UNDERWATER COLOR CORRECTION

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DECLARATION

I declare that this thesis entitled "UNDERWATER COLOR CORRECTION is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature	:	--
Name	:	--
Date	:	--

APPROVAL

I hereby declare that I have checked this report entitled “UNDERWATER COLOR CORRECTION” and in my opinion, this thesis it complies the partial fulfillment for awarding the award of the degree of Bachelor of Electrical Engineering with Honours

Signature	:	....
Supervisor Name	:	....
Date	:	....

DEDICATIONS

To my beloved mother and father

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ABSTRACT

This report presents the color correction for underwater images. Recovering correct or at least realistic colors of underwater scenes is a very challenging issue for imaging techniques. The crucial reason for this problem is due to the density of the seawater and the penetrating of light. Since the light will be absorbed and scattered by small particles when travels in water, underwater imaging exists in difficulties of color cast. It gives impact to the limitation of visibility in the sea water. The need to correct colors of underwater images is an important task required in all image-based applications like underwater research such as coral bleaching and navigation as it is vital for the researchers to monitor and tracking the corals's health and pathway for the underwater transportation. To restore the color of the images, the method that is used in this project is Unsupervised Color Correction method and it was technically simulated in MATLAB by using 36 numbers of input images that categorised to; bluish, greenish and normal images respectively. In UCM method, it mainly has two stages to solve the problems mentioned above. First, equalization of RGB colors to achieve equal color values of the RGB component. Second, contrast to RGB color models to improve the contrast of the images. The result is evaluated visually and quantitatively by using Sobel edge detector to detect the edge and proved that whether the color of the images is improved by using Unsupervised Color Correction method. From the results obtained, it shown that the input images that is bluish and greenish improved significantly rather than the normal images that having a deterioration in terms of visual and the number of edges.

ABSTRAK

Laporan ini membentangkan pembetulan warna untuk imej bawah air. Memulihkan warna yang betul atau sekurang-kurangnya warna realistik di bawah air adalah isu yang sangat mencabar untuk teknik pencitraan. Alasan penting untuk masalah ini adalah kerana ketumpatan air laut dan penembusan cahaya. Oleh kerana cahaya akan diserap dan tersebar oleh zarah-zarah kecil apabila bergerak dalam air, pengimejan bawah air wujud dalam kesulitan warna cast. Ia memberi impak kepada penglihatan di air laut. Keperluan untuk membetulkan warna gambar bawah air adalah satu perkara penting yang diperlukan dalam semua aplikasi berasaskan imej seperti penyelidikan bawah air seperti pemutihan dan pelayaran karang kerana penting bagi penyelidik untuk memantau dan menjejaki kesihatan karang dan laluan untuk pengangkutan bawah laut. Untuk memulihkan warna imej, kaedah yang digunakan dalam projek ini adalah kaedah Pembetulan Warna Tidak Teratur dan secara teknikalnya disimulasikan dalam MATLAB dengan menggunakan 36 bilangan imej input yang dikategorikan; imej biru, kehijauan dan normal masing-masing. Dalam kaedah UCM, ia mempunyai dua peringkat untuk menyelesaikan masalah yang disebutkan di atas. Pertama, penyamaan warna RGB untuk mencapai nilai warna yang sama komponen RGB. Kedua, kontras dengan model warna RGB untuk meningkatkan kontras imej. Hasilnya dinilai secara visual dan kuantitatif dengan menggunakan detektor kelebihan Sobel untuk mengesan tepi dan membuktikan sama ada warna gambar itu diperbaiki dengan menggunakan kaedah Pembetulan Warna Tak Bertanda. Dari hasil yang diperoleh, ia menunjukkan bahawa imej input yang kebiruan dan kehijauan bertambah baik dengan ketara dan bukannya imej biasa yang mengalami kemerosotan dari segi visual dan bilangan tepi.

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RGB	Red, Green, Blue
HSI	Hue, Saturation, Intensity
HE	Histogram Equalization
UCM	Unsupervised Color Correction Method

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter introduces underwater color correction and the cause of color distortion of underwater images. It consists of research background, problem statement, motivation, objectives and project scope.

1.2 Research Background

Images have become a significant way to acquire and record information replacing traditional sensors and the application of vision system are becoming more and more vast. Due to speedy development and advancement of technology, people have started to explore the ocean which consists of abundant energy, luxuriant mineral resources and biological supply. As ocean exploration increased, the area of underwater image processing has drawn many attentions over the last years. However, color distortion will affect the images in underwater environment and this caused the difference in the perspective of the objects at the underwater environment compared to their appearance in reality perspective. Image distortion occur due to seawater density which is 800 times denser than air [1]. Water surface divides the moving light from air to water into reflected light and penetrating light. When light rays move from the air to the water, it is partly reflected back into the air and partly enters the water.

Additionally, the penetrating light that enters the water reduced as going deeper and deeper towards the bottom of the sea. This is because the water molecules absorb a certain amount of light [2] which resulted in darker images as the depth increases. As shown in the Figure 1-1, not only the amount of light rays is reduced when it deepens but the colors also will disappear gradually depending on the wavelength of the light. At the depth of 3m red color disappears, then orange color begins to disappear. Yellow color will fades away at the depth of 5m then followed by the green and purple color will goes off at further depth. Figure 1-2 shows that blue color is able to travel to the furthest depth due to its short visible wavelength. This makes the underwater images having been dominated mainly by blue color. In addition to excessive amount of blue color, the images also lost its brightness and contrast. The need to correct colors of underwater images is significant task required in all image-based applications like underwater research such as coral bleaching and the navigation. Therefore, underwater color correction is needed to improve the distorted images.

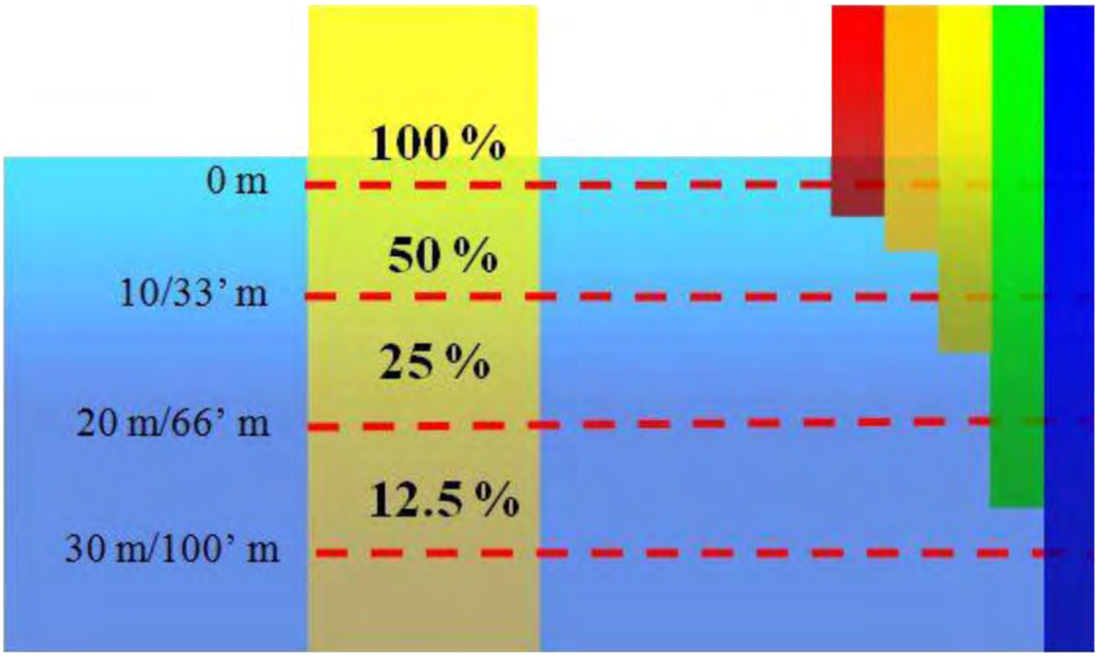

Figure 1-1: Different wavelengths of light are absorbed at different depths [1]

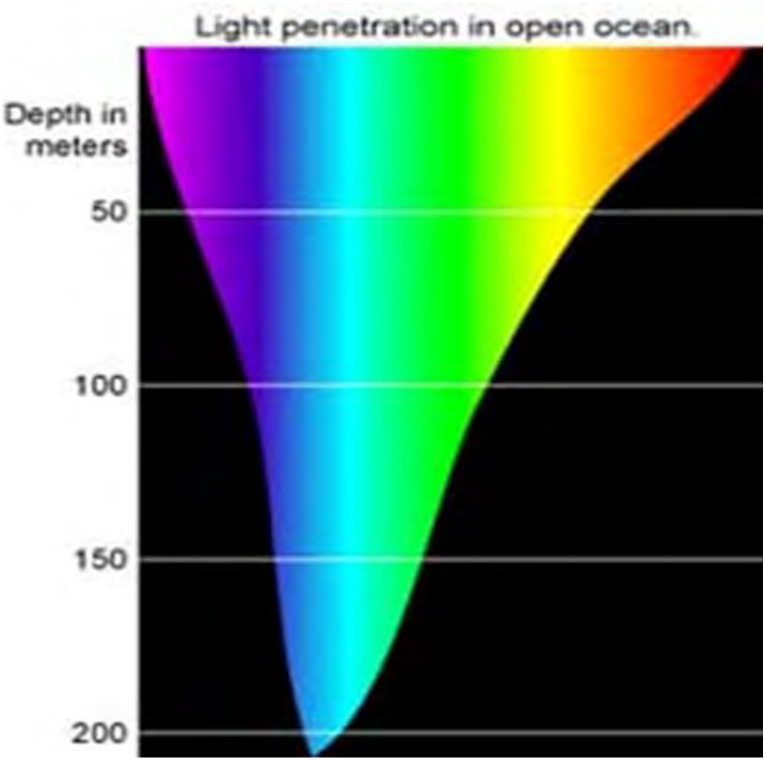

Figure 1-2: Color Penetration Pattern [2]

1.3 Problem Statement and Motivation

Coral reefs are important to protect the coastline from the damaging effects of the waves and tropical storm. Other than that, it provides shelter for many marine organisms and also it is the source of nitrogen and other essential nutrients for marine food chains. Due to developing activities and the increasing number of the coastal populations, the habitat of coral reefs are threatened. 60% of the world's coral reefs are at risk [3] due to human action such as coastal advancement, devastating fishing and aquatic pollution. Corals are bleached when there is pollution – This causes the color of the corals to fade away and change to white color because the algae that live in the corals will leave them when the surrounding environment was polluted.

In order to get data of surveys on coral reefs and fish population, one method used by scientist are the satellite. From the satellite, large-scale images can be obtained but because of the large size, the details of the data may not be accurate. So, another method is to dive into the sea and to take pictures of the corals. It is not practical for scientist to dive and gather the data alone, so they hire or request volunteers to help them. But the volunteers may use different camera and method, thus the quality of the image will become varies too. It is also known that the underwater view will looks in bluish or greenish tone. To regain and improve their colors to have a good visibility for research purpose, this project will use Unsupervised Color Correction method.

The motivation of this project is to spread the awareness about the coral bleaching problems and to obtain the natural colors of any objects in underwater as it is vital to underwater research such as survey on corals and fish. By using Unsupervised Color Correction method, the quality of the underwater images will be improved.

1.4 Objectives

The main aim of this project is to improve the color distorted of the underwater images by using Unsupervised Color Correction method. The objectives for this project are as follows:

i) To improve the color of images in the underwater environment.

ii) To obtain an equally distributed histogram output to show that the images have undergo the color improvement.

1.5 Project Scope

The project scopes included:

i) The technique used is simulated in MATLAB.

ii) The 12 of image dataset was referred to [4], [5], [6], [7], [8] and [9] be tested on the underwater images corresponding to image that have bluish or greenish tone and poor contrast.

1.6 Conclusion

The color of the images needs to be improved so that it can be used to provide accurate information to marine scientists. Thus, the conditions of coral reefs can be more closely monitored and suitable actions can be performed quickly to ensure the sustainable environment for future generations.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents related literature concerning basic theory of vision system and underwater image color correction techniques and why the UCM is the most suitable method for this project compared to the others method.

2.2 Basic Concept Of Digital Images

Digital image consists of picture elements that is called as pixel [10]. Commonly, pixels are sort in an ordered rectangular array. Dimension of the arrays represents the size of an image. The image height is determined by the number of rows in the array and the image width is the number of columns (M×N) matrix [11]. The coordinate system of image matrices described x as increasing from left to right and y as increasing from top to bottom. For each of the pixels, it has their own intensity value or brightness [12].

For grey images, it only has one color frame and its intensity is from darkest grey (black) to lightest grey (white) and it's ranged from 0-255 as shown in Figure 2-1. For color images, it has three color frame, Red, Green and Blue. Images represented in the RGB color model include three component images, one for each primary color respectively. The three primary colors can produce a broad array of colors if it combines in various ways such as in Figure 2-2.

Figure 2-1: The Intensity Range [13]

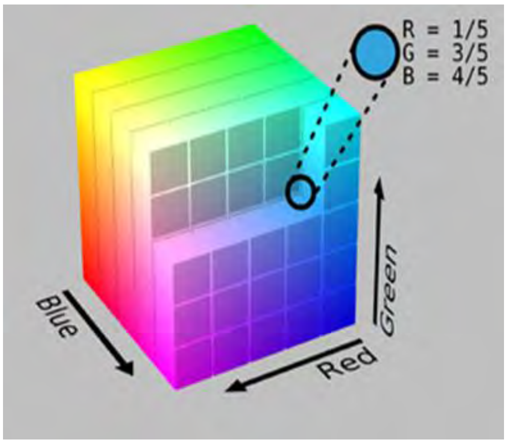

Figure 2-2: RGB Color Model [14]

Hue is a color attribute that describes a pure color, saturation gives a measure of the degree to which pure color is diluted by white light and intensity is brightness. Other than the RGB color model, HSI model is also an important basic theory in the vision system. Based on Munsell color model in Figure 2-3, it represented as a three-dimensional cylindrical shape that equals to hue (H), saturation (S), and intensity (I) [15], and it was the first model that isolates the three color components into disciplinary independent, regular, and three dimensional space.

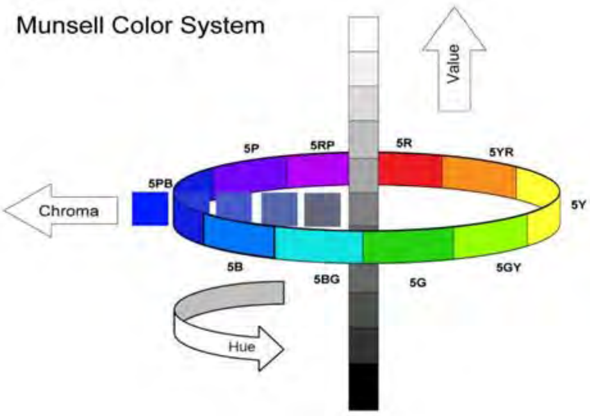

Figure 2-3: Munsell Color Model [15]

In the vision system topic, the histogram of an image usually refers to a graph that displaying the number of pixels in an image (on the y-axis) at each contrary intensity value (on x-axis) found in that image as shown in Figure 2-4 [16]. There are 255 different feasible intensities for an 8-bit grayscale image, and so the histogram will graphically show 255 numbers displaying the dispersal of pixels amongst those grayscale values. Histograms can also be taken of color images which is individual histograms of red, green and blue channels or a 3-D histogram can be produced, with the three axes representing the red, blue and green channels, and intensity at each point representing the pixel count. The left side of the graph represents the blacks or shadows, the right side represents the highlights or bright areas and the middle section is mid-tones.

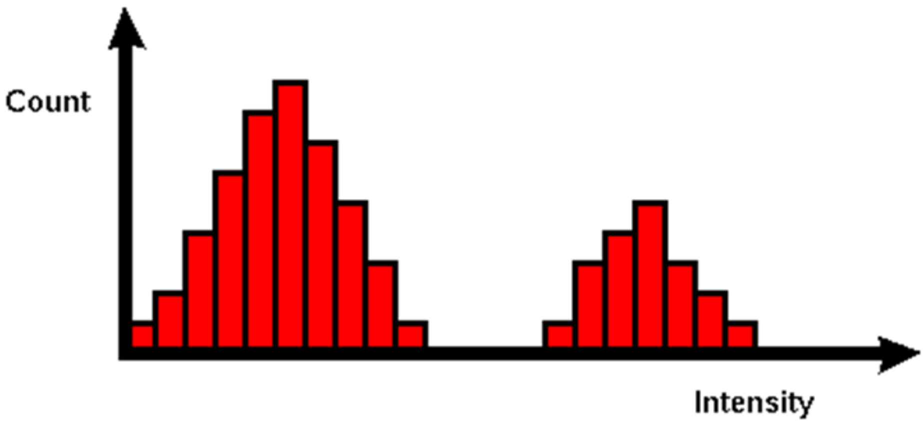

Figure 2-4: Image Histogram [16]

When the input image has a good contrast and no disturbance occur, the histogram of the image will be equally distributed. If it is in high intensity, the graph will more on the right side and if it is in low intensity the graph will more at the left side as shown in Figure 2-5. The histograms has wide application in image brightness. Not only in brightness, but histograms are also used in adjusting contrast of an image. Another important use of histogram is to equalize an image so that the image will have a better output in term of color.

Figure 2-5: Comparison of the Histogram Image [17]