International Journal of Scientific Research & Engineering Trends
Volume 4, Issue 5, Sept-Oct-2018, ISSN (Online): 2395-566X

A Survey on various Haze and Underwater Digital Image Enhancement Techniques

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Abstract- **As the digital world is growing with various kind of data like text file, image, video. Out of those image plays an important role in different field such as remote sensing, social media, etc. The degradation in image quality may be attributed to absorption and back scattering of light by suspended underwater particles. Moreover, as the depth increases, different colors are absorbed by the surrounding medium depending on the wavelengths. So maintain the image quality is done by Digital image processing on various issues. These papers give a brief survey of haze and underwater image enhancement techniques for various conditions. As environment condition vary from time to time by the presence of fog, dust, water. Image analysis features are describe in this paper with there requirements.**

Keyword s- **Digital Image Processing, Haze , Information Extraction, Fog removal. Visibility restoration. etc.**

I. INTRODUCTION

Image in open environment or outdoor scenes consist of various noise in form of fog, rain, haze, etc. Due to the presence of these noise overall quality gof the image get degrade. As these unwanted particles in the image scattered light from the source to the object. So removal of these unwanted information is highly desired in the image because of its different requirement for analysis. This can be understand by an example that suppose one computer algorithm required image that is free from those unwanted information.

So if input in such type of algorithm contain those haze, dust, etc. produce error in the image processing output. So pre-processing of such type of image is highly desired by various users of different fields. One could easily see how a car navigation system that did not take this effect into account could have dangerous consequences.

Accordingly, finding effective methods for haze removal is an ongoing area of interest in the image processing and computer vision fields. Underwater image enhancement techniques provide a way to improving the object identification in underwater environment.

There is lot of research started for the improvement of image quality, but limited work has been done in the area of underwater images, because in underwater environment image get blurred due to poor visibility conditions and effects like “absorption of light”, “reflection of light”, “bending of light, “denser medium (800 times denser than air)”, and “scattering of light” etc. These are the important factor which causes the degradation of underwater images [1]. 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 medium than air. Therefore, when light rays moves from the air to the water, it is partly reflected reverse and at the same time partly enters the water.

The total light amount that enters the water also starts reducing start it goes deeper in the sea. Similarly, the water molecules also absorb certain amount of light.

As a result, the underwater images are getting darker and darker as the deepness increases. Not only the quantity of light rays is condensed when it goes deeper but also colors drop off one by one depending on the wavelength of the colors. For example, first of all red color disappears at the depth of 3m.

Secondly, orange color starts disappearing while we go further. At the depth of 5m, the orange color is lost. Thirdly most of the yellow goes off at the depth of 10m and finally the green and purple disappear at further depth. From the fig1 it can be clearly understand that, the blue color travels the longest in the water and in depth due to its shortest visible wave length.

Which makes the underwater images having been dominated only by blue color because of this effect of blue color the original color of any object under the water is affected. In addition to excessive amount of blue color, the blur images contain little brightness, little contrast and so on [3].

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Volume 4, Issue 5, Sept-Oct-2018, ISSN (Online): 2395-566X

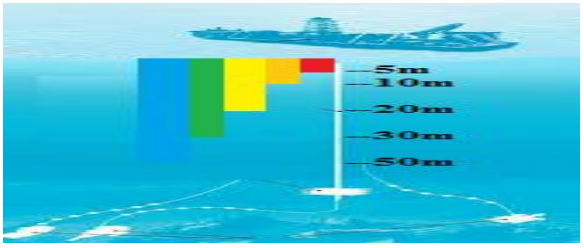

Fig.1 Light absorption by water under sea.

II.DIFFERENT TECHNIQUES

1. Visibility Restoration Technique-As researcher are continuously working in removing haze, fog, water mist from the image for further analysis, so various techniques are developed so far shown in fig. 2. Few of those are explained below:

2. Dark channel prior-In [2] Dark channel technique is developed in order to calculate the atmospheric light in the image. So it is emerged as a common technique in non sky part of the image because few color channels has very less intensity in the few pixels. Here in dark color channel low intensity is present because of the below three components:

- Surface Colourful objects such as grass, trees, etc.
- Shadow of tree, building, pillers, etc.
- Any high intensity object surface such as black stone, trunk, etc.

So most of outdoor image is full of above three points which include colorful object, few shadows and dark channels which fill image with noise. In presence of fog in environment image get brighter then actual image without fog. So it can be conclude that dark channel of the image have high intensity of image in region with higher haze. So in order to find the light intensity an approx value is find by estimating the thickness of the haze.

In case of shady channel prior this technique use pre and post processing steps in order to improve results. In post processing stepladder technique use flexible matting or two-sided filtering etc. This can be understand as if J(x) is input image, I(x) is hazy image, t(x) is the transmission of the environment. The reduction of image because of presence of fog can be calculate by:

$$Iatt\ x = J(x)\ *\text{t(x)} \qquad (1)$$

The effect of fog is Air light effect and it is calculate as:

$$\text{Air Light}\ (x) = A(1 - t(x)) \qquad (2)$$

Shady channel for an random image J, uttered as J shady is defined as:

$$Jdark(x) = (min/y \in \Omega\ x)*(\min JC\ Y\ ) \qquad (3)$$

In this Jc is color image comprising of RGB components, 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:

$$Ic/Ac\ (x) = (\text{t(x)}*J\ c/Ac\ (x)\ )+ \text{1-t(x)} \qquad (4)$$

Fig.2 (a) input haze images.

Fig.3 (b) Dark channel output images.

3. Clahe-In [3] CLAHE stands for (Contrast limited adaptive histogram equalization). This technique does not require any desired weather data for the dispensation of hazed picture. Firstly, the picture taken by the camera in hazy condition is transformed from RGB (red, green and blue) color space to HSV (hue, saturation and value) color space. The pictures are transformed because the person intelligence

colors similarly as HSV represent colors in better way as compare to RGB.

Secondly strength module is processed by Contrast limited adaptive histogram equalization without effecting hue and saturation matrix of the HSV color modal. This technique use histogram equalization to a background area. The novel histogram is abrupt and the clipped pixels are rearranged to each gray level. In this each pixel strength is reduced to maxima of user selectable shown in fig. 3. Finally, the picture operated in HSV color modal is transformed back to RGB color modal.

Fig.4 (a) input image.

Fig.5 (b) output image.

4. Wiener filtering-In [4] Wiener filtering is utilize for the counter of problems such as color bend while utilizing shady channel first when the pictures with high white region is operate. While taken shady channel first the value of media function is approx which generate halo distortion in output picture.

So, median filtering is come in existence to calculate the media function, so that edges can be conserved. After making the median function further precise it is shared with wiener filtering so that the picture reinstatement difficulty is altered into optimization problem. So in images having large white region this technique is highly recommended. Overall execution for the algorithms is quite less.

Fig.6 (a) Original foggy image (b) Defogged image (c) Weiner defogged image.

5. Bilateral filtering-In [5] Bilateral filtering technique is use for the restoration of hazy image. Here this technique smooth the image without affecting the edge region of the image, this is done by combing the near by values of the pixel. This can be understand as the pixel value is replace by the surround pixel value average. The weight assigned to each neighbor pixel decreases with both the distance in the image plane and the distance on the intensity axis.

This filter helps us to get result faster as compare to other. While using bilateral filter we use pre-processing and post processing steps for better results. Histogram equalization is used as pre-processing nd histogram stretching as a post processing. These both steps help to increase the contrast of image before and after usage of bilateral filter.

This algorithm is independent of density of fog so can also be applied to the images taken in dense fog. It does not require user intervention. It has a wide application in tracking and navigation, consumer electronics and entertainment industries.

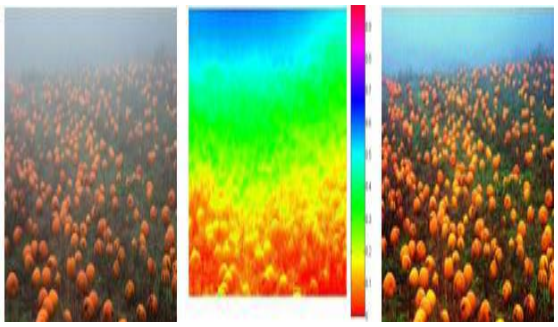

Fig.7 (a) original foggy ‘pumpkins’ image (b) corresponding air light map using bilateral filter, and (c)Restored image.

III.FEATURES FOR HAZE REMOVAL

As Image is collection or sequence of pixel and each pixel is treat as single value which is a kind of cell in a matrices. In order to identify an object in that image some features need to be maintained as different object have different feature to identify them which are explain as follows:

1.Color feature- Image is a matrix of light intensity values, these intensity values represent different kind of color. so to identify an object colure is an important feature, one important property of this feature is low computation cost .

Different Image files available in different color formats like images have different colure format ranging from RGB which stand for red, green, and blue. This is a three dimensional representation of a single image in which two dimensional matrix represent single color and collection of those matrix tends to third dimension.

In order to make intensity calculation for each pixel gray format is use, which is a two dimension values range from 0 to 255. In case of binary format which is a black and white color matrix whose values are only 0 or 1. With the help of this color feature face has been detected efficiently in [8].

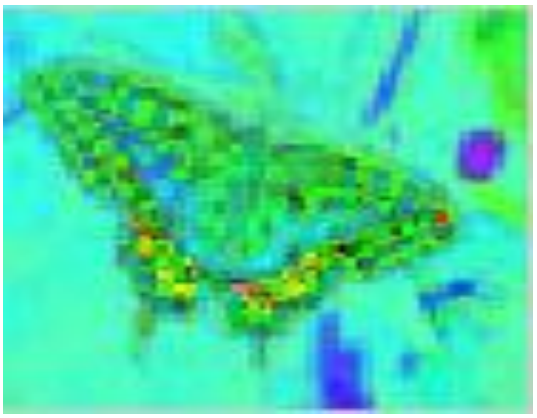

Fig. 8 Represent the HSV (Hue Saturation value) format of an image.

2. Edge Feature-As image is a collection of intensity values, and with the sudden change in the values of an image one important feature arises as the Edge as shown in figure 7. This feature is use for different type of image object detection such as building on a scene, roads, etc [7].

There are many algorithm has been developed to effectively point out all the images of the image or frames which are Sobel, perwitt, canny, etc. out of these algorithms canny edge detection is one of the best algorithm to find all possible boundaries of an images.

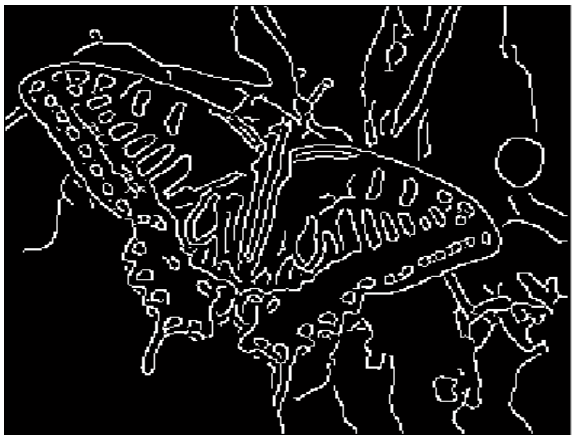

Fig. 9 Represent Edge feature of an image.

3. Texture Feature - Texture is a degree of intensity difference of a surface which enumerates properties such as regularity and smoothness [6]. Compared to color space model, texture requires a processing step. The texture features on the basis of color are less sensitive to illumination changes as same as to edge features.

4.Corner Feature- In order to stabilize the video frames in case of moving camera it require the difference between the two frames which are point out by the corner feature in the image or frame shown in fig. 8. So by finding the corner position of the two frames one can detect resize the window in original view. This feature is also use to find the angles as well as the distance between the object of the two different frames. As they represent point in the image so it is use to track the target object.

Fig. 10 Represent the corner feature of an image with green point.

IV.RELATED WORK

In [1] Our method is a single image approach that does not require specialized hardware or knowledge about the underwater conditions or scene structure. It builds on the blending of two images that are directly derived from a color compensated and white-balanced version of the original degraded image. The two images to fusion, as well as their associated weight maps, are defined to promote the transfer of edges and color contrast to the output image.

To avoid that the sharp weight map transitions create artifacts in the low frequency components of the reconstructed image, we also adapt a multi scale fusion strategy. Our extensive qualitative and quantitative evaluation reveals that our enhanced images and videos are characterized by better exposedness of the dark regions, improved global contrast, and edges sharpness.

In [2] first derived the inherent optical properties of underwater images. Using formation model and DCP algorithm they estimated the red color channels to improve the images.It showed good improvement on dehazing when compared with other existing methods.

In [3] restored the color and enhanced on underwater images affected by light scattering using the WCID algorithm. The proposed WCID method performed better than other dehazing and histogram equalization methods. Bingquan Huo and Fengling [4]recovered a sing haze image by using the optical model and DCP model followed by estimation of transmission. The DCP and estimate transmission model approach enabled dehazing when the problem cannot be solved by optics alone.

In [4] Histogram equalization (HE) [14] is another common enhancement method in the spatial domain. HE takes into account the statistical distribution of the values of each channel but still does not take into account the location information, so it often enhances noise and image details at the same time. A typical improvement is the use of generalized histogram equalization, discrete wavelet transform, and KL-transform [15], which achieved a better performance.

V.CONCLUSIONS

With the high demand of image in various fields researchers get attracted for analysis. This paper cover various approaches of haze and underwater image enhancement of different scenes and situations. As unfavorable weather condition make high data lose, so recovering those is done by extracting features from the image. It is obtained that dark channel removal is important technique that recover image efficiently, in worst weather condition. It is also obtained that color and edge feature plays an important role for object detection in image or video frame. In future a perfect algorithm is with good feature combination is desired which can enhance these images where object get identify easily.

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