representation of points in an RGB color model. In color space it describes colors in terms of the Hue (H), Saturation (S), and Value (V). Irrespective of the value being at either min or max intensity level, hue and saturation levels will not differ. CLAHE can only be applied on V and S components[5] .

2.3 Image Based Technique Using Four Filters

The proposed technique comprises a combination of four filters. They are homomorphic filtering, wavelet denoising, bilateral filtering and contrast equalization. These filters are applied on the degraded underwater images, sequentially. This proposed technique enhances the quality of the underwater

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images. It can be employed prior to computer vision techniques.

2.3.1 Homomorphic filtering

It is a frequency filtering method which is preferred to other techniques because it corrects non-uniform lighting and sharpens the image features at the same time [3].

2.3.2 Wavelet denoising

Thresholding is a simple non-linear technique. It operates on one wavelet coefficient at a time. If the coefficient is smaller than the threshold, set to zero; otherwise it is kept as it is or modified. Wavelet transform of noisy signal should be taken first and then thresholding function is applied on it. Finally the output should undergo inverse wavelet transformation to obtain the estimate [3].

2.3.3 Bilateral filtering

Bilateral filtering is a non-linear filtering technique. It is used to smooth the images by preserving edges. This is done by means of a nonlinear combination of nearby image values[6] . It is an edge-preserving and noise-reducing smoothing filter for images. The intensity value at each pixel in an image is replaced by a weighted average of intensity values from nearby pixels. This weight can be based on a Gaussian distribution. Traditional filtering is also known as domain filtering. It enforces closeness by weighing pixel values with coefficients that fall off with distance. The range filtering averages image values with weights that decay with dissimilarity. The combination of both domain and range filtering is termed as bilateral filtering.

2.3.4 Contrast stretching and colour correction

Contrast stretching is often called normalization. It is a image enhancement technique which attempts to improve the contrast in an image by „stretching" the range of intensity values. Color correction is performed by equalizing each colour. In underwater image colours are rarely balanced correctly. This processing step suppresses prominent blue or green colour without taking into account the absorption phenomena [5].

Gasparini and Schettini [23] have developed a tuneable cast remover for digital photographs based on a modified version of the white balance algorithm. This approach first deducts the presence of a cast using a detector and secondly it removes the cast. The approach has been applied to a set of images downloaded from personal web pages. Garcia have presented a significant literature addressing the lighting problems in underwater images. The researchers have reviewed several techniques related to image enhancement. They include illumination-reflectance model, local histogram equalization, homomorphic filtering and subtraction of the illumination. Their approach tends to address the issues concerning the correction of light in homogeneities basis with homomorphic filter. They have attempted to reduce the amount of noise using histogram equalization technique. Chambah and Semani have proposed an approach in relation to underwater colour constancy enhancement of automatic live fish recognition based on Gray World Automatic Colour Equalization. They have used a combined algorithm based on GW (Gray World), ACE (Automatic Colour Equalization) and WP (Retinex White Patch) for underwater image recognition in real-time. WP method is based on the mean of the image and it does not have any effect on image. ACE enhances the image without supervision. They carried out several steps in order to apply the proposed approach to underwater image recognition. For the sake of segmentation they subtract the background in order to recognise the image (e.g., fish). Using this process, small false detection is found and discarded using threshold. The use of this approach helps to remotely select the fish from the fish tank and choose the fish display on the screen in order to recognise image in real-time. Andreas [17],[] have developed an approach for underwater image enhacement by using several algorithms including Histogram Equalization, Gaussian Blur and Log-Gabor. In the first instance, they apply histogram equalization to remove backscattering, attenuation and lighting effect. Applying the histogram methods does not guarantee the removal of noise in the images. In order to address this issue, they further use Gaussian blur, a low pass filtering method. Actually, they select two images from original image using division and subtraction. After fusion, the remaining noise is removed using multi-scale de-noising algorithm based on complex valued Log Gabor wavelets [17].

III. PROPOSED WORK

In our proposed method we will apply un-sharp masking technique for image enhancement. Unsharp masking (USM) is an image sharpening technique, often available in digital image processing software. The "unsharp" of the name derives from the fact that the technique uses a blurred, or "unsharp", positive image to create a mask of the original image. After enhancing the image, it may be possible that image can get some noise. For removal of noise adaptive fuzzy switching median filter will be apply. This technique uses two stages, one for detection and second for reduction. It is a hybrid of simple adaptive median filter and fuzzy switching median filter. Adaptive property enables the Noise adaptive fuzzy switching median filter to expand the size of its filtering window according to the local noise density. It makes possible to filter high-density of salt and pepper noise. Firstly Detection stage detects the noisy pixels and creates a histogram of corrupted image then these detected noisy pixels will be subjected to the second stage of the filtering process. Noise free pixels are remained unchanged. After filtering stage maximum detected noise pixels will be filtered and simulation results show the filtered image.

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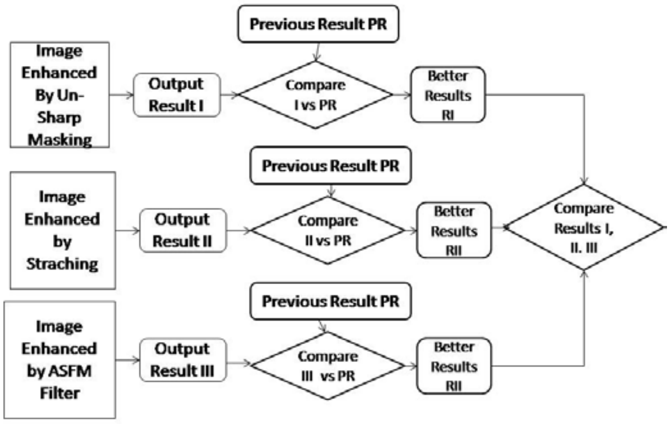

Figure 3.1: Workflow Diagram of proposed algorithm

IV. Expected Outcome

The performance of the proposed will be evaluated both objectively and subjectively. Both results are expected to demonstrate superior haze removal and color balancing capabilities of the proposed method over the others. In the experiment, we will compare our method with the others.

V. Conclusion

Exploring, understanding and investigating underwater activities are gaining importance from the last few years. Today, scientists are keen to explore the underwater world. However, the area is still lacking in image processing analysis and methods that could be used to improve the quality of underwater images. Underwater image enhancement techniques provide a way to improve the object identification in underwater environment. There is a lot of research started for the improvement of image quality, but limited work has been done in the area of underwater images. Histogram Equalization is one of the well-known image enhancement for contrast enhancement because it is simpler and effective. Basic idea of HE is to re-map the gray levels of an image. It tends to introduce some annoying artifacts and unnatural enhancement. Though CLAHE is used to minimize the effects, it is very time consuming. The technique which uses filters makes use of four filters sequentially. It is very complex and time consuming. Hence proposed method can show better and improved enhancements on underwater images with the capability of noise removal.

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