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UNDERWATER IMAGE ENHANCEMENT

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Abstract: Underwater image processing has been always a very challenging problem. Under the effect of environmental factors, underwater images are exposed to some problems, such as colour cast, low visibility, and few edge details. Image Improvement includes numerous operations similar as discrepancy stretching, noise trimming, mock coloring, noise filtering etc. To improve the view of images. Underwater images bears mediocre because of nature of luminosity. When light enters into the water it got replicated , Noticed and scattered as water is denser medium then air, so the amount of luminosity sink when it enters from breeze to water and got dispersed in different tracks. Scattering causes the blurring and reduces the color contrast. So a novel approach is proposed to enhance underwater images by gamma correction to improve the brightness of dimmed images. The dark channel prior clear haze and noise effect, providing better observable quality. At the final stage, the contrast limited adaptive histogram equalization contrast and brightness of dehazed image. The enhanced fuzzy-free, natural appealing output can be used for display and analysis purpose.

Keywords: Pre-processing, Gamma correction, Dark channel prior, Contrast Limited Histogram equalization.

1. INTRODUCTION

Image enhancement is the tool to process the input image to make it more appropriate and clearly distinct for the required application. Image enhancement enrich the content of the image and adjust the visual influence of the image on the detective. Image enhancement upgrades the different features of the images. It emphasize the image features like boundary, contrast to build exhibit of pictures more useful for examination and study. Qualitative slant is used in enhancing images to construct a visually impressive image. Image enhancement includes many methods such as pseudo coloring, noise filtering, contrast stretching, and noise clipping, etc. to enhance the sight of images.

Underwater images bears poor quality because of nature of luminosity [1]. When luminosity enters the water it got cloned, absorbed and dispersed as water is denser medium then air , so the amount of luminosity sink when it enters from breeze to water and got dispersed in different tracks. Scattering causes the blurring and reduces the color contrast.
Images captured under water are disfigure due to the absorption and disperse effects. The luminosity received by the camera is generated by three elements [2]: a direct component intent light from the item or object onward dispersed component randomly deviating gleam on the camera and back dispersed component reflects light towards camera before it reaches the item or objects. This source effects such as dim, masking details of the image and may lead to fabricate noise.
When the luminosity wave generate through the water medium, different frequency components of luminosity wave produces different immersion profile [13].

The immersion of light wave depends upon different factors such as quantity of hang particle in water, cloudiness and sensible of water etc. It is seen that, light wave becomes frail after traveling few interspace in water. Figure 1 shows the comparison between absorption of light wave of different colors. Red wave moves in very low interval and can spread only one to two meter in pure water, green light moves roughly about 26 meters while blue light moves the highest space and can spread more than 30 meters in pure water. So any item or object perfidious more than 10 meters may lost its native color and the color of the objects appear to be blue.

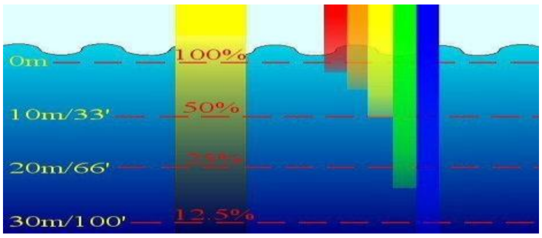

Fig 1: Immersion of color factors in water

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2. LITERATURE SURVEY

Malik et.al. [1] describes a novel strategy to enhance underwater videos and images using fusion principles. They presented a new method for estimating the optical transmission in hazy scenes. So the scattered light is removed to improve the scene visibility depending upon the estimation and recover haze-free scene contrasts.
Kaiming et al [2] described an estimation of the distance factor that reduces leaks and high frequency-enhanced filtering to reduce blurry and clear water layers. They first proposed the Dark Channel Prior (DCP) to be used in the air. DCP is based on prior knowledge. Pixels in typical images are less intense in at least one color channel, but foggy images do not have this characteristic.
Xinjie et al [3] proposed using Dark Channel Prior (DCP) and Luminance Stretching (LS) to restore the visual effects of blurred sky images. Yang and Wang [16] designed a delicate function to replace the minimal filtering operation. Its purpose is to fundamentally avoid edge allocation errors.
Prasath et al method [4] uses DCP to segment the foreground and background areas. The underwater image formation model resembles the atmospheric degradation model proposed by. However, it ignores the fact that the attenuation rate of the component of light- ray propagating through water gradually decrease with the wavelength value rise, and this model is consequently defective.

Omkar [5] proposed an algorithm that uses WCID to help restore the color balance of the image efficiently and remove the haze. In this technique called Pixel Distribution Shift Color Correction (PDSCC) for color digital images to correct the white reference point and ensure that the white reference point is chromatic.

Miao Yang et al [6] Image resolution and image enhancement are very important in most remote sensing applications for image processing.The enhanced image provides a lot of visibility and interpretability, and we can conclude that it is superior in terms of sharpness and color.
kemi [7] Proposed an integrated color model (ICM) and unsupervised color correction method (UCM). They built a variational Retinex model to improve the illumination of underwater images. Then restored underwater images by combining Dark Channel Prior (DCP) -based decluttering with wavelength correction. Finally the visual quality of underwater images is improved using the principle of fusion. In addition, they suggested improving white balance by compensating for the loss of the red channel before resorting to traditional Gray World law.
Sophiya et al. [7] proposed a method based on image blurring and light absorption (IBLA) to more accurately estimate the background light and depth of an underwater scene. In 2018, they proposed another method based on the Generalized Dark Channel Prior (GDCP) [8] by finding the difference between the background light and the observed intensity.
Kashif. [8] proposed improvements based on global and local histogram equalization and dual image multiscale fusion (GLHDF). This achieved good performance, but had some limitations in handling muddy water images. This method describes the reflection of light as a function of the structure of the sea. Another problem is that water causes the narrowness to bend and spread, or to create wrinkle patterns. Water quality mainly depends on and controls the filter characteristics of water, such as the scattering of dust particles in the water According to Radhika [9], some of the partially horizontally polarized light is reflected and some travels vertically in the water. The quality of vertical polarization helps reduce the brilliance of objects and efficiently captures deep colors that may not be captured otherwise. These studies have shown that when light hits the image plane, there are three main components: direct components, forward scatter, and backscatter.

3. PROPOSED METHODOLOGY

Underwater images are usually degraded by the effects of absorption and scattering. Underwater imaging is very important in current technology for detecting objects such as fish, algae, and small particles. Light scattering and color changes are two major causes of underwater imaging distortion, reducing the visibility and contrast of captured images and affecting the predominant underwater environment with pale blue tints.
Firstly input images undergone a pretreatment to remove noise particles before dehaze, and the second method is gamma correction to improve the brightness of the fade image. Dark Channel Prior removes the effects of haze and noise. The contrast and brightness of the declouded image is then restored using adaptive histogram equalization with limited contrast. Finally, use Histogram Matching to generate an output image based on the shape of a particular histogram. Purpose of display and analysis. Enhanced, fog-free, naturally responsive output can be used for display and analysis purposes. Figure 2 shows the sequence of methods which images undergo

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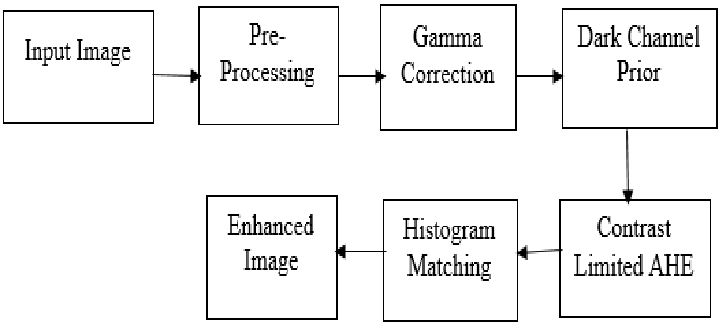

Fig2: Methodology for Underwater Image Enhancement

3.1 PRE PROCESSING

3.1.1 Median Filter

Median filter used to lessen noise in an image. This filter calculates the median of all pixels with inside the kernel area. Then fee of the imperative pixel is changed with the aid of using calculated median [10]. Median filter is broadly used to eliminate "salt and pepper "noise. The median blur characteristic is implemented median filter to an image. This characteristic accepts kernel size. It have to be bizarre integer extra than 1.

3.2 GAMMA CORRECTION

The gamma correction controls the general brightness of an image. For shiny image, invert the gray or cost image, manner as for darkish images, then invert once more and recombine if the usage of the cost image.

- Read the enter
- Convert to gray or HSV price
- Compute the ratio log(mid- gray)/log(mean) on the grey or price channel
- Raise the enter or price to the energy of the ratio
- If the usage of the price channel, integrate the brand new price channel with the hue and saturation channels and convert lower back to RGB.

Here the brightness is depends upon the mid gamma value if value is less than 1 it will shift towards the darker end of spectrum. If the value is more than one shift towards the darker end of the spectrum. Gamma value is equal to one no affect on the input image.

3.3 Dark Channel Prior

Dark Channel Prior or defogging set of rules is based at the atmospheric scattering version for defogging processing [12]. Through this foggy and non-fog images, a number of the mapping relationships that exist are obtained, after which in keeping with The formation procedure of the fog image is reversed to repair a clean photo.

3.3.1 Atmospheric scattering model

The atmospheric scattering version, that's commonly used to explain the influence of awful climate situations at the image. The atmospheric scattering version may be defined as

$I(x) = J(x)t(x)+A(1 - t(x))$ (1)

x is the spatial coordinates of the image

- I(x) represents the foggy image (the image to be defogged)
- J(x) represents the image without fog (image to be restored)
- A represents the global atmospheric light value

t(x) represents the transmittance

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3.3.2 Dark channel definition

In maximum non-sky neighborhood areas, a few pixels will usually have as a minimum one colour channel with a completely low value. For an photograph J(x), the mathematical definition of its dark channel is expressed as follows:

$$J^{\text{dark}}(\mathbf{x}) = \min_{\mathbf{y}\in\Omega(\mathbf{x})}\left(\min_{c\in\{r,g,b\}} J^c(\mathbf{y})\right), \tag{1}$$

3.3.3 Dark channel prior theory

The dark channel prior factors out that the dark channel of the fog-unfastened photograph J(x) within side the non-sky place has a tendency to 0,that is:

$$J^{\text{dark}} \to 0. \tag{2}$$

3.3.4 Formula transformation

According to the atmospheric scattering model, the primary method is barely processed and converted into the subsequent method:

$$\frac{I^c(\mathbf{x})}{A^c} = t(\mathbf{x})\frac{J^c(\mathbf{x})}{A^c} + 1 - t(\mathbf{x}). \tag{3}$$

Assuming that the transmittance t(x) of every window is a constant, denoted as t'(x), and the price of A has been given, minimal operations are completed on each aspects of the equation on the equal time, and we are able to get:

$$\min_{\mathbf{y}\in\Omega(\mathbf{x})}\left(\min_c \frac{I^c(\mathbf{y})}{A^c}\right) = \tilde{t}(\mathbf{x}) \min_{\mathbf{y}\in\Omega(\mathbf{x})}\left(\min_c \frac{J^c(\mathbf{y})}{A^c}\right) + 1 - \tilde{t}(\mathbf{x}). \tag{4}$$

g-loose image,consistent with the aforementioned darkish channel previous theory:

$$J^{\text{dark}}(\mathbf{x}) = \min_{\mathbf{y}\in\Omega(\mathbf{x})}\left(\min_c J^c(\mathbf{y})\right) = 0. \tag{5}$$

Therefore, it is able to be deduced:

$$\min_{\mathbf{y}\in\Omega(\mathbf{x})}\left(\min_c \frac{J^c(\mathbf{y})}{A^c}\right) = 0. \tag{6}$$

3.3.5 Transmittance calculation

$$\tilde{t}(\mathbf{x}) = 1 - \min_{\mathbf{y}\in\Omega(\mathbf{x})}\left(\min_c \frac{I^c(\mathbf{y})}{A^c}\right). \tag{7}$$

To envisioned transmittance may be corrected with the aid of using introducing a issue w among zero and 1 (generally 0.95), as shown in the formula:

$$\tilde{t}(\mathbf{x}) = 1 - \omega \min_{\mathbf{y}\in\Omega(\mathbf{x})}\left(\min_c \frac{I^c(\mathbf{y})}{A^c}\right). \tag{8}$$

The above derivation method assumes that the atmospheric mild price A is known. In practice, it may be acquired from the unique fog map with the assist of the darkish channel map. Specific steps are as follows:

First acquire the dark channel map, and extract the brightest first 0.1% pixels with inside the darkish channel map in line with the brightness

- Find the price of the factor with the best brightness with inside the corresponding function with inside the

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unique fog map I(x), and use it because the atmospheric mild price A.

In addition, due to the fact the transmittance t is just too small, it's going to reason J to be too large, and the restored haze-loose photograph as an entire may be immoderate to the white field. Therefore, it's far vital to set a decrease restrict t0 (normally 0.1) for the transmittance, whilst the price of t is much less than At t0, take t=t0. Substituting the transmittance and atmospheric mild price acquired above into the method, the very last photograph recuperation method is as follows:

$$\mathbf{J}(\mathbf{x}) = \frac{\mathbf{I}(\mathbf{x}) - \mathbf{A}}{\max(t(\mathbf{x}), t_0)} + \mathbf{A}. \quad (9)$$

This is the precept procedure of the dark channel a prior defogging algorithm. The following is a quick complement to the processing impact diagram with inside the paper. The darkish channel earlier principle factors out that the darkish channel of the fog-unfastened picture J(x) with inside the non- sky vicinity has a tendency to 0.

3.4 CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION

Adaptive histogram equalization (AHE) is a image processing approach used to enhance evaluation in images. It is used for enhancing the nearby evaluation and improving the definitions of edges in every vicinity of an picture. A variation of adaptive histogram equalization referred to as evaluation restricted adaptive histogram equalization (CLAHE) prevents this with the aid of using proscribing the amplification. The history evaluation has progressed after histogram equalization. But examine the face of statue in images. We misplaced maximum of the statistics there because of over-brightness.

It is due to the fact its histogram isn't limited to a selected vicinity. So to clear up this problem, adaptive histogram equalization is used. Here picture is split into small blocks referred to as "tiles" (TileGridSize is 8x8 with the aid of using default in OpenCV). Then every of those blocks are histogram equalized as usual. So in a small area, histogram might confine to a small vicinity (until there may be noise). If noise is there, it'll be amplified. To keep away from this, evaluation proscribing is applied. If any histogram bin is above the required evaluation.

3.5 HISTOGRAM MATCHING

Histogram matching is to take an enter photograph and generate an output photograph this is primarily based totally upon the form of a particular histogram [14].

Here cv.calcHist() characteristic to locate the histogram. The capabilities and parameters:

cv.calcHist(images, channels, masks, histSize, ranges[, hist[, accumulate]])

- **Images**:It's miles the supply photograph of kind uint8 or float32. It need to accept in rectangular brackets, ie, "[img]".

- **Channels**: It's also given in rectangular brackets. It is the index of channel for which we calculate histogram.
- **masks**: masks photograph. To locate histogram of complete photograph, it's miles given as "None".

- **HistSize**: This represents our BIN count. Need to accept in rectangular brackets. For complete scale, we pass [256].

- **Ranges**: RANGE. Normally, it's miles [0,256].

4. RESULTS AND DISCUSSION

The results obtained by this method are shown in below. The experiment performed in pycharm using Matplotlib and opencv.
Figure 3 depicts the output of different stages of algorithm. (a) The first underwater images are taken as an input and then these images are processed through derived algorithm. (b)Median filter removes the salt and pepper in the image (c) Gamma correction provides sufficient brightness for dimmed images.(d)It shows the dark particle in an image (e) The atmospheric light present in the image (f) The dark channel prior efficiently removes theeffect of haze and noise in

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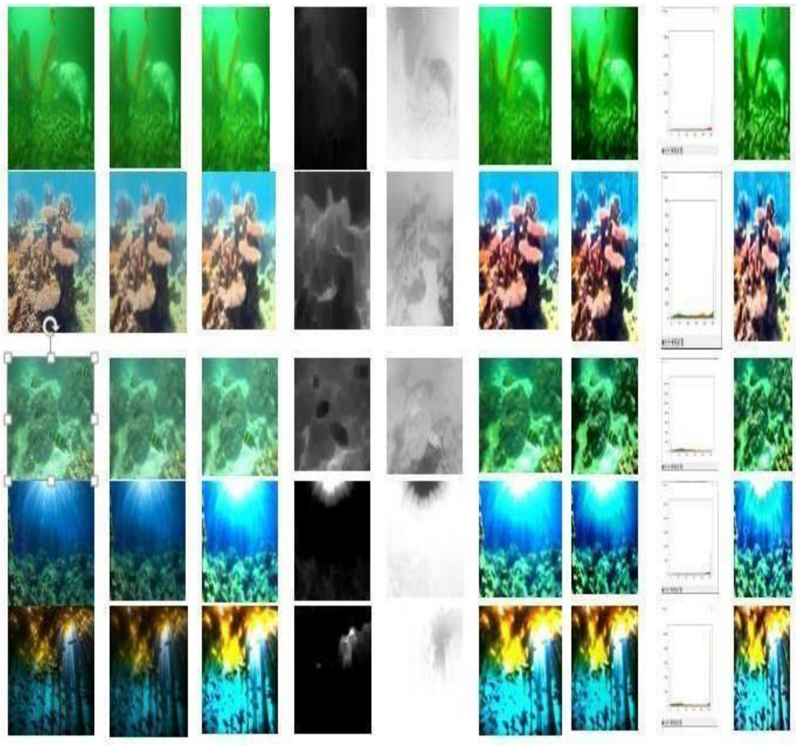
the image.(g) The low contrast dehazed image is processed by CLAHE to enhance contrast and intensity.(h) Generate an output image that is based upon the shape of specific histogram and adjusts the contrast of an image by using its histogram. The contrast enhanced output ismatched with input image to obtain smooth output and sharp the image.(i)



(a) (b) (c) (d) (e) (f) (g) (h) (i)

(a) Input image (b) Median Filter (C) Gamma Correction (d) Dark channel (e) Atmospheric light (f)Haze Free (g)CLAHE (h) Histogram matching (i) Enhanced Output image

Fig 3: Experimental Results

4.1 PERFORMACE EVALUATION

The Experimental consequences in under desk suggests that the proposed system. The more suitable haze loose output image suggests each information of an image which may be in addition used for show and evaluation purpose.

The Mean Square Error (MSE) and Peak Signal to Noise Ratio (PSNR) are usually used to evaluate the image noise. Since there's no to be had floor fact for actual underwater photographs and calculated the MSE and PSNR values among the uncooked underwater photographs and the corresponding resultant photographs. Despite the values of the MSE and PSNR aren't very goal on this case, the ones values never the less have a few guiding significance for comparing the overall performance of specific methods. The lesser MSE and higher PSNR values suggest much less noise and better quality. Totally 40 images are considered for experiment. Due to space constraints only for five images the results are shown in Table 1.

Table1: Performance Evaluation of existing with original images.

Images	**PSNR**	**MSE**
Image1	67.8821	1.892
Image2	52.798	2.943
Image3	68.464	2.601
Image4	47.907	1.274
Image5	58.101	3.687

The below graph clearly exhibits the comparison results of ,mean square error (MSE) and peak signal- to-noise ratio

(PSNR) of 5 images which is shown in figure 4. The lower average MSE values and higher average PSNR values indicate that the proposed approach introduces a small amount of noise.

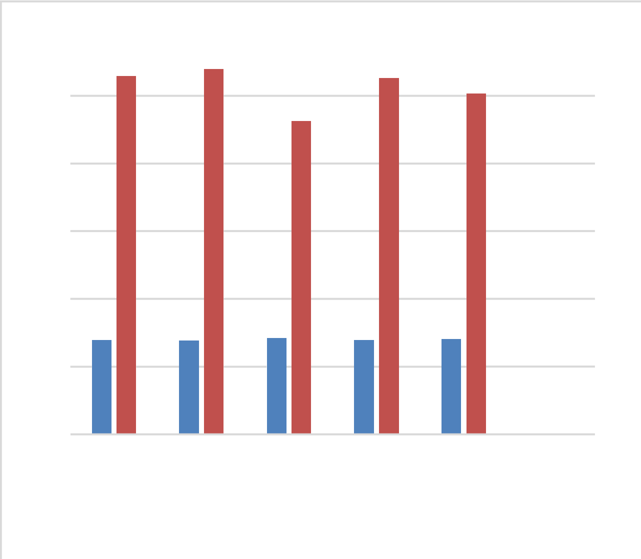


Fig 4 : Performance evaluation

5. CONCLUSION

Underwater images enhancement strategies offer a manner to enhance the assets or item detection in underwater. Underwater image enhancement primarily based totally on dark channel dehazing approach together with gamma correction that improves the brightness of the dimmed images. Dehazing algorithm primarily based totally on dark channel earlier offers superior output through doing away with the impact of absorption and scattering components. The evaluation of an image is regained the use of CLAHE which avoids the over amplification of noise through placing clip limit. The overall system offers noise unfastened superior image, keeping herbal look with stepped forward visibility and precious information. The destiny scope is that constructing an set of rules which enables to reconstruct image taken below different liquids.

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