Under Water Image Restoration and Enhancement Using Image Processing in MATLAB

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Abstract. Because of the circumstances of diffused illumination and light assimilation, underwater photographs typically encountered a modest difference in color saturation due to color immersion. When underwater photos with similar shade colors are captured under different lighting situations, restoring and enhancing such images is difficult. Several different common approaches may be used to increase the quality of submerged photographs; however, these solutions are only sometimes successful. The underwater image may be created as a flawless picture and a blend of background light, with that of each sensor tightly set. The studies were primarily focused on enhancing image quality and minimizing noise. Several ways have been proposed in recent years to increase the visibility of undersea pictures (UI) by reducing haze, and certain color correction techniques have been presented to improve the impression of UIs. This study provides an overview of recent approaches to underwater picture restoration.

Keywords: Image restoration · underwater image restoration · DCP · Filtering methods Application

1 Introduction

Oceanographers rely heavily on underwater photography to learn more about the marine ecosystem. Underwater photography is used to undertake underwater surveys and research on aquatic life and features. Yet, because of reduced visibility, acquiring good photographs of items underwater is challenging. As light reaches the aqueous medium, it is dispersed by suspended particles and partially absorbed by the medium. Beer's law of refraction explains this phenomenon by stating that "the water layers of identical thickness will absorb an equal amount of light as it travels through the medium." Longer-wavelength light components are readily absorbed at the water's surface, whereas shorter-wavelength light components are able to penetrate deeply [1]. For a wide range of uses, including underwater communications systems and pipeline detection, several computer vision techniques have been presented as ways to improve pictures captured

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underwater. Image repair and enhancement of underwater images are two of the primary areas of focus for most present research efforts. Contrast enhancement focuses with the alteration of colors in underwater photographs, while image restoration is based on certain optical models and is also known as deconvolution. In this process, the scene's brightness is determined from the mode of the original photograph [2].

The actions of scattering and absorption cause the images to be distorted when they are acquired when the camera is submerged in water. The light did receive by the camera is produced by three factors a direct component that reflects light from the objects, a forward scattering component that deviates light on the camera at random, and a backscattering component that reflects light back towards the camera before it attains the objects [3]. This results in impacts such as blurring and masking of the image's features, and it might even contribute to noise production. As a light wave travels through a material like water, the various frequency components of the light wave cause distinct absorption profiles [3]. A medium of water possesses the quality of absorption that is not the same as that of a medium of air. Light beam absorption is affected by several elements such as water velocity, suspended particle concentration, turbidity, salinity, and so on. It is discovered that light waves get weaker over a short distance in water [3].

A Facial Detection (FR) system is a form of identification or verification that is carried out by an artificial system. This is accomplished by comparing the facial characteristics of various photographs included inside a face database. Image processing, computer systems, cars, and authentication procedures are just some of the many applications that substantially use FR systems. In different lighting conditions, error rates of less than 1% were recorded in the Facial Recognition Vendors Test (FRVT) as well as the Multimodal Biometric Assessment (MBE) 20102. The Fourier Transform, the Discrete Wavelet Transform, and the principal.

Component Analysis are the three most common feature extraction techniques used in conventional methods. The capacity of feature extraction to identify facial features best determines its usefulness. For optimum face recognition, the variance in lighting and position should be reduced, and as a result, pre- processing of testing and training photos must be completed. In this article, a novel method for the extraction of features is provided. This method is built on Wavelet Transform (HT), and it is based just on the extraction of notable peaks from Hough Transform. Hough created the Hough Transform in 1959 for computer analysis of bubbles chamber photography. In 1962, this approach was patented as U.S. Patent 3,069,654 under Method and Meant for Identifying Complicated Patterns. The Hough transform is commonly employed as a feature extractor in numerous pattern recognition systems, and one such approach is detailed [4]. As a result of this, natural photos taken underwater tend to be mostly blue or green, in contrast to images taken above ground. Forward scattering and backwards scattering are the two main categories that may be used to describe the dispersion of light in water [5].

Decompression and image convolution analysis with the use of the software like artificial neural networks and look once software (YOLO) with Python and MATLAB provides pictures with good and clear resolutions for the underwater images generated with water mark filters [13].

2 Literature Survey

Numerous groups may be utilized to classify the existing underwater dehazing techniques. Particularly useful is the category of techniques that requires the use of specialized hardware. Optical/laser-sensing technology will be used in the UWLI divergent beam underwater Lidar imaging system. Use this method to snap some shots of murky seas below the surface. Nevertheless, these systems have a greater cost and greater power usage. In the second group, we find the circularly polarized light methods [6]. These strategies use a polarization filter mounted to the camera to capture several pictures of a single location with varying levels of polarization. For instance, calculation with an approximation of the transmission map from the polarization of the backscattered light is mentioned [7]. Even though they help regain access to far-off regions, they are only of limited use when dealing with dynamic circumstances since they cannot be utilized for video collecting. As a result, their utility is restricted.

Secondly, some construct a scene model from a large number of pictures or an accurate approximation of the scene. Narasimhan and Nayar (2003) provide a paradigmatic case of this kind when they analyze the variation in the intensity of scene points in response to varying climatic conditions and therefore detect a deep discontinuity in the image [8]. Solutions like this are only practical for everyday users since they need data that is only sometimes readily available, such as photos and a depth estimate [8]. Thirdly, a class of methods makes advantage of the similarities between light's path through fog and water. Recent years have seen the development of various single-image dehazing techniques that may rescue previously lost outdoor images due to fog. These methods of dehazing use a reversal of the Koschmieder's vision model to restore the original brightness of the objects. Restoration underwater pictures utilizing Dark Channel Prior (DCP) an approach, is one article that relaxes the assumptions upon which the initial development of this model was based. These include constant atmospheric illumination, a constant extinction coefficient independent of light wavelength, and a constant room scattering mechanism [9]. Using depth map refinement, Yang Lu et al.(2013) suggested a single-picture dehazing approach [10]. The depth map can be smoothed down with the help of better bilateral filtering, but there will still be some residual noises on the picture. Torres- Méndez & Dudek, 2007, suggested a Markov random field mrf learning approach to estimate the relevant color value of each pixel of hyper spectral imaging and a mathematical stability model to evaluate the attenuation coefficient using depth map as a light absorption method [11]. In (Zuiderveld, 1994) there is an analysis, proposal, contrast limited adaptive histogram equalization (CLAHE) was described as a method for adjusting the target area based on an interpolation between the histograms of neighboring regions [12]. Light irregularities persist on the treated picture, however, since the processing is performed locally rather than on the complete image. The HDR imaging technique served as inspiration for the espouse fusion approach, which, in very turbid water, is unable to effectively eliminate scatter.

3 Materials and Methods

Simulink MATLAB and underground image enhancement and resolution software were used for providing a clear picture with good picturesque depiction. The system designing of the image resolution software is given below as follows:

3.1 System Design

Experimental Results and Discussion Analysis.

Figure 1 shows the flow chart of the methodology used in the MATLAB filter for screening and sorting the images with a clean and good resolution. The results as depicted in Fig. 2 helps in analyzing the imaging in the different color scale resolutions and image scaling after using the additional resolution color filters in the HSV space. The domain image is analyzed in the additional filters like restoration, degradation, fragmentation, pixel resolution and image color selection for obtaining the best possible photos with small fine resolution patterns. The image function analyses the images by removing the noise filter and background color distortion. As depicted in Fig. 3, the image is depicted in the form of bar graph diagram and histogram with pixel size scaling. Thus, MATLAB picture resolution helps obtain the best possible images involving background functions like noise and picture pixel distortion factors. Artificial neural networks help in providing a fine resolution to the image as shown in Fig. 2 with sharpness, brightness, light and dark contrast so that the background image haziness in the underground water body is removed. Water waves generate haziness and distortion while viewing the image thus the MATLAB filters help in providing a clear resolution with bright image contrast. The simulation model application in MATLAB is used to refine the image and improve the output display with attractive feature visualization. The underground water image enhancement tool provides a good resolution for underwater images that look attractive to watch.

$$r_{rc}(x) = I_g(x) \times (1 - I_r(x)) \quad (1)$$

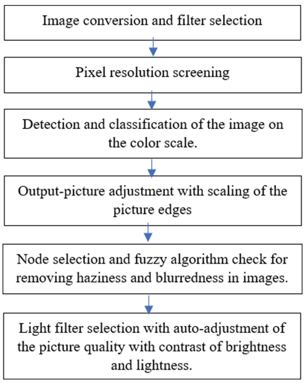
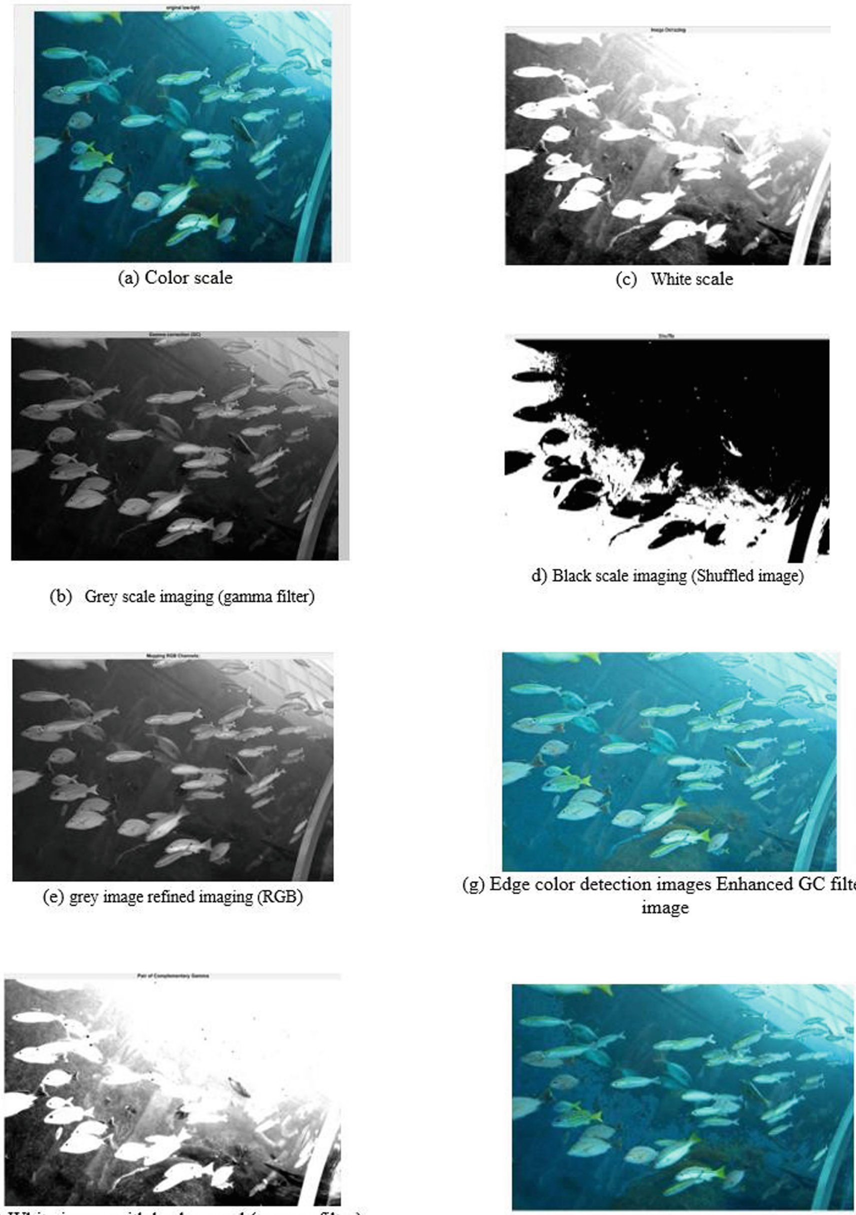


Fig. 1. Shows the flow chart of image acquiring and image adaptation and resolution according to the requirement



(a) Color scale

(c) White scale

(b) Grey scale imaging (gamma filter)

d) Black scale imaging (Shuffled image)

(e) grey image refined imaging (RGB)

(g) Edge color detection images Enhanced GC filter image

(f) White image with background (gamma filter)

(h) HSV space image

Fig. 2. Showing the different images in the different color scale resolution

$$I_{rc}(x) = I_r(x) + r_{bc}(x) \times (I_g - I_r) \tag{2}$$

$$r_{bc}(x) = I_g(x) \times (1 - I_b(x)) \tag{3}$$

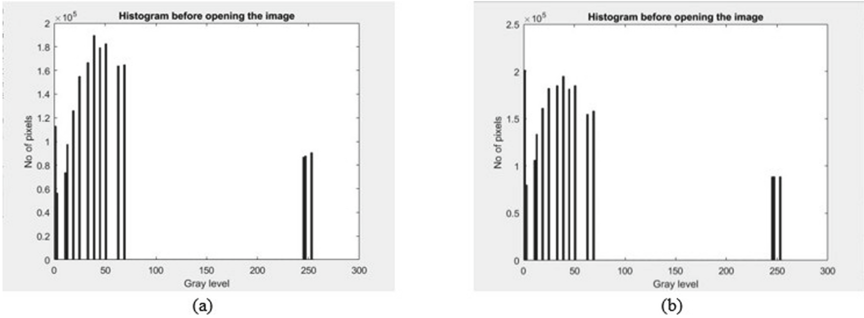


Fig. 3. Showing the different images in the bar-graph diagram in the pixel form MATLAB software has various wavelength color filters for activating and attenuating the different color background accordingly to improve the image resolution.

Table 1 Histogram plot a, b with the number of pixels

Number of pixels (a)	Gray scale intensity (a)
1.80×10^5	50
1.60×10^5	60
1.65×10^5	70
1.00×10^5	250
Number of pixels (b)	Gray scale intensity (b)
1.8×10^5	50

$$I_{bc}(x) = I_b(x) + r_{bc}(x) \times (I_g - I_b) \tag{4}$$

The above equations define the intensity of light in the RGB (red, blue, green) filter with normalization to get the best image out after polarization image capture. $I_r(x)$ is the intensity of red light, $I_b(x)$ is the intensity of blue color. The limit function for the color values is in the range of (0,1). $\underline{I_g}$ is the average intensity of green color light and $\overline{I}r$ is the average intensity of red light. $r_{rc}(x)$ is the compensation value for the red color in the filter. Ib is the intensity of blue color pixel in the filter. $\underline{I_b}$ is the average intensity of the blue color pixel light (Fig. 4).

3.2 Performance Measure Analysis

The effectiveness of the suggested FC-CLAHE methodology is evaluated and compared with the performance of a variety of histogram equalization techniques. These methods are based on image quality measuring tools such as the Contrasting Enhancement Indicator (CII), Discrete Efficiency (DE), Absolute Mean Brightness Factor (AMBC), and Peak Signal-to-Noise Ratio (PSNR). The Contrasting Enhancement Index (CII) is used to assess the profitability of the suggested FC- CLAHE approach versus current

Number of pixels (a)	Gray scale intensity (a)
1.80 x 10^5	50
1.60 x10^5	60
1.65 x 10^5	70
1.00 x 10^5	250
Number of pixels (b)	Gray scale intensity (b)
1.8 x 10^5	50
1.5 x 10^5	60
1.6 x 10^5	70
0.8 x 10^5	250

Fig. 4 Equations RGB filter:

contrast enhancement methods. Contrast Enhancement. All the above-mentioned features are present in the MATLAB. The appropriate filters for different wavelength color like red, blue, green, yellow, grey, black and white can be appropriately removed and adjusted accordingly to provide a good contrast image. HSV (hue, saturation, value and red, green, blue filter were used for refining the images obtained under water.

4 Conclusion

To conclude, underwater image restoration and enhancement using MATLAB image processing is an effective technique for improving the quality of images captured underwater. This technique utilizes various MATLAB image processing techniques, such as contrast stretching, noise reduction, and color correction, to enhance the visual quality of underwater images. By improving the visibility and clarity of underwater images, this technique has many practical applications in fields such as marine biology, underwater exploration, and oceanography.

Overall, the effectiveness of underwater image restoration and enhancement using MATLAB image processing depends on the quality of the original image, the specific algorithms used, and the skill of the operator. However, with careful application and optimization, this technique can produce impressive results, allowing us to gain a better understanding of the underwater world and its inhabitants.

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