Evaluating the Research Gaps of Underwater Image Enhancement Techniques

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ABSTRACT
Enhancement is among the challenging factors in image processing. The goal of enhancement is to enhance the structural appearance of a picture without the degradation in the input image. The enhancement techniques make the identification of key features easier by eliminating noise and other artifacts within an image. In this paper, we present an overview of image enhancement processing techniques applied on visibility restoration. More specifically, we categorize processing methods based on representative techniques of Image enhancement.

Keywords
Image Enhancement, Visibility Restoration, Haze Removal

1. INTRODUCTION
Image enhancement problem can be formulated in the following manner: given an input low quality image and their output as high quality image for particular applications. It is known fact that image enhancement is an active topic in medical imaging which has received much attention in recent years. The objective is to enhance the visual appearance of the image or to provide a "better" transform representation for further automated image processing. It further analyzes background information which is used to understand object behavior without requiring expensive human visual inspection. Carrying out image enhancement in low quality image is tough problem because of these reasons. Due to low contrast, one cannot clearly extract objects from the dark background. Most colour based methods will fail on this matter if the colour of the objects and that of the background are same. This influences the typical working of automatic monitoring system, outdoor recognition system and intelligent transportation system. By the usage of haze removal procedures of picture one can improve the stability and strength of the visual framework [2].

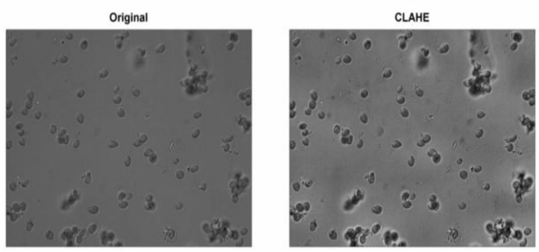

Figure 1: (a) Original image (b) Processed image

2. VISIBILITY RESTORATION TECHNIQUES
For removing haze, fog, mist from the image various techniques are used. Typical methods of image restoration to the fog are:

2.1 Dark Channel Prior
Dark channel prior [3] is used for the estimation of atmospheric light in the debased image to get the more proper result. This technique is mostly used for non-sky patches, as at least one color channel has very low intensity at some pixels. The low intensity in the dark channel is predominantly because of three components:-

1. Colourful items or surfaces (green grass, tree, blooms and so on)
2. Shadows (shadows of car, buildings etc)
3. Dark items or surfaces (dark tree trunk, stone)

The attenuation of image due to fog can be expressed as:

$$I_{att}(x) = J(x)t(x) \quad (1)$$

Iatt(x)=Attenuation of image

J(x)=Arbitrary image

t(x)=Estimate Transmission

the effect of fog is Airlight effect and it is expressed as:

$$Iairlight(x) = A\big(1 - t(x)\big) \quad (2)$$

$Iairlight(x)$ =Airlight effect of image

t(x)=Estimate Transmission

Dark channel for an arbitrary image J, expressed as J dark is defined as:

$$Jdark(x) = \frac{min}{y \in \Omega(x)} (\min J^C\,(Y)) \quad (3)$$

Jdark=Dark channel for an arbitrary image

Jc=Color image comprising of RGB component

$\Omega(x)$=Local patch which has its origin at x

In this J^c is the color image comprising of RGB components, $\Omega(x)$ represents a local patch which has its origin at x. The low intensity of dark channels is attributed mainly due to shadows in images, saturated color objects and dark objects in images.

After dark channel prior, we need to estimate transmission t(x) for proceeding further with the solution. Another assumption needed is that let Atmospheric light A is also known. We normalize (4) by dividing both sides by A:

$$\frac{I^c}{A^c}(x) = t(x)\frac{J^c}{A^c}(x) + 1\text{-}t(x) \quad (4)$$

t(x)=estimate transmission

Jc=Color image comprising of RGB component

2.2 Polarization Based Method

In this method two or more images of the same scene are taken with different polarization filters. The basic method is to take multiple images of the same scene that have different degrees of polarization, which are acquired by rotating a polarizing filter attached to the camera, but the treatment effect of dynamic scene is not very good. The shortcoming of this method is that it cannot be applied to dynamic scenes for which the changes are more rapid than the filter rotation and require special equipment like polarizer and not necessarily produce better results [4].

Figure 2: a) Original image b) Restored image using polarization [15]

2.3 CLAHE

CLAHE is abbreviated as Contrast limited adaptive histogram equalization [1]. This method does not need any predicted weather information for the processing of hazed image. The image captured by the camera in foggy condition is converted from RGB (red, green and blue) color space into HSI (hue, saturation and intensity) color space. The image is converted because the human sense colors, similarly as HSI represent colors. Secondly intensity component is processed by CLAHE without effecting hue and saturation. This method uses histogram equalization to a contextual region [3]. The original histogram is clipped and the clipped pixels are redistributed to each gray-level.

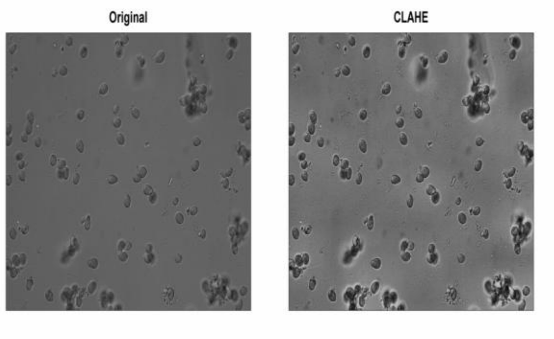

Figure 3: (a) input image (b) output image [12]

3. LITERATURE SURVEY

3.1 M. Chambah et al (2003) [4] displayed in their paper a few advances in color reclamation of submerged pictures, particularly concerning the solid and non uniform shade cast which is regular of submerged pictures. The proposed color revision system is focused around ACE model, an unsupervised shade evening out calculation. Pro is a perceptual methodology reused by some adjustment instruments of the human visual framework, specifically gentility, consistency and color steadiness. A perceptual methodology displays a great deal of points of interest: it is unsupervised, strong and has nearby separating properties. The restored pictures give better comes out when shown or handled (fish division and gimmick extraction). The exhibited preparatory results are fulfilling and guaranteeing.

3.2 A. Weidemanna et al. (2005) [5] show a dis-section on the execution of the framework in different water conditions utilizing a few target sorts and a correlation with jumper and Polaroid recognizable proof. Incidental in-situ optical properties of retention and dissipating were taken to help resolve the ecological data contained in the LUCIE picture. A few new abilities are at present being composed and tried, among them a differential polarization imaging framework, a settled observable pathway framework with step-gaze capacity for high determination mosaic zone scope, an exactness dimensioning framework and a jumper guided and worked variant. L.

3.3 Mendez et al. (2005) [6] In this paper, they consider the issue of shade reclamation utilizing factual priors. This is connected to shade recuperation for submerged pictures, utilizing a vitality minimization detailing. Submerged pictures exhibit a test when attempting to revise the blue-green monochrome gaze to bring out the shade we know marine life has. For sea-going robot errands, the nature of the pictures is vital and required continuously. Our technique improves the color of the pictures by utilizing a Markov Random Field (MRF) to speak to the relationship between shade drained and color pictures. The parameters of the MRF model are gained from the preparation information and afterward the most likely color task for every pixel in the given shade exhausted picture is surmised by utilizing conviction spread (BP). This permits the framework to adjust the shade reclamation calculation to the current natural conditions furthermore to the assignment prerequisites. Test comes about on an assortment of submerged scenes show the achievability of our technique.

3.4 S. Bazeille et al. (2006) [7] proposes a novel efficient methodology to improve submerged pictures by a dehazing calculation, to repay the lessening error along the proliferation way, and to take the impact of the conceivable vicinity of an artificial light source into attention. Once the profundity map, i.e., separates between the items and the Polaroid, is evaluated, the frontal area and foundation inside a scene are portioned. The light intensities of closer view and foundation are contrasted with figure out if a counterfeit light source is utilized amid the picture catching methodology. In the wake of remunerating the impact of artificial light, the dimness wonder and inconsistency in wavelength weakening along the submerged engendering way to Polaroid are revised. Next, the water depth in the image scene is estimated according to the residual energy ratios of different color channels existing in the background light. Based on the amount of attenuation corresponding to each light wavelength, color change compensation is conducted to restore color balance.

3.5 Kashif Iqbal et al. (2007) [8] have proposed a methodology with a specific end goal to enhance the impression of submerged pictures, taking into account slide extending. The destination of this methodology is twofold. Firstly, the complexity extending of RGB calculation is applied to even out the shade differentiate in pictures. Furthermore, the immersion and intensity extending of HSI is utilized to build the real nature and tackle the issue of lighting. Intelligent programming has been created for submerged picture upgrade. The nature of the pictures is factually represented through the histograms.

3.6 Wang, et al. (2010) [9] has investigated that fog expulsion from the picture rely on the obscure profundity data. This algorithm is based on the atmospheric scattering physics-based model. In this on selected region a dark channel prior is applied to obtain a novel estimation of atmospheric light. This model is based upon some observation on haze free outdoor image. In non-sky patches, at least one color channel has very low intensity at some pixels. The low intensity in that region is due to shadows, colorful objects, dark objects etc. This calculation is focused around the environmental scrambling physical science based model. In non-sky patches, not less than one shade channel has low force at a few pixels. The low power in that locale is because of shadows, bright protests, dull items and so forth.

4. PROPOSED METHOD IMPLEMENTATION

Figure 5 shows the first input foggy image which is processed by the proposed algorithm and other existing techniques. The results of input image shows that the trunk of tree have better natural color for proposed method due to color change recompense is directed to restore shade parity. The execution of the proposed calculation for wavelength and picture de-hazing (WCID) is assessed both dispassionately and subjectively by using ground-truth shade patches and feature downloaded from the Youtube site. Both results exhibit that pictures with altogether upgraded perceivability and unrivaled shade devotion are acquired by the WCID proposed.

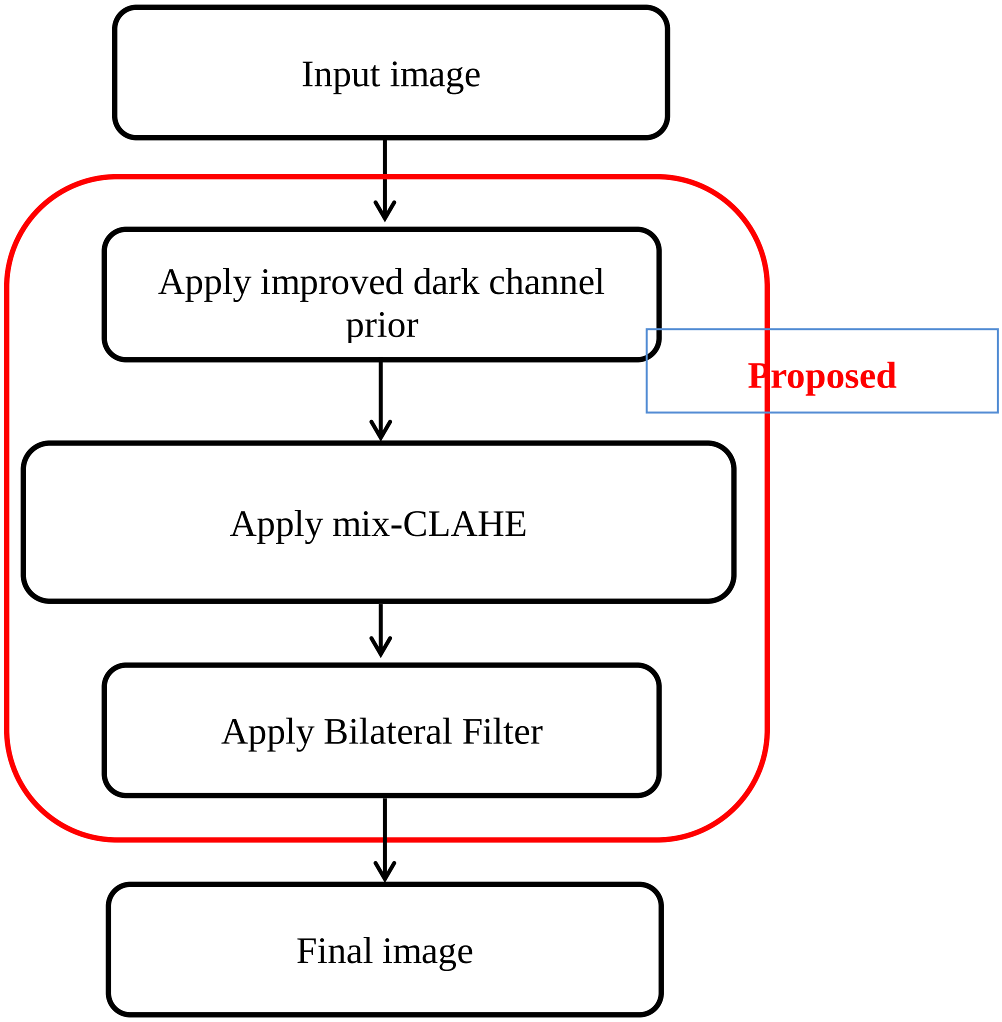

Figure 4: Flowchart

Figure 5 (a)

Figure 5 (b)

Figure 5 (c)

Figure 5: 1st image outputs a) Input Foggy Image b) CLAHE Output c) Proposed Output [10]

In Proposed output image result the fog is more effectively removed and the brightness of image is also retained.

6. PERFORMANCE EVALUATION

The comparison among proposed and other available methods will be drawn by taking the following parameters:

1. Mean square error
2. Contrast gain

6.1 Mean Square Error

MSE stands for mean square error. Mean Square Error (MSE) of an estimator is one of many ways to quantify the difference between values implied by an estimator and the true values of the quantity being estimated.

Table 6.1: Mean Square Error Comparison of Different method

IMAGE NO.	CLAHE	PROPOSED METHOD
1	137	73
2	439	367
3	136	69
4	280	194
5	367	495

MSE measures the average of the squares of the "errors." The error is the amount by which the value implied by the estimator differs from the quantity to be estimated.

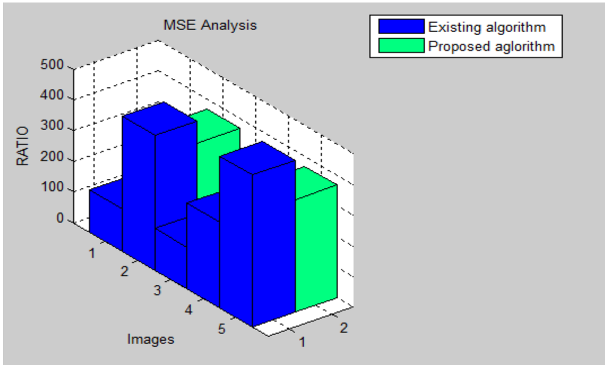

Figure 6.1: Quantized analysis of the mean square error between proposed method proposed algorithm and Existing algorithm.

Proposed algorithm shows the better results than the existing algorithm for all images. As, mean square error should be reduced so it is observed from graph that value of mean square error for proposed method in every image is less than the mean square error of Dark channel prior method. The difference between mean square vary according to the density of fog the images with more dense fog shows greater difference and with less fog shows less difference. So, proposed method shows better result for both cases.

6.2 Contrast Gain

Contrast gain is the gain appeared in the signal for the proposed algorithm. This increases the accuracy of the signal at the required range. This also increases the signal strength.

Table 6.2: Contrast Gain comparison of different method

IMAGE NO.	CLAHE	PROPOSED METHOD
1	7.2581	7.7418
2	3.8077	5.0585
3	4.5123	8.4301
4	2.9530	4.1819
5	5.0585	5.5098

Contrast gain is an important parameter. This parameter tells the gain of the signal. Here one is the input signal taken firstly for the progression of the underwater images. The comparison of the signal is done between the CLAHE and proposed algorithm. The contrast gain should be large in the proposed algorithm in comparison of the CLAHE algorithm (existing algorithm).

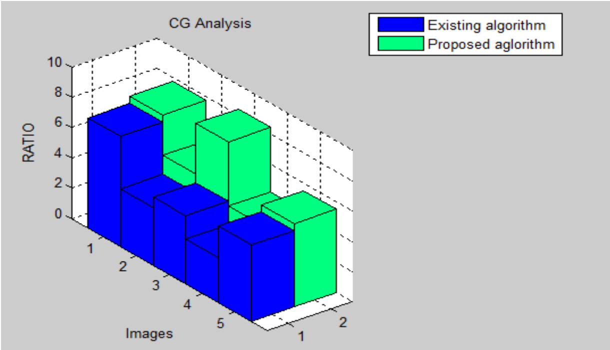

Figure 6.2: CG graph between Proposed and Existing algorithm

So, proposed method shows better result for both cases.

7. CONCLUSION AND FUTURE SCOPE

Image enhancement algorithms provide a wide selection of approaches for modifying images to accomplish visually acceptable images. The decision of such techniques is really a function of the particular task, image content, observer characteristics and viewing conditions. Haze removal methods are much more ideal for vision applications. It's found that many the researchers have ignored numerous issues; i.e. no method is correct for different kind of circumstances. The existing strategies have dismissed the usage of bilateral filter to decrease the noise issue that will be displayed in the output image of the present haze removal methods. New methods will incorporate the dark channel prior and CLAHE to improve the outcomes further. The bilateral filtering is additionally done as a pre-processing step to evacuate the noise from the input picture. The near future scope would be the development of adaptive algorithms for effective image enhancement using Fuzzy Logic and Neural Network.

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