Dark Channel Prior Algorithm for Enhancing Underwater Images

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Abstract- **Images of outdoor scenes typically contain haze, fog, or completely different varieties of half degradation caused by helices inside the part medium absorbing and scattering light-weight as a result of it travels from the provision to the observer. Image obtained at completely different colors and sizes. Finding effective ways that for haze removal is associate ongoing house of interest inside the image method and laptop vision fields. This task is significant in several out of doors applications like remote sensing, intelligent vehicles, underwater imaging and much of extra. Underwater Imaging might be a significant analysis house in ocean engineering. Underwater images are captured from underwater surveys. Exploring, understanding and work underwater activities of images unit gaining importance. But underwater footage has poor visibility and low distinction due to haze. Haze is development that hinders the quality of underwater footage. Haze removal might be a tough and complicated draw back as results of its supported unknown depth information.**

Index Terms-**Image Processing, De-hazing, Visibility Restoration, Light Intensity**

I.INTRODUCTION:

Here, we'll go through a cutting-edge technique for image de-hazing to improve underwater photos. Two of the most significant issues with distortion for underwater images are scattering and colour change. Large suspended particles, such those seen in abundance in turbid water, are what induce scattering. Depending on the degree of attenuation that light travelling in water experiences, colour change or colour distortion results, giving ambient underwater areas a dominant bluish tone. A quick joint trigonometric filtering de-hazing technique and a fresh underwater model to take into consideration attenuation variations throughout the propagation channel are two of our primary contributions. The updated photographs feature lower noise levels, more exposure of the dark areas, and more overall contrast, while the tiniest details and edges are visibly improved.

Underwater imagery may be a necessary tool for analysis in ocean engineering. Underwater haze reduction techniques are becoming very common due to the growing adoption of various vision underwater applications. Under sea video was used to capture images of the undersea world. The enigmatic underwater world is one that scientists are eager to explore. Underwater video, however, has low visibility and contrast because of haze. It's possible that the visibility of underwater footage is decreased by haze, a natural occurrence. Because the results rely so much on depth information that is unknown, the removal of haze could have a significant and burdensome disadvantage. Haze reduces the scene's ability to stand out and makes the colors appear less bright. As a result, removing the haze could be a stylish and difficult effort. A variety of techniques have been created to clear up the haze in underwater footage and enhance image quality.

II. LITERATURE REVIEW:

It was that the main degradation effects can be associated with partial polarization of light .This paper proposed an image recovery algorithm based on a couple of images taken at different orientations with a polarizer .Distance map of the scene was also derived. It resulted into improvement of scene contrast and color correction and underwater visibility range was nearly doubled. The authors given associate underwater image improvement technique mistreatment associate integrated color model. They planned associate approach supported slide stretching: initial, distinction stretching of RGB formula is employed to equalize the color distinction within the pictures. Second, saturation and intensity stretching of HSI is applied to extend verity color and solve the matter of lighting. The blue color part within the image is controlled by the saturation and intensity to form the vary from pale blue to deep blue. The distinction quantitative relation is thus controlled by decreasing or increasing its worth. [1]

Underwater photography often suffers from distortion caused by two main factors: light scattering and color alteration. Light scattering occurs when light interacts with objects underwater, bouncing off waterborne particles multiple times before reaching the camera. This results in reduced visibility and contrast in the captured images. Color changes in underwater photography are primarily due to variations in how different wavelengths of light are absorbed in water, leading to a bluish tint in the photos. Existing techniques for processing underwater images struggle to effectively address both light scattering and color shift distortion, especially when artificial lighting is present. This paper introduces a novel systematic approach to enhance underwater images. It includes a detection algorithm designed to compensate for discrepancies in light attenuation along its path through the water and to account for the potential impact of artificial light sources.[2]

Underwater imaging plays a pivotal role in scientific research, technological advancements, and popular recreational activities. Nevertheless, it grapples with the persistent issue of poor visibility. This paper introduces a novel computer vision approach aimed at alleviating the degradation effects in underwater vision. The study delves into an analysis of the physical phenomena responsible for reduced visibility. It becomes evident that the primary degradation effects are closely tied to the partial polarization of light.

Subsequently, the research paper introduces an algorithm tailored to reverse the image formation process, with the ultimate goal of restoring clear visibility in scene images. This algorithm depends on the collection of multiple images captured through a polarizer at different orientations. Notably, it also produces a distance map of the scene as an auxiliary outcome. Furthermore, the paper delves into an in-depth exploration of the algorithm's susceptibility to noise, offering a comprehensive analysis in this aspect. [3]

De-fogging algorithms are increasingly advantageous for numerous vision applications. A comprehensive literature survey has uncovered several research gaps:

1) Many existing methods have failed to address techniques for mitigating the issue of noise in the output images produced by current fog removal algorithms.
2) There has been limited attention given to the integration of the dark channel prior (DCP) approach in previous research.
3) The issue of uneven lighting, which can significantly hinder the performance of de-hazing algorithms, has often been overlooked by researchers.
4) Remote sensing and underwater imaging have not received as much research focus and effort as other areas in the context of de-fogging algorithms.

III. PROBLEM STATEMENT AND SOLUTION

Problem Statement

Underwater images often experience a range of quality issues, encompassing turbidity, blurring, diminished contrast, and color distortion attributed to light scattering and absorption. While many existing methods primarily address forward and backscatter components, this study uniquely incorporates forward scatter as a significant factor in underwater image degradation. To propose a system this will identify haze and removing the artificial intensity light from Image.

Problem Solution

For many visual applications, haze-removal algorithms become more useful. It is shown that various issues, such as the fact that no technique is accurate in all situations, have been disregarded by the majority of recent investigations. The study highlights a significant oversight in the existing fog removal algorithms, specifically the absence of methods to tackle the problem of noise that can manifest in the output images. Techniques for removing haze are also impacted by the problem of uneven and excessive lighting. Therefore, in order for the enhanced approach to be more effective, the current practices must be changed. The usefulness of haze-removal techniques increases for various visual applications. It is demonstrated that different difficulties have been ignored by the majority of recent investigations, including the fact that no technique is accurate in all circumstances. The approach asserts that there has been a disregard for strategies aimed at mitigating the noise issue that could potentially arise in the output images generated by current fog removal algorithms. The issue of unbalanced and excessive lighting also affects haze removal methods. Therefore, altering current practices is necessary for the upgraded strategy to be more successful.

Objective of Work

a) To implement de-hazing algorithm that will resolve noise issue and haze issue in existing fog removal algorithm using Underwater Image Formation Model effectively
b) To find out the exact quality of image after applying algorithm.
c) Compare both images before and after applying algorithm

IV. PROPOSED SYSTEM:

The goal of restoration is to fix or get rid of noise or other defects that degrade an image. There are numerous different types of degradation, including haze, blurring, noise, missing camera focus, dirt, and scratches. We want to save our old pictures with high quality, but sometimes liquids like water fall and makes it dull or spoils it. So, in that case we need some technique to restore and clear it. In many use cases there is need of clear high-quality image, which is very difficult to achieve. In that case the input image can be restored and clear image given as input to next step.

WORKING MODELS:

Model Architecture

An architecture diagram, often referred to as a system architecture diagram, is a visual representation of the components, relationships, and structures of a system or application. It provides a high-level view of how various parts of a system interact and work together to achieve a specific purpose. Architecture diagrams are commonly used in software engineering, systems design, network architecture, and various other fields to communicate and document the structure and behavior of complex systems.

The model architecture consists of two important steps; one is of removing the degradation and then restoring the image with de-hazed feature details. These two modules are inter-connected with the technique Dark Chanel Prior.

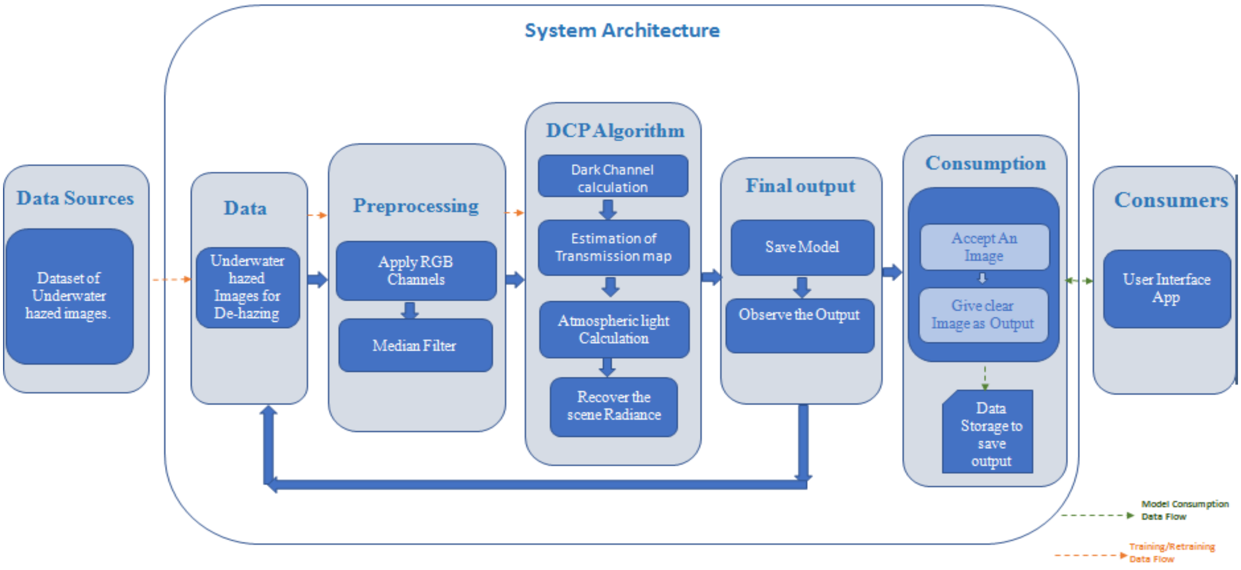


Fig.1 - Architecture of de-hazing model

Segmentated Image

Active contouring is a segmentation technique used to separate objects or regions of interest from an image for further processing and analysis. It employs forces and constraints to delineate contours, which represent the boundaries of the objects within the image. These contours are defined by a set of interpolated points, with the interpolation method being typically linear, spline-based, or polynomial, depending on the curve characteristics within the image.

RGB Channels

In the context of images, various color spaces such as RGB, BGR, HSV, CMYK, etc., can represent different aspects of saturation. However, they all share the concept of channels, which play a crucial role in shaping the image. Channels in this context refer to grayscale representations of the image, with each channel corresponding to a specific color component. Grayscale images consist of a single channel, where each pixel represents the light intensity at that point, typically in shades of gray. Grayscale images should not be confused with black and white images (binary images), where pixels are either black or white, without any gradations in between.

RGB Images: Contrasting grayscale images, RGB images are three-channel images that represent color information using red, green, and blue channels.

Median Filter

The median filter stands as a non-linear image processing technique that enjoys extensive application in the realm of noise removal. Its effectiveness in reducing noise while safeguarding image edges makes it a popular choice, especially for tackling salt and pepper noise. The operational principle involves a sliding "window" or neighborhood pattern traversing the image, pixel by pixel. At each step, the pixel's value is substituted with the median value calculated from the values found within the window.

What sets the median filter apart from an average filter, which substitutes the pixel with the average value, is its utilization of the middle (median) value. This unique approach endows it with robustness against outliers in the image, enhancing its ability to restore image quality.

Dark Channel Prior

In numerous single-image de-hazing techniques, the estimation of the atmospheric light component (denoted as A) is a crucial step. Traditionally, this estimation is based on identifying the haziest and least transparent pixels within the image. Typically, this involves selecting the highest intensity pixels, under the assumption that they represent the atmospheric light. Subsequently, refinements are applied to this initial estimate.

However, in real-world images, the brightest pixels may not necessarily correspond to the atmospheric light; they could instead belong to objects such as white cars or buildings. To mitigate this issue, the dark channel prior method employs a different approach. It identifies the darkest 0.1% of pixels in the dark channel, which is a representation of haze thickness. From these pixels, the one with the highest intensity in the original input image is chosen as the estimate for the atmospheric light component we have:

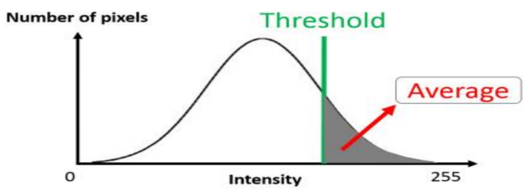
$$J^{dark}(\mathbf{x}) = \min_{c\in\{r,g,b\}} \left(\min_{\mathbf{y}\in\Omega(\mathbf{x})} (J^c(\mathbf{y})) \right),$$

Where Jc may be a color channel of J and Ω(x) may be a native patch targeted at x. Our observation says that apart from the sky region, the intensity of J dark is low and tends to be zero, if J may be a haze-free out of doors image. We tend to decision J dark the dark channel of J,

Transmission Estimate

In many single-image de-hazing approaches, the atmospheric light component (A) is estimated from the most opaque region in the image, typically the region with the highest intensity. This estimate is further refined during processing. However, in real-world images, the brightest region might not correspond to the atmospheric light but could be due to objects like white cars or buildings. To overcome this, the dark channel of a hazy image provides a good approximation of haze density. The method selects the top 0.1% brightest pixels in the dark channel, which represent the most opaque haze regions. Among these pixels, the one with the highest intensity in the input image is chosen as the atmospheric light component. This approach assumes that the color of the sky is very similar to the atmospheric light component in a hazy image. The color of the sky is sometimes terribly almost like the region lightweight A in a very haze image and that we have:

$$\min_c\left(\min_{\mathbf{y}\in\Omega(\mathbf{x})}\left(\frac{I^c(\mathbf{y})}{A^c}\right)\right)\rightarrow 1, \text{ and } \tilde{t}(\mathbf{x})\rightarrow 0,$$



Recovering the scene radiance

The recovery of scene radiance using the transmission map relies on a particular equation. However, when both the direct attenuation term, denoted as J(x) t(x), and the transmission t(x) are extremely close to zero, the directly estimated scene radiance, J, can become sensitive to noise. To address this potential problem, a constraint is introduced on the transmission term, t(x), ensuring it doesn't fall below a specified lower bound, denoted as t0. This constraint serves the purpose of retaining a small amount of haze in regions with high levels of haze. Consequently, this constraint enhances the robustness of the de-hazing process, particularly when dealing with challenging conditions.

V. RESULTS AND DISCUSSION:

The exchange of information between an information processing system and the outside world is known as input/output. The system's inputs are the data it receives, and data sent from it is its outputs. Followings are the some of the sample input and output. Front Page with Sample Input and Output – The front-page UI interface is as shown in figure below. It allows the user to upload the degraded image using “Upload Image” button. Once the user clicks on it, the file explorer window appears. The user is allowed to navigate and select the input image file. Once the image is uploaded, user clicks on it image processing button it processed given image and converted into RGB channels. After that median filter technique is used to remove noise. Haze Remove button is used for remove haze from the image. The created output is displayed on the screen for the user in the option of final output image.

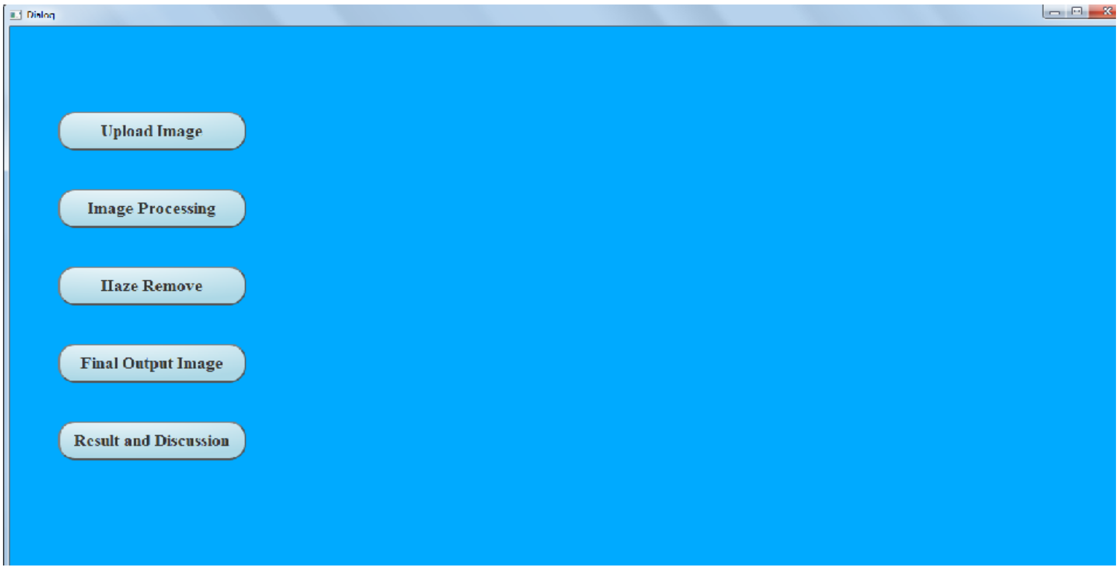
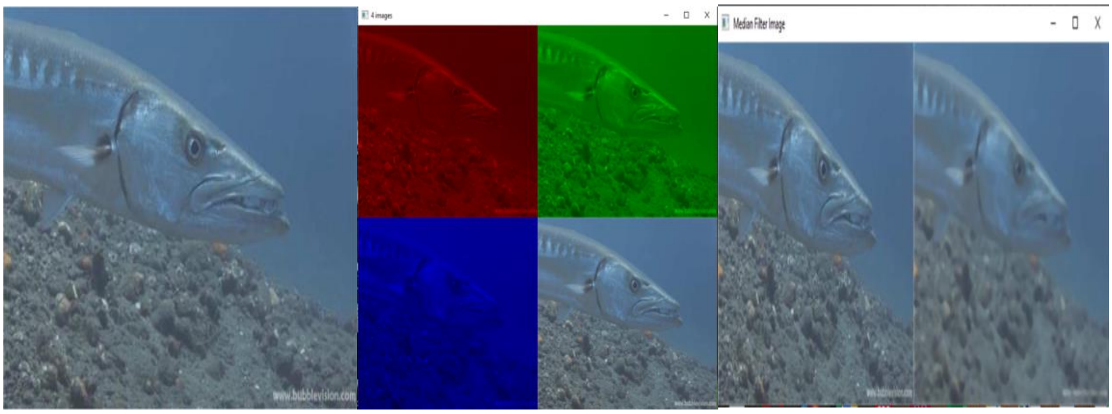
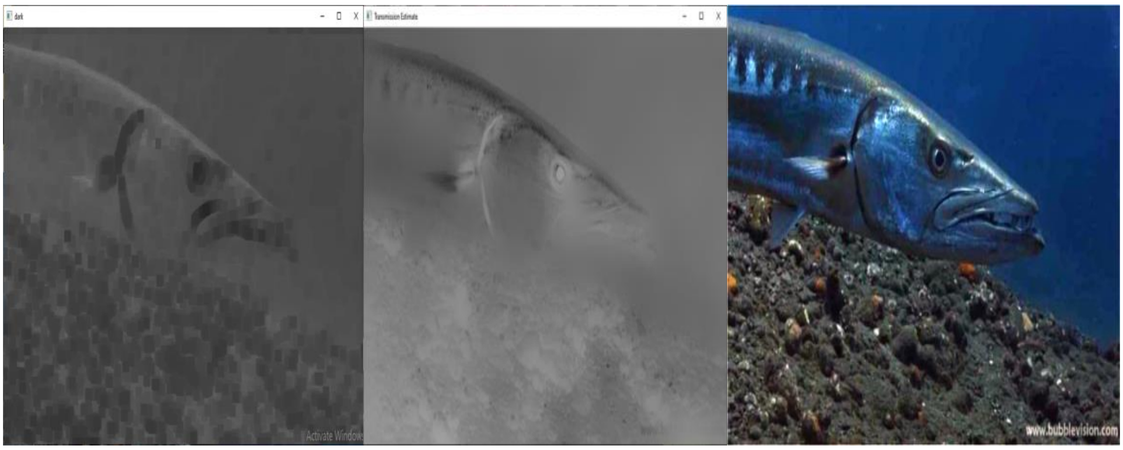


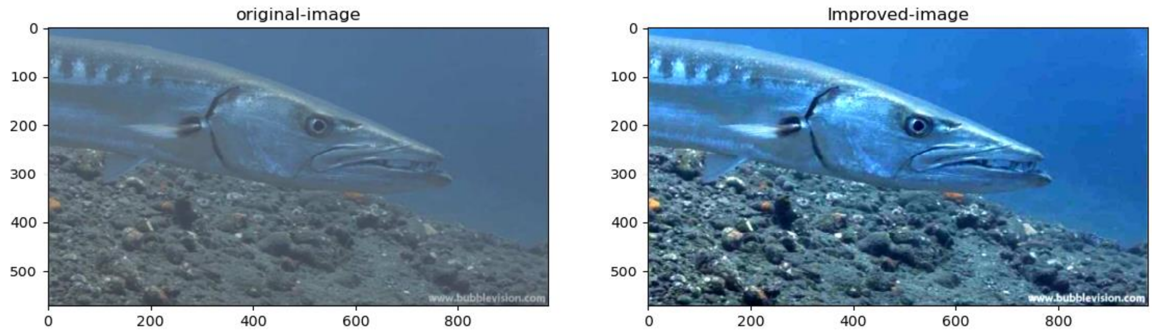
Fig.1 – The front-page UI interface



(a) (b) (c)



(d) (e) (f)



(g)
Fig. 2 – (a) An Input Image (b) RGB Channel Image (c) Median Filter Image (d) Dark Channel Prior (e) Transmission Estimate (f) Haze Remove (g) Final output Image

Evaluate the Model

There the input is compared with actual output. However, in the image restoration the generated output should be as real as possible. The created model is evaluated with the MSE, PSNR and SSIM metrics using the test dataset.

1) Mean squared error (MSE) –

The MSE is a metric used to quantify the level of error in statistical models. It assesses the average of the squared differences between the original image and the enhanced image. When the model's predictions are completely accurate, the MSE is zero. As the error in the model's predictions grows, the value of MSE increases. Another term for the mean squared error is the mean squared deviation (MSD). Following equation is used for calculating MSE.

$$MSE = \frac{1}{N}\sum_{i=1}^{N}(Y_i - \hat{Y}_i)^2$$

2) Peak Signal-to-Noise Ratio (PSNR) –

The PSNR is a metric that gauges the extent to which noise can impact the quality of an image's representation when compared to the maximum achievable power for that image. To calculate the PSNR effectively, it's crucial to compare the image in question to a pristine, noise-free image that possesses the highest possible power level. Following equation is used for calculating PSNR.

$$PSNR = 10 \log_{10}\left(\frac{MAX_I^2}{MSE}\right)$$

3) Structural Similarity Index Measure (SSIM) –

The SSIM is a statistical metric employed to evaluate the degree of similarity between two given images. This system computes the Structural Similarity Index, which falls within a range of -1 to +1 when assessing two provided photos. A score of +1 signifies a high level of similarity or identity between the two images, while a value of -1 indicates a significant contrast between them. Often, these values are adjusted to fit within the range [0, 1], where both extremes hold the same meaning. Following equation is used for calculating SSIM.

$$\text{SSIM}(x, y) = \frac{(2\mu_x\mu_y + c_1)(2\sigma_{xy} + c_2)}{(\mu_x^2 + \mu_y^2 + c_1)(\sigma_x^2 + \sigma_y^2 + c_2)}$$

The following Fig. 3 – Performance indicator values and Fig. 4 – Performance indicator bar represent the PSNR, MSE and SSIM parameter to quantify the performance of our above provided image.

Fig. 3 – Performance indicator values

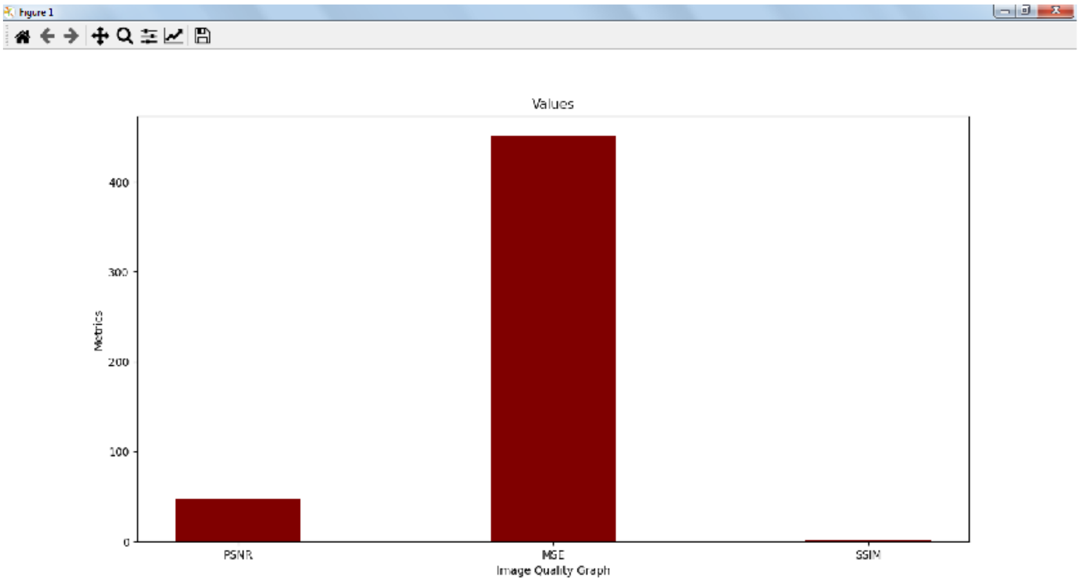


Fig. 4 – Performance indicator bar

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CONCLUSION:

The discipline of image processing known as underwater imaging is a vibrant one. New methods and applications for improving underwater photographs are regularly reported in the development of new products. Here, we provide an improved technique for underwater picture de-hazing that operates on underwater photos, eliminates artificial lighting, and maintains image quality. In our suggested method, we focused on adding the de-hazed frame to the input underwater image for enhanced underwater image quality.

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