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Recent trends and challenges in Image Enhancement Techniques for Underwater Photography

Shubhangi N. Ghate[1] , Dr. Mangesh D. Nikose[2]

Sandip University, Nashik, Maharashtra, India.

Abstract- Image enhancement is the method to enhance the images in quality wise and improving its colour components. Colour characteristics and its behaviour are important factor to enhance the quality The High-definition underwater photography is used in various applications such as aquatic ecosystem observation, fish production, environmental impacts, oceanography, etc. This paper provides survey of various image enhancement techniques is used for under water images. The major problem in underwater photography is visual acuity, poor perseverance and it is not meet the real time high definition displays. This paper explains and solves these issues by usingimage enhancement multi-algorithms. In this review, various image enhancement techniques are discussed in underwater photography and compared advantages and disadvantages.

Keywords- Underwater Photography, Image Enhancement, Colour components, Image Quality

I. INTRODUCTION

High-definition photography and display methods are used in different applications such as aquatic, environmental impact and observation, etc. The problems in earlier underwater optic methods are low perseverance, low quality, pictorial elements issues, and visual acuity. It doesn't meet the real time needs and high-definition display in extreme environments [1]. Image formation process is available but limited sources, available instruments and perseverance factors are major issues.The light reflection is another major constraint in sea. It is scattered from the water due to light.The water quality and filtering are another problems and influencing the photography.

The various methods are developed to broaden the scope of underwater images and improve image quality. The picture quality is defined in terms of RGB and its perseverance. The above factors are considered for image quality assessment and their performance [2]. The following issues affect underwater photography: Atmospheric light attenuation reduces visibility to about 20 metres in clear water and 5 metres or less in muddy water. As a result, the light source enters the water and causes absorption. It means that the light energy is removed and the direction of the light wave path is scattered.

II. LITERATURE REVIEW

A. Underwater image light enhancement

The image quality enhancement and restoration are done by using valuation of images using ambient light, depth-dependent colour changes and pixel values. The light intensity and ambient is the major factors. The latter difference is obtained from ambient of the light and scene transmission. The removing of colour casts and image contrast is applied by using Adaptive colour correction [4][2].

In 2010 Iqbal, K.; Odetayo, M.; James, A.; Salam, R.A.; Talib,et al, Image enrichment is accomplished through the use of unsupervised colour correction methods.Underwater photographs are reduced in contrast and have a non-uniform colour cast using this method[4].Light absorption and scattering are major issues in the aquatic environment, according to their research.To improve image quality, anmethod of unsupervised colour correction (UCM) for underwater image quality enhancement is proposed.This method has unique feature like RGB Colour model, contrast improvement, HSI values process, etc. In this method, the colour cast is equalised and find the values. Next, to improve the quality of photograph alteration method is suggested and increases the RGB colour stretching. Red colour histogram method is applicable for colour stretching and finding maximum/minimum value of each pixel. HSI colour model is used for calculating Saturation and Intensity factor which gives stretching contrast correction and true colour saturation values [6],[3].

In 2011, Hung-Yu Yang et al, suggested unclear images in underwater photography in deep-sea engineering are tedious process. The dark channel method is proposed for improve the quality. The median filler is applied to find depth map images and colour correction method is used for improve colour contrast. The both methods are decrease the performance time in underwater image processing. So, the above methods require less computation time and effective implementation in real time underwater image processing [7].

In 2015, ShaorongXie et al, in turbide water imaging are extremely changed due their light and intensity. So, they have done underwater examination using Forward looking sonar with its independent of light and turbidity. The sonar image has high noise and little contrast. The above method focused image processing is applied for pipeline surface. The Gabor filter is used for image improvement and edge detector is applied for estimation of edges.Hough and Kalman filler are applied for estimating pipeline parameter and forecast the next pictural element [8].

Shamsuddin et al, the low resolution images can be captured from normal digital camera and it has partial visual capability. The following problems are addressed partial range visibility, poor contrast, uneven lighting, smearing, colour deterioration and noise using photography scenario methods. The major focuses are colour deterioration during photography [9]. The automatic and manual process is applied to get extended histogram values.

Hitam, et al, designed mixture contrast model for histogram equalization and underwater photograph enhancement. This technique is used to improve the quality of underwater photography. [10]. This is Hybrid Contrast Limited Adaptive Histogram Equalization (CLAHE) method which has the specific underwater photograph colour spec image enrichment codes. The above methods are useful in CLAHE on RGB and HSV colour models. The Euclidean rule is applied for colour spaces calculation. The visual quality is enhanced by using contrast and reducesnoise level.

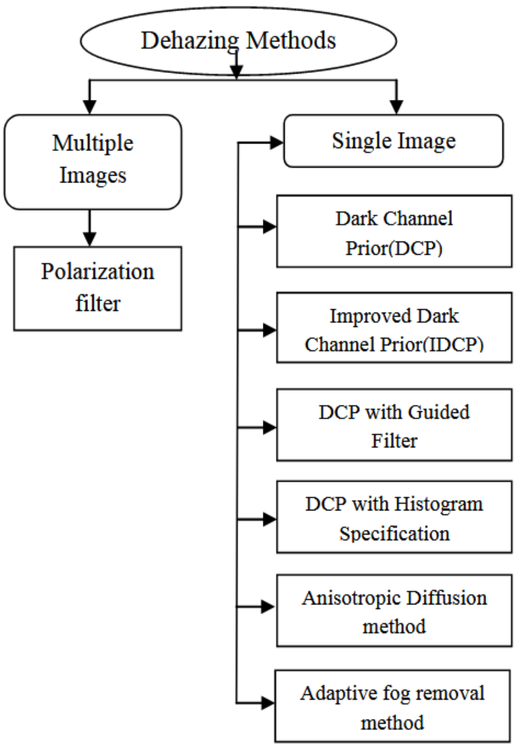

Fig 1- Classification of Dehazing Methods

In 2018, report from Voronin et al, the image enhancement is focused on logarithmic process and transform is applied for various applications [11]. The Limited adaptive histogram method is applied for domain coefficients calculation and local value processing. The image enrichment method is applied for underwater photography, featured colour models; improve the lighting and brightness gradient.

B. Underwater Dehazing Techniques

Image distribution, uneven diffusion, and light absorption complicate underwater photography. The atmosphere is caused by humidity, which is calculated using Haze model particle suspended techniques. This method is used to assess the degradation of image quality in muddy and populated areas.Polarisation and light from the atmosphere are the two major factors that lower image quality, according to Schechner et al. The preceding method effectively removes haze points and polarises image filters.[13].

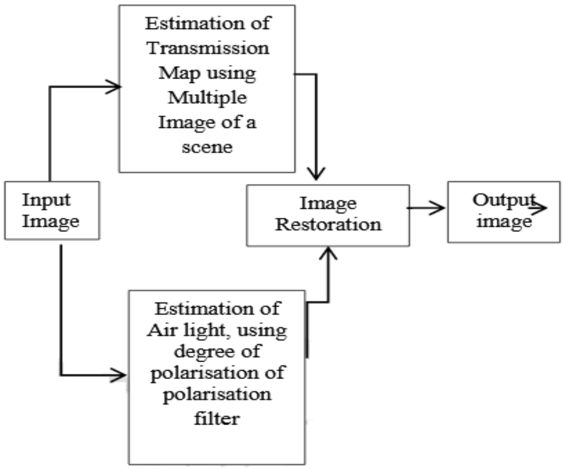

Fig 2- Polarization of images

Bin Xie et al. use to enhance image quality, it employs an image dehazing algorithm with a dark channel priority scheme.To calculate intensity in YCbCr space, the Multi-Scale Retinex method is used.To find high quality image factors, a combination of dark channel prior and haze image model is used. As a result, the preceding method produces a faster comparative result. [14].

The dark channel method developed by Hue et al. is a single input processing method that uses haze removal calculations to determine image restoration values. Based on key observations, this method produced better results in outdoor haze-free images. The thickness factor and edges are used to estimate the local region values. [16].

The dark channel method, according to Yin et al., can be applied to a single image. Haze points are used to calculate pixel values, and low intensity values are marked. Image formation table values can be used to estimate each position.This effect has the potential to degrade overall picture quality. This method has the the benefit of producing both image estimation and transmission map results. The disadvantage is that the image quality is reduced when predicting haze images and hallo effects.

Birk et al. specify that soft matting results are improved by using an improved dark channel prior method. To blend and smooth the image texture, a bilateral filter is used. This method avoids the error caused by pixel brightness levels.As a result, the above method is more efficient, requires fewer computations and produces better quality images. The disadvantage is that the halo effect must be mapped in every region, preventing accurate results. [15].

C. Image Color enhancement

The underwater photography image enrichment method is applied for capture images and Yang et al, enrichment method is suggested for calculating air-light dark channel values and depth map median values [28].

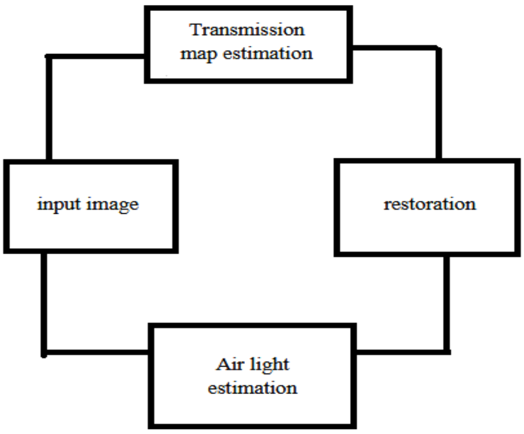

Fig 2- IDCP method

An unsupervised colour correcting algorithm is utilised to increase the persistence of underwater photos. This approach improves image quality while also calculating aerial light levels. The dark channel approach is used to remove low intensity values, and the associated characteristics such as tint, tone, hue, saturation, dark and bright objects are validated. The soft matting algorithm is used to remove the black effect and restore image quality. The iteration technique is used for high-dimensional picture processing and smoothing. According to Chiang et al., a wavelength-based dark channel is used in the de-hazing process to eliminatehaze and darkness. To handle the de-hazing process, image sampling and the histogram process are used in this method.As a result, colour distortions and attenuation occur. Colour line algorithms are proposed by Fattal et al. for veiling light processes, and they eliminate hazy objects. However, removing scatters in high turbulence photography is a time-consuming process. [17].

Lu et al, the veiling light approximation method is used for remove high light images and attenuation values. The better results are determined by calculating the attenuation factor using coefficient values. This technique is more time-consuming, and unsuitable for underwater applications. A novel colour image enhancement approach is applied for calculating hue-saturation-intensity values. For calculating HSI and HSV colour models, wavelet-domain filtering (WDF) and constrained histogram stretching (CHS) algorithms are used. In this case RGB model is converted ti HSI representation component. HSV another one model is used for calculating pixel positions. CHS algorithm is used for HSV formulations.The major contribution is HSV values calculated with contrast, colour rendition, non-uninform illumination and denoising [21].

In 2018, Sun et al. [23] used a deep pixel-to-pixel network model to improve underwater images. An encoding-decoding process is used to supervise and decode the underwater images. The converted images are configured and assigned a dark channel prior to processing.To reduce noise and attenuation factor, convolution and de-convolution are used. Each pixel is examined and added to the deep neural network model. Low-level characteristics are removed from the photos, and an image enhancing procedure is applied. Otherwise, it is an adaptive-driven process in which each pixel is used to achieve image quality in the deep network process. [16].

Chongyi et al. propose two methods to cut down on external noise and increase quality: underwater de-hazing and underwater image contrast. The image restoration, visibility, colour images, and degradation processes are all governed by the de-hazing algorithm's set of rules.This method's main contribution is that it distributes each histogram value to all deep networks, which allows us to improve the brightness and contrast of underwater photographs. There are two kinds of improved images:

1. Images with a natural appearance and
2. Images with a relatively suitable display.

Image quality, brightness, lighting, contrast, and saturation factors are specified for both categories. [19].

D. Underwater white balance techniques:

The general phenomenon is that water absorbs light and travels a long distance. To capture underwater images, some artificial lighting is used. The originality may be altered, however, because artificial lighting produces more brightness. Light sources are reflected off of objects, causing their quality to change.

The balancing method can be used to achieve both the balancing of unwanted colour effects and the balancing of contrast. To locate the haze region and degraded values, histogram stretching is used. It is important factor degradation to calculate luminance, chromaticity, and saturation. The pixel representation determines the above-mentioned factor values. Depending on the lighting, brightness, and colour models, each pixel may differ.Image enhancement can also benefit from encoding-decoding methods. As a result, image quality suffers as well.[21][22][40][41].

Amjad Khan et al. created an underwater image enhancement system based on wavelet fusion for detecting low contrast colour images. The wavelet transform is utilised to locate the foggy degraded images, which are processed in parallel. This procedure enhances image quality and produces a better result. To collect the data and generate the histogram, the wavelet fusion procedure use low and high pass filter technologies. For clipping and recognising visible surfaces, the contrast adaptive histogram equalisation method is utilised. Normalisation and image cutting are the method's shortcomings. [27].

Yan-Tsung Peng et al. devised a depth estimation approach for repairing under water photos based on blur and absorption. To improve and restore photos, the image formation model is applied. Because depth is a significant component in determining colour channel values, this method successfully recovered underwater photos. The underwater photographs are processed correctly, and the depth is determined. The hazy levels are inspired by underwater photography. The depth factor is then used to compute the brightness of the scene. [28].

According to Munwar Ali Shaikh's [29] research, the attenuation process selectively alters the wavelength spectrum as light penetrates water, influencing the intensity and appearance of a coloured surface. Because colour attenuation and loss are proportional to the overall distance between the observer and the scene, the primary purpose is to adjust for red attenuation and loss. The green channel has been well preserved underwater in compared to the red and blue channels. Light having a long wavelength, such as red light, is lost first when travelling in clear water.Because the green channel includes more opponent colour information than the red channel, compensating for the stronger attenuation is very significant, thus we correct for the red attenuation by adding a proportion of the green channel to the red channel.

The amount of compensation should be proportionate to the difference between the mean green and mean red readings.

Sophiya Philips et al, the colour casting methods are used to eliminate the unwanted blur images and check attenuated wavelength, fogginess and lighting factors [30].This is white balance fusion calculation and produces the enhanced results. The resultant values are balanced values and fusion specific results. The impulse response calculated by using Laplacian fusion method. The results give human visual images and eliminate back-scattering effects.The resultant values depends absorption factor and high order wavelength. This method eliminates fogginess and blurriness. The Fusion method gives clear vision underwater images.

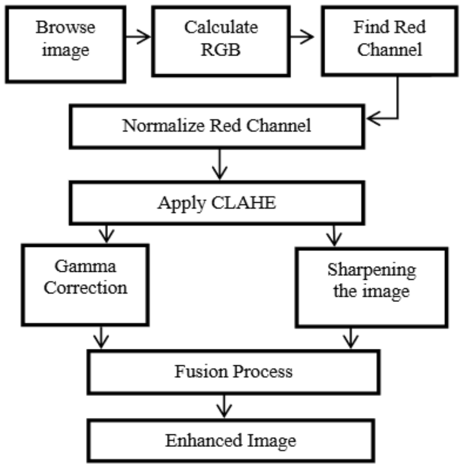

Fig 3- Image enhancement process layers

The report form Siawlang et al, the colour cast values are removed from scattered images and improve the contrast using Gray world method. This method is used to find colour cast values and apply visual pleasing. So the integrated adaptive graph world calculation and differential gray level histogram methods are used to find cast and contrast. The output of each image can be classified by using intensity components. The intensity values are varies based on hue, saturation, illumines and intensity factors. The final enhanced images have both chromaticity and hue results [31].

E. Hardware based Image enhancement

Narsimhan et. al. Camera captures video and outdoor factors is affect the quality. Outdoor scene scattered due to poor contrast and atmosphere. This is physics-based approach that describes uniform distribution of bad weather condition and appearance.The changes in each intensity values are recorded and find the constraint factor. The depth discontinuities are calculated from each scene and find the scene structure. This is fast algorithm to find resorescence contrast, gray scale process, RGB colour, multispectral values and IR images [32][24].

Duo-min et al, the captured images are applied to Lidar Imaging process and produce fast gated result. This method is suitable for high turbid water. Each step is clearly monitoring and permitting water scattering noise. The underwater images are collected and apply light pulse process for reducing water scattering effect. Here finding noise factor and scattering input images are dynamically changed. The final result shows that improved intensity and deleted contrast underwater images.

Levoy et al, explained confocal microscopy is used to find 3D visual effect of each images. This method each biological section is analysed and scattered. The confocal images are replacing large scale images and appear microscopy array for storing images. The recorded videos or scene are produced real apertures [34].

The polarisation lens of the camera is another factor to affect the quality. The several images are captured based on degrees of polarization, rotation and shearing factor. The lens is associated with back-scattered light and estimate the transmission map. These methods are very important for recovering distant regions [37].

Kopf et al, GIS based model is applied for calculating and manipulating casual photograph and combining existing geo reference digital images. This is interactive approach and each stage the photograph is aligned. The registered histogram values are recorded and combine the values. In this model, we align the photograph and find abundance results.The following details are verified in each stage depth, texture, GIS data, haze values, lighting and relighting values. The above values are recorded and compare the results with previous photograph result and dehazing values. These information can be recorded and find out the range values. This is novel synthesis result and produce geographical results [36].

III. MATHEMATICAL STUDY AND COMPARISONS

The comparative result of Glamery and Jaffe model is applied for calculating total irradiance incident points. This point is calculated from using direct components, forward and backward scattering [38]. The direct component is reflected directly and converted to image plane. At each images are coordinated from x component. The component x can be expresses as,

$$\mathbf{E_D(x) = J(x)e^{-\mu d(x)} = J(x)t(x)}$$

where, J(x)denotes the radiance of the object (object brightness), d(x) is the distance between the observer and the object, and η is the attenuation coefficient. Underwater medium can be selected from the exponential term $e^{-\eta d(x)}$ is also known as the transmission t(x).

The existing floating particle values are selected from underwater medium and the absorption values are stored based on scattering and lighting. The underwater medium can be set by using incident rays of light. Forward scattering method is applied for random deviation process and lighting the ray can be find using random camera lens.

The experimental results are shows the impact of convolution between direct attenuation factor and spread function. Back scattering method is used for artificial light and finds water particles. This is superimposed method and finds camera changing positions. Back-scattering acts as a glaring veil over the object.This method is influencing the camera changing position, camera angle and light source results.

This can be expressed by following formula,

$$\mathbf{E_{BS}(x) = B_\infty(x)(1 - e^{-\mu d(x)}}$$

Where, $B_\infty(x)$ is back-scattered light colour vector

The existing underwater image enhancement and dehazing techniques can be grouped in several scattered images. The following clauses are find out based on various reviews,

1] **Methods using specialized hardware:** In this method a specialised hardware components is need for setting acquisition system. It is very expensive and power consuming.

2] **Polarization-Based Methods:**

This method is applied for distant regions and video models. But the problem limited range and not suitable for dynamic scenes.

3] Rough approximation of the scene model:

This method is used to find depth approximation values, which is generally used for common frame images.

4] Methods for removal of Fog Haze:

This is fog haze removal method and find assumption from multiple underwater images. It is more challenging process due to extinction result and scattering. This is wavelength based approach so each stage the values are recorded and storage is need for removal of fog haze.

The following table shows that advantages of various approaches,

Table 1: Approach and Advantages of Image enhancement techniques

Approaches	Advantages
Unsupervised Colour Correction Method (UCM)	Image Enhanced based on Illumination and Contrast
Sonar image detection method	Suitable for extreme turbid water
Dark Channel Method	Implementation time is low
Wavelength Compensation and De-hazing	It is suitable for deep water (De-hazing and

	image quality)
Based on Color Diminished and Stretched	It is used in marine image processing applications
Adaptive Histogram Equalization by Enhancing contrast, dropping noise	Visual quality is increased
Polarisation	Very simple method for calculating colour images
Dark channel prior	Single image transmission map approach
DCP-Multi-Scale Retinex	Automatic process
Haze Removal before DCP	Suitable for outdoor image processing in haze models
Improved Dark Channel Prior (IDCP)	Estimation time is less and accurate result will get

IV. CONCLUSION

The above section various image enhancement techniques are discussed based on underwater images inputs. This study focuses on the underwater photography can be analysed based on various reviews. The camera motions and direction are captured. The attenuation and coefficient are strongly depends light wavelength and colour. This is straightforward method de-hazing is applied for finding depth. The non-uniform artificial illumination and selective absorption model is used for finding colour image histograms.The various approaches and advantages are summarised in each section. The single and multiple images are processed techniques also discussed. The various imaging conditions are also in taken part and produce geographical values. Also we discussed different modes, climate variation, eco system, and light various also taken. Here the image dataset is very important and need high storage values. This paper clearly explains various image enhancement methods. Various underwater images are taken into account for fixed dataset at various levels. In future, to increase the degrees of freedom and more capture dynamic images can be modelled.

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