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An Under Water Image Enhancement by using HSV and Histogram Equalization Methods

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Abstract: Underwater image processing is one of the important and challenging methods in Digital Image Processing. Generally, underwater images are get degraded due to light scattering effect, object blurrness effect, wave length dependent color attenuation. So, we need to enhance the image which is captured in under water. Basically, there are a lot of methods to enhance the image. In this paper, an Underwater Image Enhancement technique is proposed. To get a better enhanced image, here we using HSV, V transform algorithm and Histogram Equalization techniques. At starting stage, an underwater image is converted from RGB color space to HSV color space. Later, extension of V element is done under the control of the start and end of interval. Then, it is converted from HSV color space to RGB color space and the histogram equalization is applied to each R, G, B components. After that, R, G, B components are combined to form a color image. At last Gaussian filter is applied to the underwater image.
Keywords: Underwater image enhancement, HSV-V Transform algorithm, Histogram equalization of color images, RGB color space.

I. INTRODUCTION

Actually Underwater imaging is an efficient field to the researchers, but lot of effort and time is required to be stable in this field. Researchers are very excited to research on under water species and aqua animals. For that, they capture some images in underwater .Due to scattering of light, light reflection on underwater and floating objects on water being infinitesimal vague . Sometimes an image became a very light or very dominant and sometimes it may be a darker or low contrast. Many methods have been developed to overcome this problem of image degradation. Underwater images play a vital role in scientific research and for archaeology. So, it is very important to enhance the image. Image enhancement process is used, to improve the standard of the image by ameliorating its properties.

Recently, many works are done on image enhancement. But every method suggests that to improve the image quality by doing lot of process. For an efficient work we need to do less effort, less time and less money to spend. Mainly, the past works suggests the methods on various approaches such as contrast stretching, histogram equalization, contrast limited adaptive histogram equalization. Normally, Quality of underwater images can be enhanced by improving brightness, correction of color, increasing the viewing. The researchers proposed various methods such as “swaram optimization is proposed by Iyad Abu Doush”. They show RGB adjustment by PSO and applied the enhancement model for ordinary images improved by PSO. This results is compared with others results by using entropy and mean value. “Performance of fuzzy and histogram based color image enhancement was proposed by Taranbir and ranvneet kaur siddu”. They show extract of v component from HSV image and dividing the range of pixels and the pixel values. “Color constancy Deskewing algorithm is proposed by Lakshmi and Loganathan”. They use L*A*B color space. “Underwater image enhancement with HSV and histogram is proposed by Deperlingu, Kose and Guraksin”. They introduce Gaussian filter to remove or avoid noise. All the above methods are little bit complex. So we need an easy process to enhance an underwater image. In this paper we proposed a better image enhancement technique by using HSV domain, V-transform algorithm, histogram equalization techniques and Low pass Gaussian filter to get better image. All this process is explain in second section.

II. PROPOSED TECHINQUES FOR UNDERWATER IMAGES

The Flow chat represents the main proposed techniques

*RGB COLOR MODEL

Images represented in RGB color model consist of three component images, one for each primary color when fed into an RGB monitor, these three images combine on the phosphor screen to produce a composite color image. The number of bits used to represent each pixel in RGB space is called Pixel Depth.

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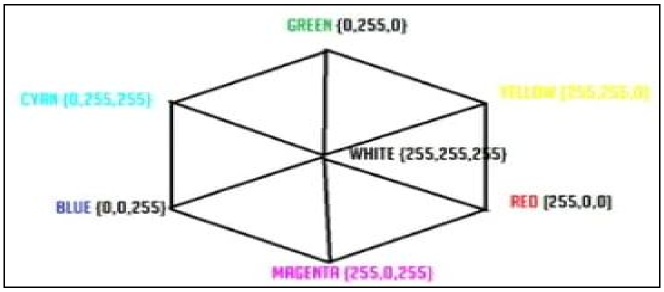
Initially, an underwater image is separated into its R (Red), G (Green) and B (Blue) components and is converted from RGB to HSV color space. After that, extension of v element is coordinated under the control of the start and end of the interval .Then, it is converted from HSV to RGB color space and histogram equalization is applied to each R, G and B components.
After that R, G, B components are combined to form a color image. Finally, Gaussian low pass filter is applied to under water image.

A. HSV

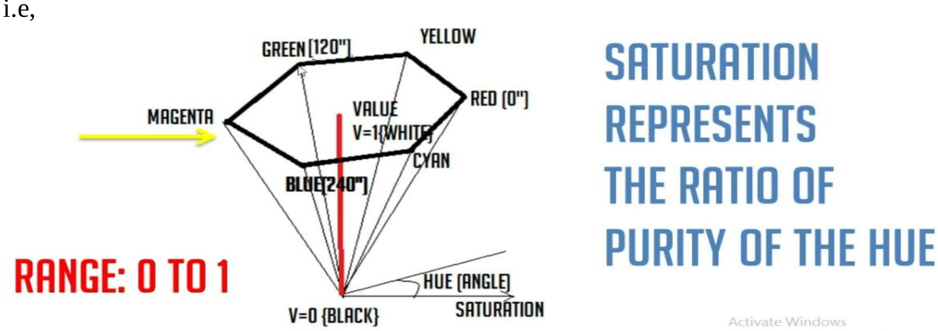
HSV color model has 3 main components.

1) HUE

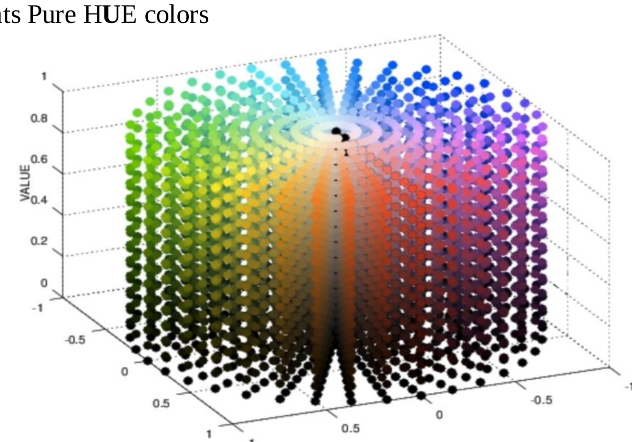


In Hue, u represents the angle with the vertical axis of all the 6 colors (RED, MAGENTA, BLUE, CYAN, GREEN, YELLOW) which cover total 360 degrees of Color hexagon and are separated by 60 degrees.

2) *Saturation:* Saturation represents Purity of the color .The below diagram is the tilted side of hexagonal. The angle defines hue but it is vertical axis which defines the saturation. So the vertical axis saturation decides the purity of the color i.e, saturation represents saturation of u and ranges from 0 to 1. Example To find out how much the color is pure, let say the saturation is 1 and the angle is 0 i.e, u is zero then we get a pure red color, if the saturation is 0.25 and angle is yellow so we get quarter of ratio of yellow color, if we have angle 120 and the saturation is zero then we get black color because the saturation is zero it means gray scale i.e,



3) *Value:* Value decides the brightness of color .it varies from 0 to 1.V=0 means black color and v=1 means white color. The top surface of the Hexagon represents Pure HUE colors



The HSV Color model also called as HSB (hue, saturation, brightness) model is a color model that is close to how human perceive color. Using this model, an object with a certain color can be detected and to reduce the influence of light intensity from the outside. Actually it is an alternative representation of the RGB color model. HSV model designed in the 1970s by computer graphics researchers to more closely align with the way human vision perceives color-making attributes. The color model describes color (hue), in terms of shade (saturation) and their brightness (value).

$$H = \begin{cases} \arccos\left\{\dfrac{(R-G)+(R-B)}{2\sqrt{(R-G)^2+(R-B)(G-B)}}\right\} & B \le G \\ 2\pi - \arccos\left\{\dfrac{(R-G)+(R-B)}{2\sqrt{(R-G)^2+(R-B)(G-B)}}\right\} & B > G \end{cases}$$

$$S = \frac{\max(R,G,B) - \min(R,G,B)}{\max(R,G,B)}$$

$$V = \frac{\max(R,G,B)}{255}$$

R^1=V-R/v-min(R, G, B) ………..eq(1)

G^1=V-G/v-min(R, G, B) …………eq(2)

B^1=V-B/v-min(R, G, B) …………eq(3)

$r=\frac{R}{R+G+B}$, $g=\frac{G}{R+G+B}$, $b=\frac{B}{R+G+B}$ ……….eq(4)

$$h = \cos^{-1}\left(\frac{0.5(r-g)+(r-b)}{\sqrt{(r-b)^2+(r-b)+(g-b)}}\right), \quad h \in [0,\pi] \; for \; b \le g$$

…………………eq(5)

Hue

$$h = 2\pi - \cos^{-1}\left(\frac{0.5(r-g)+(r-b)}{\sqrt{(r-b)^2+(r-b)+(g-b)}}\right), h \in [0,\pi] \; for \; b > g$$

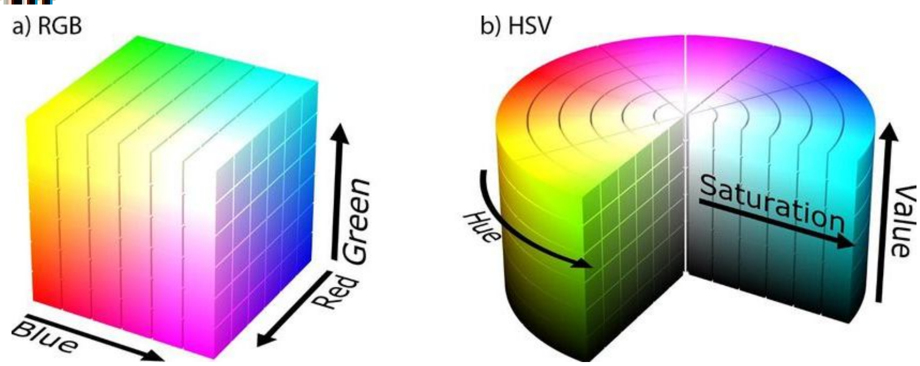
………………eq(6)

Saturation

$s = 1 - 3Min(r, g, b)$; $s \epsilon [0,1]$ …………eq(7)

Value

$V = \frac{R+G+B}{3.255}$ ………………eq(8)



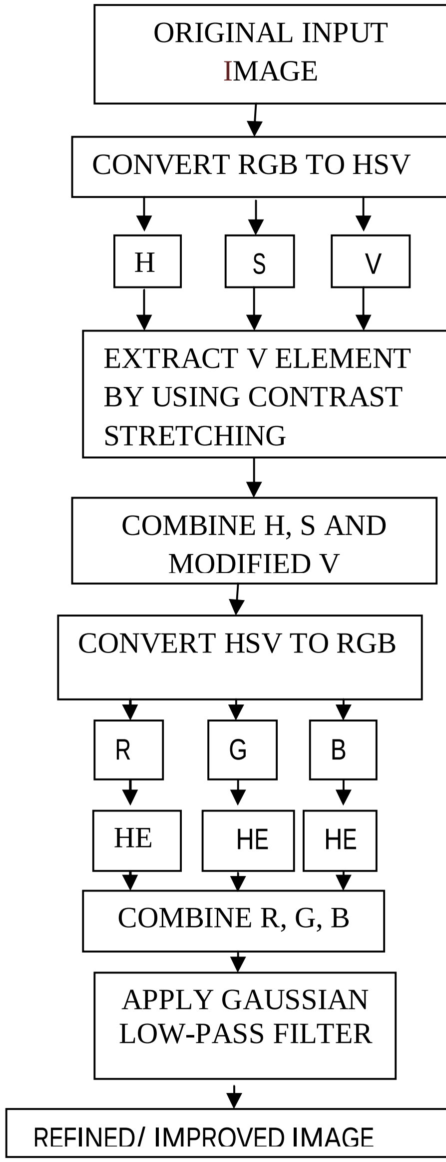
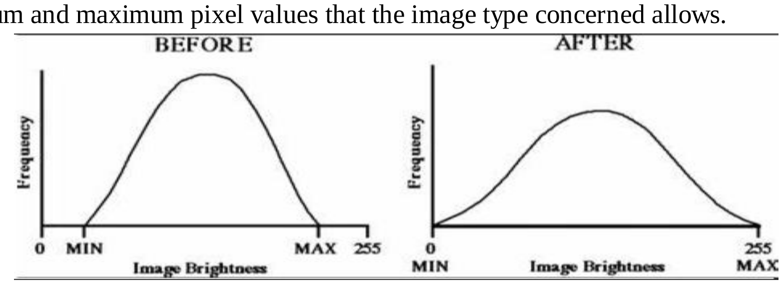


Fig (1): The block Diagram of proposed method

B. *Contrast Stretching*

Contrast Stretching(often called Normalization) is a simple enhancement technique that attempts to improve the contrast in an image by 'stretching ' the range of intensity values it contains to span a desired range of values, For example the full range of pixel values that the image type concerned allows. It differs from the more sophisticated histogram equalization in that it can only apply a linear scaling function to the image pixel values. As a result the 'enhancement' is less harsh. HOW IT WORKS: Before the stretching can be performed it is necessary to specify the upper and lower pixel value limits over which the image is to be normalized often these limits will just be the minimum and maximum pixel values that the image type concerned allows.



C. HSV to RGB

After modifying v element by using contrast stretching we combine h, s and modified v then we convert HSV TO RGB

This function will create a HSV model from a RGB model. The algorithm behind the conversion is described by the formulas below.

$$M=max\{r,g,b\}$$
$$m=min\{r,g,b\}$$
$$c=M-m$$
$$v=M$$
$$h=\begin{cases}(\frac{g-b}{c} mod 6)*60 & r=M, c\neq 0\\ (\frac{b-r}{c}+2)*60 & g=M, c\neq 0\\ (\frac{r-g}{c}+4)*60 & b=m, c\neq 0\\ 0 & c=0\end{cases}$$
$$s=\frac{c}{v}$$

The meaning of the variables:

M - the RGB component with the greatest value

m - the RGB component with the smallest value

c - chroma

r, g, b - the components of the RGB model (red, green, blue)

h, s, v - the components of HSV model (hue, saturation, value)

The components of the RGB model (r, g, b), saturation (s) and value (v) should have values in the range [0,1], while the hue (h) should have values in the range [0,360].

$$c=v*s$$
$$m=v-c$$
$$x=c*(1-|\frac{h}{60} mod 2-1|)$$
$$(r,g,b)=\begin{cases}(c+m, x+m, m) & h\in[0,60)\\ (x+m, c+m, m) & h\in[60,120)\\ (m, c+m, x+m) & h\in[120,180)\\ (m, x+m, c+m) & h\in[180,240)\\ (x+m, m, c+m) & h\in[240,300)\\ (c+m, m, x+m) & h\in[300,360)\\ (m,m,m) & otherwise\end{cases}$$

D. Histogram Processing

Under water images which have low contrast and visibility as a result of selective attenuation based on the wave length of the light passing through water needs some corrections to extract from them.

Histogram is a graphical representation of the intensity distribution of an image. In simple terms it represents the number of pixels for each intensity value considered. A color histogram of an image represents the number of pixels in each type of color component. Histogram equalization cannot be applied separately to the Red(R) ,Green (G), Blue (B), components of the images color balance .However it the images is first converted to another color space ,like HSV/HSL color space then the algorithm can be applied to be luminance or value channel without resulting in changes to the hue and saturation of the images.

Color histogram is flexible constructs that can be built from images in various color spaces RGB chromaticity or any other color space of any dimensions.

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E. Histogram Equalization

Histogram equalization is a method to process images in order to adjust the contrast of an image by modifying the intensity distribution of the histogram. Histogram equalization can be done in three ways

1) Compute the histogram of the image.
2) Calculate the normalized sum of histogram.
3) Transform the input image to an output image

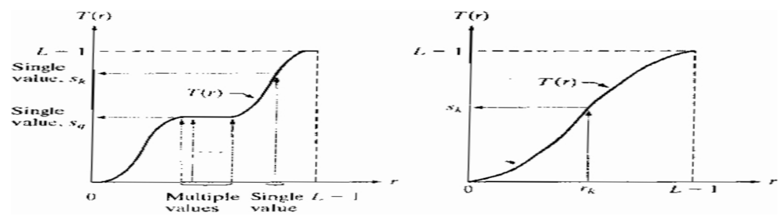
The histogram of digital color image process of gray levels from 0 to L-1 is a discrete function

$h(r_k) = n_k$

Where
r_k= k^{th} gray level
n_k= Pixels image gray level
n=the total number of pixels in image
k= 0, 1, 2, ------L-1
r= 0 represents black and r= 1 represents L-1

$$s = T(r) \quad 0 \leq r \leq L-1$$

$T(r)$ is a monotonically† increasing function in the interval $0 \leq r \leq L-1$

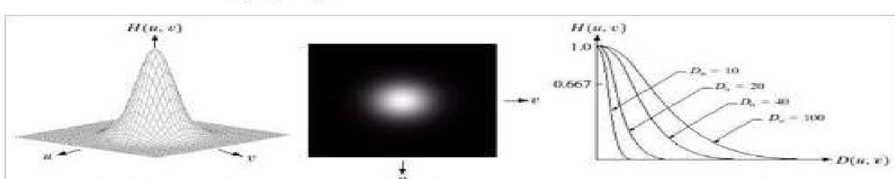


F. Gaussian Low Pass Filter

Gaussian low pass filter are very important in many signal processing and image processing. Gaussian LPF is used to reduce noise in image. Gaussian low pass filter is also known as Gaussian warming. It is commonly used when reducing the size of an image. When down sampling an image, prior to re-sampling .This is to ensure that spurious high frequency information does not appear in down sampling image. The key function of Gaussian filter is that the Fourier transform of a Gaussian is also a Gaussian so the filter has the same response shape in both spatial and frequency domain and therefore does not incur the ringing effect in the spatial domain of the filtered image. This the advantage over Ideal low pass filter and Butterworth low pass, especially in some situations where any type of artifact is not acceptable, such as medical images. Mathematically, applying a Gaussian blur to image is the same as convolving the image with a Gaussian function. Since the Fourier transform of Gaussian is another Gaussian, applying a Gaussian blur has the effect of reducing the images high frequency components; a Gaussian blur is thus is thus a low pass filter.

The transfer function of a Gaussian lowpass filter is defined as:

$$H(u, v) = e^{-D(u,v)/2\sigma}$$



A)Perspective plot of a GLPF transfer function B)Filter displayed as an image C)Filter radius cross section for various values of D

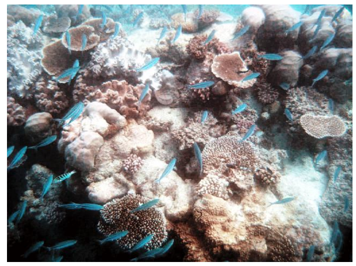
Do=cut off frequency a specific non negative number
D(u, v) =distance from point (u, v) to the center of the filter
H(u, v) =transfer function General formula for filtering
G(u, v) =F(u, v). H(u, v)
F(u, v) =Fourier transform
G(u, v) =filtered final function

III. EXPERIMENTAL RESULTS:

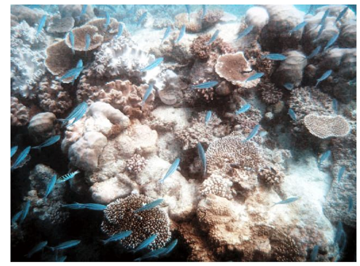
Based on methodology, experiments have been done in matlab software. By using underwater images taken from internet source finally we proved the benefit of our approach for applications such as key point matching and segmentation .The results show that the proposed method expand the status of the images very well and increases the clarity and quality of the image. Here we are taken four images. After mainly applying Histogram equalization and Gaussian filter, the quality and clearness of images are increased. We can check quality of image by comparing input image with the enhanced image. The images clearly show that the input image is increased.

INPUT IMAGE (1)

AFTER HE



AFTER FILTERING



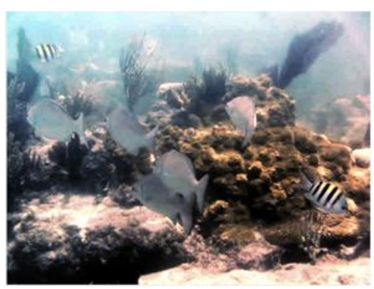
INPUT IMAGE (2)

AFTER HE

AFTER FILTERING

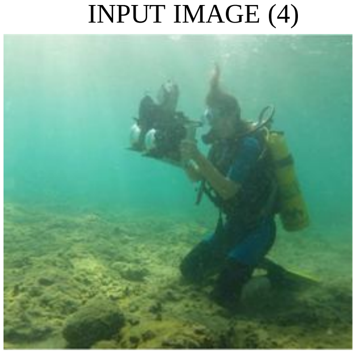
INPUT IMAGE (3)

AFTER HE



AFTER FILTERING

INPUT IMAGE (4)



AFTER HE

AFTER FILTERING

IV. CONCLUSION

Under water images normally has several problems including limited range of visibility, low contrast, non-uniform lighting, bright artifacts noise, blurring and diminishing color .These problems can be removed by image enhancement techniques. So, an ideal method has been proposed to improve underwater images easily without spending a lot of time and effort. In this context, the main aim of the paper is to offer an easy approach which contains the HSV color space with extension of v component and histogram equalization. After comparing the existing techniques with proposed technique it gives the better results than existing technique, on the basics of visual perception and performance analysis criteria. Finally, in future different combinations can also be applied to the proposed method.

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