جامعة جدة
University of Jeddah

Digital Image Processing

UNDERWATER IMAGE ENHANCEMENT

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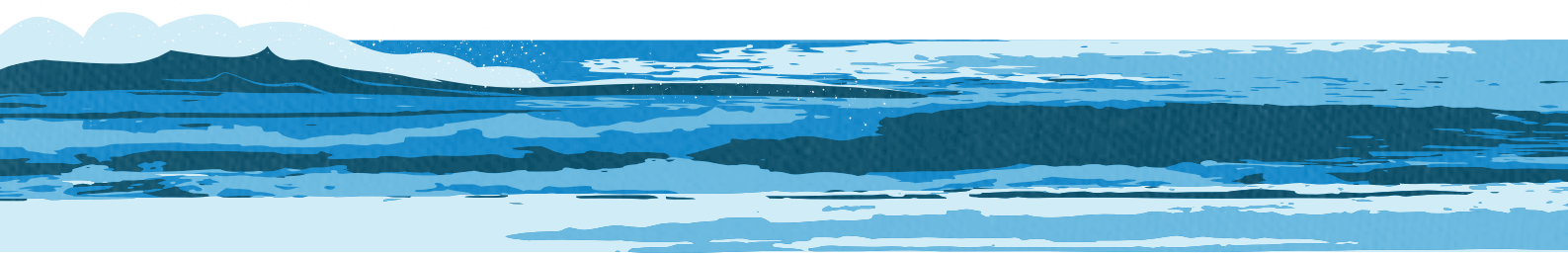

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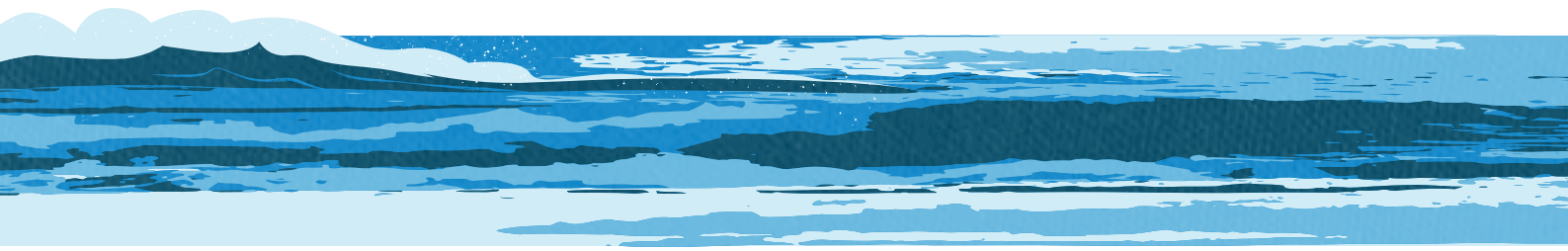
Description of the Problem:-

The earth is aquatic, about 70% of its surface is covered by water. So, underwater images are essential for ocean exploration, deep-sea exploration, and underwater archaeological excavation.
However, researchers often suffer from a severe deterioration in quality due to the scattering, absorption and refraction of light under the water. Even with cutting-edge technology, some blue-green bluish spots remain. This can present an additional challenge for researchers who document sites with coordinates. In addition, this problem increases the difficulty of various tasks such as inspection of infrastructure and cables, biology research plankton detection and archaeology autofish. Advanced image processing can bring sites to life even for those who'll never venture into the water. In this project, we proposed image enhancement and restoration methods for these low-contrast ones that cause noise and limited range visibility.

Project Goal:-

The main objective of our project is to improve underwater images, which used in a wide range of applications, from documenting the health of coral reefs to helping map and explore areas that have never been seen before, by improving the pictorial information for human interpretation, improving image contrast, resolution, and quality, and restoring the original image.



Processing identification:-

Image enhancement

refers to the process of highlighting certain information in an image as well as removing any unnecessary information according to specific needs. For example, in our case, we will eliminate green bullish (eliminate the color cast brought on by underwater light scattering), reveal blurred details, and stretch the contract.

Image enhancement techniques can be divided into two broad categories the one we focused on in our project implementation is:

- Spatial domain: enhancement of the image space that divides an image into uniform pixels according to the spatial coordinates at a particular resolution The spatial domain methods perform operations on pixels directly.

Methodology:-

- **Red and Blue Correction**

Green bullish in images caused by the underwater environment in which red channel lost due to larger wavelength, To solve that we extract individual RGB color channels to make them all have the same mean then correct them by applying white balance and finally recombine them into a single true color image

- **White Balance**

In order to give the images taken underwater a more realistic appearance, the white balancing stage attempts to eliminate the color cast brought on by underwater light scattering. This is accomplished by measuring the intensity of the ambient light and adjusting the values so that they more accurately represent the color white.

- **Histogram equalization**

Histogram equalization entails transforming the intensity values so that the output image's histogram closely matches a specified histogram. Underwater images often contain low contrast, and the application of a histogram equalization can therefore be useful in order to improve the contrast .

- **Gamma Correction**

Gamma correction, which aims at correcting the global contrast, is an important tool for correcting the contrast of underwater images, which are often too bright due to white balance issues For this reason, gamma correction should be used with care, and ideally it should be accompanied by some other kind of contrast correction technique, such as histogram equalization.

- **Image sharpening**

Image sharpening is achieved by generating a second input that corresponds to a sharpened version of the white balanced image. Underwater images often suffer from reduced visibility and details even after gamma correction and white balance techniques are applied. Image sharpening techniques are needed to address these issues.

- **fusion algorithm**

Like in computer vision, image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. In our case, we combined (sharped image and Gamma corrected).

Finding:-

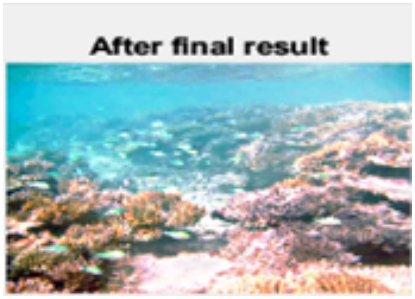

original image


After White balance


After Histogram Equalization


After Gamma correction


After sharpening


After final result

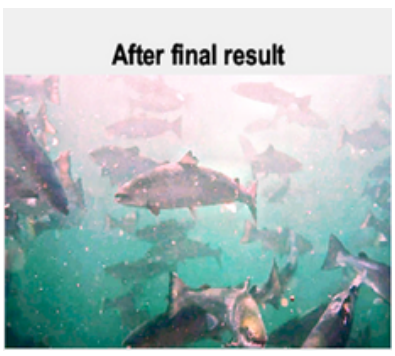

original image


After White balance

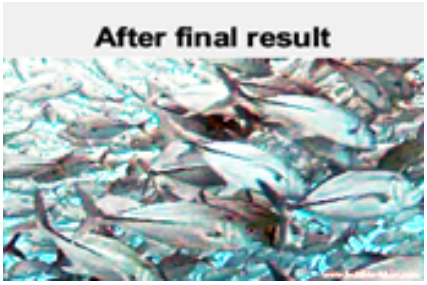

After Histogram Equalization


After Gamma correction


After sharpening


After final result

Finding:-



Comparison:

As the example shows, there is a big difference between the original and final image, which is much clearer and more balanced.

Check the results of 10 different test images in the document attached "test_images".

Analysis and Discussion:

The original images are very hazy, and their colors are unbalanced, leaning heavily toward green tones. After processing, it became presenting with a better color balance.

Conclusion:-

Using the previously mentioned methodology, we were able to improve the clarity of these images, giving us greater access to the underwater environment and its inhabitants and bringing us one step closer to protecting and preserving these remarkable resources for generations to come.

References:-

1- "MATLABDocumentation." MATLABDocumentation, www.mathworks.com/help/matlab/index.html?s_tid=hc_panel. Accessed 5 Feb. 2023.

2-"MATLAB Answers - MATLAB Central." MATLAB Answers - MATLAB Central, www.mathworks.com/matlabcentral/answers/index. Accessed 6 Feb. 2023.

3-Color Balance and Fusion for Underwater Image Enhancement by Codruta O. Ancuti , Cosmin Ancuti, Christophe De Vleeschouwer , and Philippe Bekaert. IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 27, NO. 1, JANUARY 2018[1]