UNDERWATER IMAGE ENHANCEMENT USING COLOR BALANCE AND FUSION

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ABSTRACT

Underwater images when captured for different applications and analysis, they are degraded in quality and visual parameter; also there is sometimes information loss. Here the paper presents the methodology to improve the quality of underwater images which has been degraded due different distortions like noise, light, motion blur, scattering, waves of water, color change etc. The first approach is to implement white balance for reducing color cast efficiently and Enhancing the underwater images called mixture Contrast Limited Adaptive Histogram Equalization (CLAHE) color model. The RGB and HSV colour models are operated on using CLAHE, and the Euclidean norm is utilised to merge the two results. The combined results outperform alternative underwater picture enhancement techniques in terms of peak signal to noise ratio (PSNR) and mean square error (MSE).. It suggests that the projected technique is able to classifying coral reefs in particular while visible cues are visible. Finally the weights which are one of the ways where we restore specific required information in image for better image fusion results. After fused to overall enhance the underwater image quality thus making it more informative.

Keywords- **CLAHE, HSV, PSNR, MSE.**

INTRODUCTION

It is difficult to reconstruct an underwater item from a series of photos that have been warped by the waves of moving water. Due to the quality of the images that are acquired, underwater image processing is required. This image has blurring, distortion, and quality degradation. Waves on the surface distort images taken of underwater objects from outside the water container. Different distortions will be visible in each image if a series of photographs are taken at distinct times.Refraction causes the image captured by the camera to be warped as a result of both the amplitude of the water waves and the angle of the water surface normal at the point of refraction. There won't be any refractional distortion if the water is totally flat (i.e., there are no waves). Although, if the surface of the water is being disturbed by waves, the nature of the image distortion becomes considerably more complex. Ocean exploration and other sectors frequently use underwater imaging; nevertheless, because of environmental absorption and scattering effects, underwater images suffer substantial deterioration, primarily in the form of noise, blur, etc. The task of reconstructing an underwater image is difficult. Images taken underwater could be distorted. Both motion blur and refraction have the potential to cause distortion. Additionally, it has some quality degradation, making it necessary to raise visual quality. The quality of the photographs may be improved by reconstructing them from noisy and blurry images. It is difficult to recover the item from such distorted photos.

IMAGE

A set of square pixels (picture elements) organised in columns and rows is called an image.. An image (from Latin: imago) is an artifact, for example a two-dimensional picture, that has a similar appearance to some subject usually a physical object or a person.

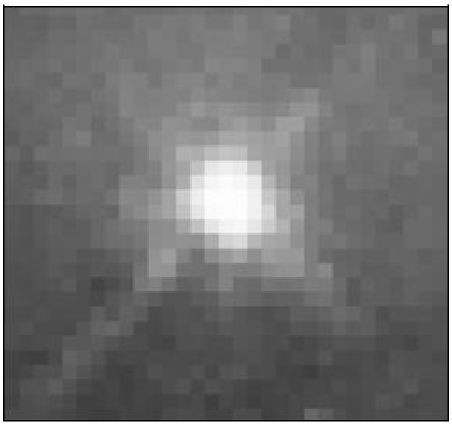

Figure : An image – an array or a matrix of pixels arranged in columns and rows

IMAGE PROCESSING

Any signal processing that involves the input of an image, such as a picture or video frame, and produces either an image or a set of parameters or characteristics connected to the image is known as image processing. The majority of image-processing methods take the image as a dimensional signal and then subject it to common signal-processing methods.Although optical and analogue image processing are also feasible, digital image processing is the most common type. This article discusses universal strategies that work for all of them. Imaging refers to the process of acquiring images (creating the input image in the first place).Using image processing, one can highlight visual elements of relevance while reducing detail not essential to the purpose at hand.An image is digitalized so that it can be saved in a computer's memory or on a storage medium like a CD-ROM or hard drive. A scanner or a video camera attached to a frame grabber board in a computer can do this digitisation process. After being digitised, an image can next be subjected to a variety of image processing techniques. The three main categories of image processing activities are image compression, image enhancement and restoration, and measurement extraction. Most people are familiar with image compression. It involves lowering the memory requirement for digital image storage. Image enhancement techniques can be used to fix image flaws that may have resulted from the digitization process or from errors in the imaging setup (for example, poor lighting). The Measurement Extraction techniques can be used to extract relevant information from the image after it is in good quality.

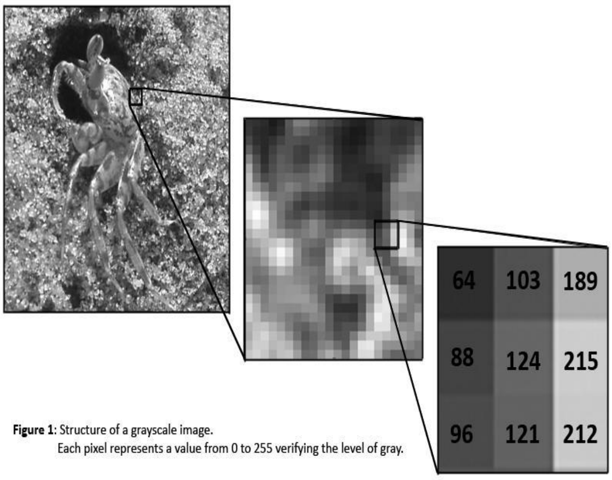

Figure : Structure of grey-scale image

The example in figure operate on 256 gray-scale images. This means that each pixel in the image is stored as a number between 0 to 255, where 0 represents a black pixel, 255 represents a white pixel and values in-between represent shades of gray.

In figure each pixel represents a value from 0 to 255 verifying the level of gray. These operations can be extended to colour images too.

Figure: A greyscale image

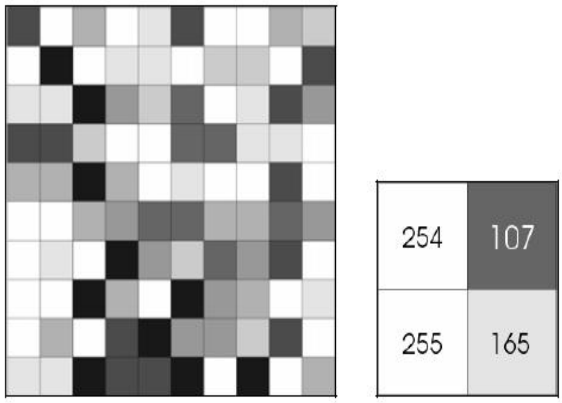

Figure: Different shades of grey

A normal greyscale image has 8 bit colour depth = 256 greyscales

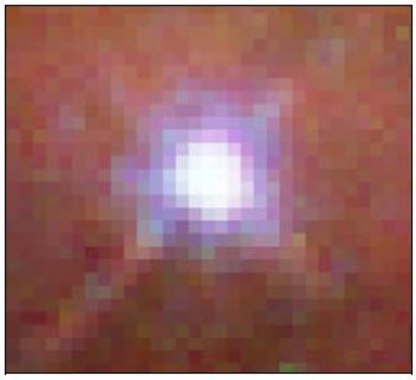

Figure: Colour image

A “true colour” image has 24 bit colour depth = 8 x 8 x 8 bits = 256 x 256 x 256 colours = ~16 million colours.

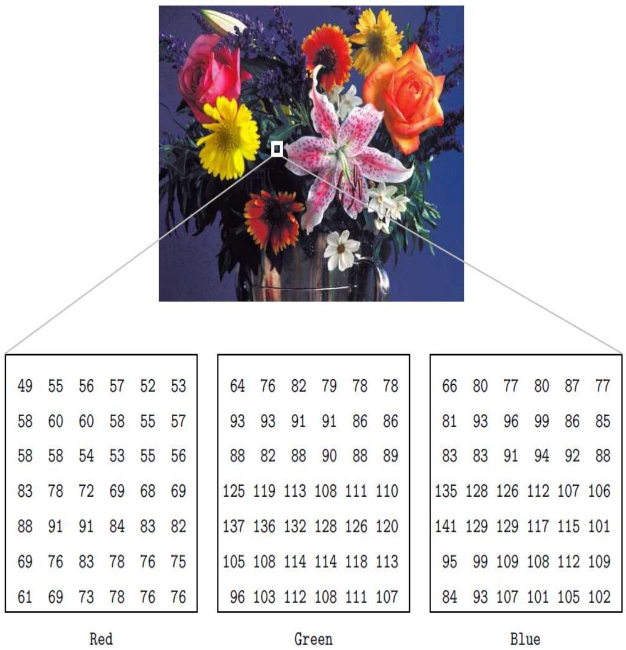

Figure: A true colour image

IMAGE ENHANCEMENT

Image augmentation is the process of enhancing the quality of digital images (desired, for example, for visual inspection or machine analysis), without being aware of the cause of the degradation. One refers to the procedure as image restoration if the cause of the degradation is recognised. The input and output of both processes are images, making them both iconical. Images can be improved in various ways using a variety of techniques, many of which are simple and heuristic. Of course, the issue is poorly defined because there is no measurable standard for image quality. In this article, we go over a few recipes that have proven to be helpful for both human and/or machine identification. These approaches are particularly problem-focused; a strategy that succeeds in one situation could fail miserably in another. To accommodate for flaws in the acquisition system, early grey level changes in addition to geometric transformations may be suggested. By calibrating with the output of a picture with a constant brightness, this can be done pixel by pixel. For contrast stretching, range compression, etc., space-invariant grey value transformations are also frequently used. The grey value histogram, which represents the relative frequency of each grey value, is the crucial distribution. Digital photographs, classic photochemical photographs, illustrations, and all other types of images can be edited in many ways. Photo retouching, the process of altering images with tools like an airbrush, or modifying illustrations using any conventional artistic medium, are examples of traditional analogue image editing. Generally speaking, raster graphics editors, vector graphics editors, and other types of graphic software.

SCOPE OF THE PROJECT

We have suggested an alternative method for improving underwater image quality. The single original image is all that is needed for our method, which is based on the fusion principle. The fundamental benefit is that our method can accurately enhance a variety of underwater photographs (from various cameras, depths, and lighting situations), recovering key faded edges and details. Additionally, the usefulness and applicability of the suggested picture enhancement method for a number of difficult underwater computer vision applications.

LITERATURE REVIEW

1. Michele Ruta, Floriano Scioscia, Giuseppe Loseto, Eugenio Di Sciascio presented restoration of underwater Images by fusion method. In the paper they presented novel strategy which enhances the visibility of underwater images effectively. They have focused on image fusion which is contributed by different weight map images. The algorithm consists of different inputs mainly computed from minmax enhanced and white balanced of input distorted image[1].

2. Liming Chen; Chris Nugent, George Okeyo presented novel strategy to enhance underwater images and videos by fusion. Their approach was first to decrease the temporal coherent noise from the image. They have also defined different weight map for videos as Laplacian contrast weight, Local contrast Weight, Saliency weight, exposed weight. Then fused image is obtained by fusion of input image with the weights[2].

3. Multi sensor image fusion technique for reconstruction of images, wavelet based image fusion technique was used to get improvement in resolution of images[3].

4. It has compared different image fusion techniques with PSNR peak signal to noise ratio, EN entropy, and MSE mean squared error. Thus image fusion using wavelet transform gives better results as compared to other methods. Review results that spatial domain provide high spatial resolution, But spatial domain has image blurring problem. Wavelet transform is a very good technique for image fusion which provides high quality spectral content[4].

EXISTING SYSTEM

Many attempts have been made to improve the visibility of such damaged photographs. Histogram equalization appears to be severely constrained for such a work since the degradation of underwater scenes originates from the combination of multiplicative and additive processes, which make gamma correction and other classic enhancing strategies ineffective.

DISADVANTAGES

- Existing system having number of issues that reduce their practical applicability.
- It cannot reduce color cost efficiently.

PROPOSED SYSTEM

- In proposed system we use 3 approach. firstly, to implement white balance for reducing color cast efficiently and Enhancing the underwater images called mixture Contrast Limited Adaptive Histogram Equalization (CLAHE) color model.
- The method operates Contrast Limited Adaptive Histogram Equalization on RGB and HSV color model and Euclidean norm is used to combine both results together.
- The combined results show less mean square error and high peak signal to noise ratio(PSNR) then other methods of under water image enhancing. It shows that the projected method is capable of classifying coral reefs particularly when visual cues are visible.
- Finally the weights which are one of the ways where we restore specific required information in image for better image fusion results. After fused to overall enhance the underwater image quality thus making it more informative.

BLOCK DIAGRAM

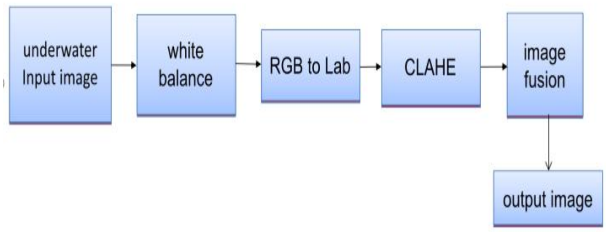

Figure: Block Diagram of Underwater Image Enhancement and Fusion

FLOW DIAGRAM DESCRIPTION

In proposed system we use 3 approach. firstly, to implement white balance for reducing color cast efficiently and Enhancing the underwater images called mixture Contrast Limited Adaptive Histogram Equalization (CLAHE) color model. The method operates Contrast Limited Adaptive Histogram Equalization on RGB and Lab color model and Euclidean norm is used to combine both results together. The combined results show less mean square error and high peak signal to noise ratio(PSNR) then other methods of under water image enhancing. It shows that the projected method is capable of classifying coral reefs particularly when visual cues are visible . Finally the weights which are one of the ways where we restore specific required information in image for better image fusion results. After fused to overall enhance the underwater image quality thus making it more informative.

BLOCK EXPLANATION

WHITE BALANCE

In order for objects that are white in person to appear white in your photograph, white balance (WB) is the process of removing artificial colour casts. The "colour temperature" of a light source, which describes the relative warmth or coolness of white light, must be taken into account for proper camera white balance.nWhen preprocessing distorted underwater photographs for restoration, we balance the white content and boost the contrast..

- This white balance technique focuses on restoring colours that have been damaged by white light that has travelled through water. Underwater photographs typically have a greenish-blue tint as a result of wave scattering as depth increases. Waves with a higher wavelength are absorbed first. Red will so absorb first, followed by other colours. The amount of colour loss varies with the observer-to-plane separation. There are two parts in this process: first, adjust the red channel, then use the Gray-World Algorithm to determine the white-balanced image.
- Four observations are used to calculate the red channel compensation. Red channels degrade quickest when they are exposed to water, however green channels are almost safe due to their lower wavelengths than red channels. Compensating In order to restore the red channel and bring back the underwater photos' natural appearance, make up for the red channel's loss by restoring a portion of the green channel to the red channel.

- The mean values of the green channel and red channel are used to compensate for the red channel using the green channel. To have a balanced output, the difference between the mean values of the green channel and the mean value of the red channel must be proportionate.

- In order to stop the red channel from degrading during the Grey World step, apply red channel compensation first to the small red channel pixel values. In situations where the red channel information is already considerable, the green channel pixel information will not be transferred to the red channel. Therefore, avoid having reddish areas appear over locations that the Grey World algorithm has exposed. Red channels that have suffered severe deterioration will be compensated, whereas red channels that have suffered less degradation and are closer to the observer do not require compensation.

- Mathematically express the above observations, the compensated red channel Irc at every pixel location () as follows:
  Irc()= Ir()+.(g r).(1 Ir()).Ig(),

Where Ir and Ig are the channels for the red and green colours in Image I, respectively, and r and g stand for the mean values of Ir and Ig in the range [0, 1], respectively. Each factor in Equation 4's second term originates from one of the aforementioned four observations and signifies a constant parameter, which typically has the value of 1 for various acquisition settings and lighting circumstances.

- When blue channel is highly degraded and the if restoration of the red channel results to be insufcient, also restore the blue channel degradation, i.e. the compensated blue channel Ibc is computed as:
  Ibc()= Ib()+.(g b).(1 Ib()).Ig(),

Where, Ib and Ig is the channels of blue color and green color of image I, and is set to the value one. Rests of the results are formulated based on the red color compensation (optionally the blue color). Using assumption of Gray-World algorithm to calculate and restore the illuminant color cast.

- Despite this, white balance is crucial to recover the colours that light via water attenuates. When it comes to edges and overcoming the dehazing challenge brought on by scattering effects, this is insufficient. In order to eliminate the haziness of the white-balanced image, an effective fusion based on CLAHE, gamma correction, and sharpening was introduced.

CLAHE

The CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION (CLAHE) colour model is used to enhance underwater photographs. The RGB and HSV colour models are processed using Contrast Limited Adaptive Histogram Equalization, and the Euclidean norm is used to integrate the two results. The combined results outperform alternative underwater picture enhancement techniques in terms of mean square error and peak signal to noise ratio (PSNR). It demonstrates that the proposed technique can categorize coral reefs, especially when visual signals are present. The visibility level of a foggy image is improved using contrast limited adaptive histogram equalization (CLAHE). Adaptive histogram equalization (AHE) differs from standard histogram equalization in that it employs a number of methods, each of which corresponds to a different portion of the image, to redistribute the image's lightness value. In contrast, CLAHE uses a distribution parameter to define the shape of the histogram, which results in higher-quality results than adaptive histogram equalization (AHE). The ray-leigh distribution parameter is utilized in this approach to produce bell-shaped histograms. The disadvantage of AHE is that it only works in homogeneous fog, whereas CLAHE uses a single image and video system and can be applied to both homogeneous and heterogeneous fog. The 'cumulation function' that is used in AHE is its second flaw.

ADVANTAGES

- high accuracy
- CLAHE able to recover important faded features and edges.

IMAGE FUSION

Gathering all the crucial data from various photos and combining it into fewer, typically single, images is known as the image fusion process. This one image has all the relevant information and is more accurate and informative than any image from a single source. Image fusion aims to create images that are more relevant and intelligible for both human and machine perception, in addition to reducing the amount of data. Multi-sensor image fusion in computer vision is the technique of fusing pertinent data from two or more pictures into one image. The final picture will have more information than any of the source pictures. Different image fusion techniques are motivated by the expanding availability of space-borne sensors in distant sensing applications. A single image must have both high spatial and high spectral resolution in a number of image processing scenarios. The majority of the equipment on the market is unable to deliver such data credibly. The integration of many information sources is made possible by image fusion techniques. Complementary spectral and spatial resolution qualities may be present in the merged image. The spectrum information of the multispectral data, however, can be distorted during the merging process by using traditional picture fusion algorithms. Image fusion creates a single image from two or more registered photographs of the same object that is simpler to understand than any of the originals. Creating new images that are better suited for human visual perception is the aim of image fusion, particularly in medical imaging. Taking the average of the two input photos is the simplest image fusion approach. When used directly, this reduces the contrast between features. Laplacian pyramid-based picture fusion is an alternative to this method, although it comes with the expense of adding blocking artefacts. Based on the WT, better fusion results were obtained.

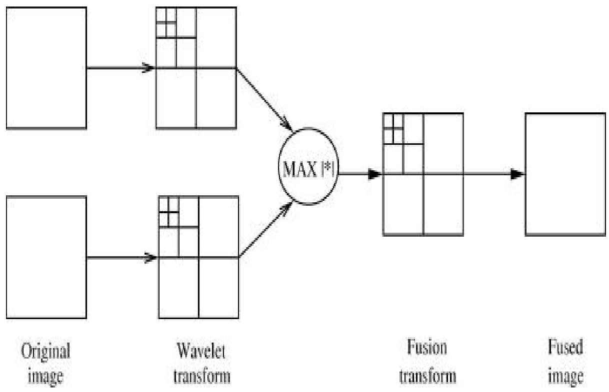

Figure: Image Fusion

The processes are as follows:

(1) Calculating WT for each image.
(2) Choosing the coefficients with the highest absolute value at each place.
(3) Calculating the inverse WT for the new image. As is widely known, the conspicuous characteristics are represented at various scales by the larger absolute value transform coefficients, which reflect greater brightness shifts.

RESULT

INPUT IMAGE

Figure: Input hazy image

Figure: Result of Underwater Image Enhancement with Clear Image

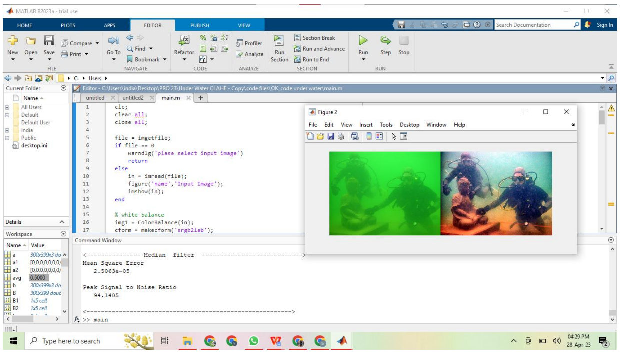

Figure: Result of Underwater Image Enhancement in Matlab

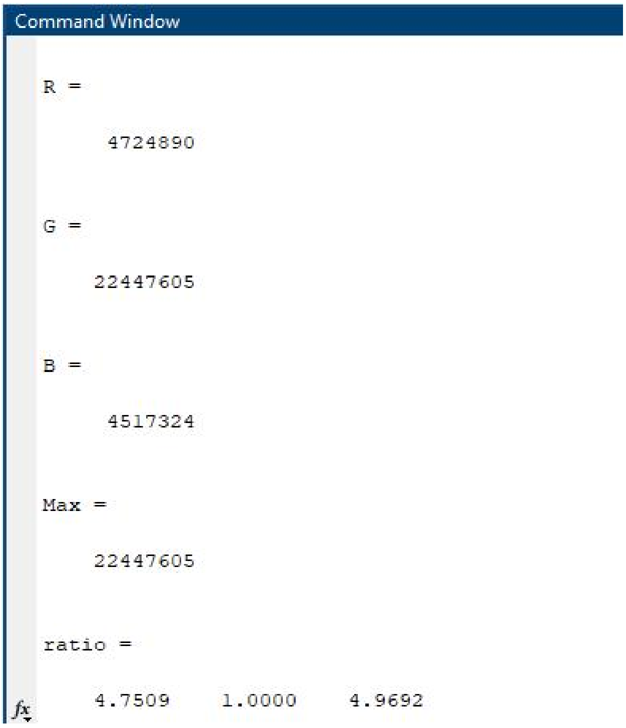

Figure: R G B Values of the Image

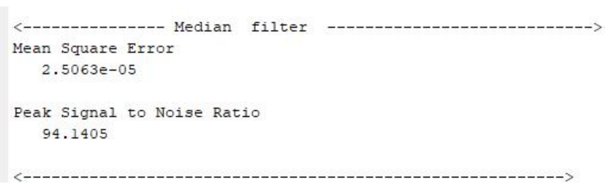

Figure: MSE and PSNR Values of the Image

APPLICATIONS

Nearly every field of research and technology can apply image processing techniques, which have a wide range of applications. Here is a brief selection of a few image processing software to give you an idea of the variety available.

1. **Health**
Examination and interpretation of X-ray, MRI, or CAT scan pictures, cell image analysis, and chromosome karyotype analysis.

2. **Agriculture**
Satellite/aerial views of the land, such as to estimate the amount of land used for various activities or to research the appropriateness of various regions for various crops, inspection of fruit and vegetables—distinguishing fresh from stale produce.

3. **Business**
examination of paper samples, automatic examination of goods on a production line.

4. **Law enforcement**
speed camera picture sharpening or deblurring, fingerprint analysis.

FUTURE SCOPE

The future scope of smart farming is vast and promising. Here are some potential areas for growth and innovation,

AI and machine learning: Smart farming systems can use AI and machine learning algorithms to analyze data from sensors and cameras to make real-time decisions about planting, harvesting, and other farming operations.

Precision agriculture: Precision agriculture techniques, such as the use of drones and precision irrigation systems, can help farmers optimize crop yields and reduce waste.

Sustainable farming: Smart farming systems can help farmers implement sustainable farming practices, such as reducing water usage, improving soil health, and reducing pesticide usage.

Blockchain technology: Blockchain technology can help farmers track the origin and quality of their crops, making it easier to sell their produce in global markets.

Predictive analytics: Predictive analytics can help farmers anticipate weather patterns, pests, and other potential risks, enabling them to make informed decisions about planting and harvesting.

Robotics: Robotic systems can help farmers automate many aspects of their operations, such as planting, harvesting, and fertilizing.

Urban farming: With the global population projected to reach 9 billion by 2050, there is an increasing need for sustainable food production in urban areas. Smart farming can enable urban farming by using vertical farming techniques, hydroponic systems, and other innovative solutions.

Overall, the future of smart farming looks bright, with endless possibilities for innovation and growth. As technology continues to evolve, farmers will have access to new tools and techniques that can help them improve efficiency, reduce waste, and increase profitability.

CONCLUSION

Due to radiation and light absorption, visibility is poor underwater. These issues lead to underwater photographs having poor contrast and resolution. In this study, a differential evolution algorithm-based contrast enhancement technique for underwater picture enhancement has been developed. The suggested method seeks to increase the contrast of each RGB component of an underwater image, where the contrast limits are set using a distinct methodology. The suggested strategy is applied to a variety of underwater photographs, and based on the outcomes, it can be concluded that the method significantly increases the visibility of underwater images.

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