International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Underwater Image Enhancement Techniques

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Doi: https://doi.org/10.55248/gengpi.5.0424.1129

ABSTRACT :

In recent years, researchers used to enhance water image innovation. Then, getting an enhancement of underwater images is not a possible thing. This is a challenging task, which is gaining priority since the human eye cannot perceive images underwater. The most important details underwater are not captured. We are using conventional image acquisition techniques, and also they are expensive. Therefore, even in the absence of expensive and trustworthy acquisition techniques, the quality of the image processing algorithms can be improved. Given these photos, which vary in terms of fuzziness and colour variation, traditional algorithms have some limitations. We proposed the Generative Adversarial Network (GAN) techniques. In the proposed model, advancement used a deep learning model for underwater image enhancement. First, we get the original image pre-processed by the convolutional neural network for color correction and the contrast of the image is improved technique. The pre-processed image is then sent to the MIRNet for further processing. A deep learning system called MIRNet can be applied to improve low-light photos. The enhancement water techniques involved for the convolutional neural network with more accuracy than the other technique.

Keywords— Image enhancement, Generative Adversarial Network (GAN), deep learning model.

Introduction:

The technique of processing an input image to make it more suitable and readable for a given application is known as image enhancement. Image enhancement modifies the image's visual impression on the viewer while also improving the image's information content. Image enhancement intensifies the features of images. It accentuates the image features like edges, contrast to build display of photographs more useful for examination and study. To enhance photos and create a visually striking image, apply the qualitative objective approach. Image enhancement includes many operations such as contrast stretching, noise clipping, pseudocoloring, noise filtering etc to improve the view of images. Enhancement increases the active range of the selected visual features, making them easier to identify. Current study indicates that the nature of light causes underwater photographs to have low quality. Since water is a denser material than air, light entering it is refracted, absorbed, and scattered, causing a decrease in light quantity as it moves from air to water and scattering in various directions. Light is blurred and colour contrast is diminished as a result of scattering. In addition to the natural water, the presence of creatures and other materials in the water also contributes to the impact of water on underwater photos. To a variable extent, light with various blue, green, and red wavelengths will find their way into water [2]. Figure 1 is an illustration of how light is absorbed by water. Every 10 metres added to depth will result in a half reduction in sunlight brightness. Almost all red colored light is decrease to 50% from the surface but blue continues to great deep in the ocean because blue color have the shortest wavelength and therefore in the water, it travels the furthest. That is why most of the underwater images are subjected to blue and green color.

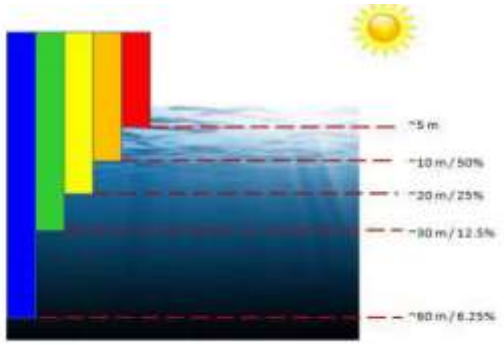


Fig 1: Light Absorbed Water

OBJECTIVE:

Regaining the quality that has been lost as a result of scatters and aggregation in the underwater environment is the main goal of underwater image improvement. These images suffer from strong absorption, low contrast, noise, and poor visibility. Therefore, improvement is necessary to prevent the aforementioned issues with the underwater photos.

SYSTEM ANALYSIS:

Proposed System

Numerous improvement strategies have been developed to address these problems and increase the quality of underwater images (highlight significant detail and visibility). This study surveys the literature on different underwater picture enhancement methods and suggests a cause for the deterioration of underwater photos. Subsequently, a detailed comparison of different image enhancement approaches is provided. Lastly, an underwater image enhancement technique is outlined and recommendations for further research are provided.

Advantage

- Image enhancement modifies the visual and highlights the edges of the deep underwater image to increase the image's information content.
- A variety of methods utilise image fusion to obtain an improved image by taking advantage of the existence of many images.
- To enhance contrast performance in underwater image processing, contrast enhancement technique is extensively utilised.

EXISTING SYSTEM

For many computer vision applications there are useful algorithms on fog removal. As per literature survey here we found that many of the existing researchers have not focused on many issues related. Research gaps given below:

- The existing methods have avoided the techniques to reduce the issue of noise is seen in the output images of the existing algorithms of haze removal.
- Much effort has not taken the dark channel prior (DCP)
- The researchers also don't take into account the issue of the uneven brightness. It makes haze removal algorithms function less well.
- (d) The water images are not given more attention.

Disadvantage

- The two main issues with underwater photographs are low visibility and poor colour contrast.
- Scattering lessens the contrast between colours and blurs light.
- These images suffer from severe degradation in the form of low resolution, color cast, color scatter, crinkle pattern, uneven light distribution.

METHODOLOGY AND DATASET

In this project, there are different techniques for underwater image enhancement.

1.Contrast Stretching

By `stretching' the series of intensity values, contrast stretching is a simple image enhancement technique that improves and enhances image contrast. A measure of image's dynamic range or the "broaden" of image's histogram is the contrast of an image. Whole range of intensity values present within the image, or in a easier way, the minimum pixel value subtracted from the maximum pixel value is called dynamic range of image. It is different from the more intricate histogram equalisation in that it is limited to a linear scaling function to the values of the image's pixels.

2. Empirical Mode Decomposition

Based on the local moment period function, EMD is a flexible tool. It is therefore appropriate for nonlinear and non-stationary data, making it a highly skilled potential for real-world software. The EMD method is rather straightforward. The basic process involves sifting the new data sets through sifter operations until the final data series are stationary. The signal is then broken down into multiple intrinsic mode functions (IMFs) and residue. The Red, Green, and Blue channels are each independently connected to the EMD. The EMD method breaks the original image into many intrinsic mode functions and a final residue.

3. Homomorphic filtering

The homomorphic filtering is utilized to fix non-uniform lighting to reinforce contrast from the impression. This is a frequency filtering technique. It is the most utilized system on the grounds that it redresses non-uniform lighting and sharpens the picture.

$$F(x, y) = I(x, y)^{*}r(x, y)$$

Where F(x, y) is the function of image detected by device, I(x, y) the illumination function and r(x, y) the reflectance function [12]. By multiplying these components filter can reduce the non-uniform illumination present in the image.

4. Anisotropic filtering

To improve picture division, anisotropic filtering de-tangles image components. This channel smoothes the picture in homogeneous range however conserve edges and upgrades them. It is utilized to smooth compositions and diminishes relics by erasing little edges enhanced by homomorphic filtering.

5. Wavelet denoising by average filter

Wavelet denoising is used to stifle the noise i.e. the Gaussian noise are normally present in the camera pictures and other kind of instrument pictures. Gaussian noise can be included when rearranging the photos. This wavelet denoising gives great results contrasted with other denoising routines because, unlike other methods, it does not assume that the coefficients are independent. Undoubtedly wavelet coefficients in normal pictures have enormous conditions. Besides the reckoning time is short.

6. Red channel method

As would be predicted for underwater photos, this technique recovers colours linked to short wavelengths, which restores lost contrast [10].
The first thing in this method to estimate is the color of the water. Pick a pixel that lies at the maximum depth with respect to the camera. It is assumed that degradation of image depend upon location of pixel. Following an estimation of the scene's water light transmission. Colour correction is then carried out.

7. Histogram equalization

Histogram equalization is a method for modifying image intensities and contrast of image in image processing using the image's histogram. Photographs with bright or dim frontal portions and backgrounds benefit from the application of histogram equalisation. This is a simple and straightforward technique. But it has a disadvantage also that is it also amplifies the background noise present in the image and lead to decrease in the useful signal. So it produces unrealistic effects in the output images. This method's fundamental principle is to map the grey levels based on the input grey levels' probability distribution.

8. Contrast Limited Adaptive Histogram Equalization (CLAHE)

It is generalization of adaptive histogram equalization. This method divides the image into separate tiles. The gray scale is calculated for each of these tiles, based upon its histogram and transform function, which is derived from the interpolation between the manipulated histograms of the neighboring sub-regions. The cumulative distribution function (PDF) of the area's pixel values provides the reference point for the transformation function. In contrast limiting, CLAHE differs from AHE. By eliminating the histogram at a client-defined value, CLAHE restricts the increase in noise.

A. CLAHE on RGB color model

RGB color is an additive color model which which depicts hues regarding the measure of red (R), green (G) and blue (B) present. It illustrates the type of light that must be transferred in order to produce the specific colours seen in the image. CLAHE is relevant to each of the three sections, i.e. red, green and blue separately. The effect of full-color RGB can be acquired by combining the individual components of model.

B. B. CLAHE on HSV color model

HSV color model defines colors in terms of the Hue (H), Saturation (S), and Value (V). HSV color model is cylindricalcoordinate illustration of points in an RGB color model. Hue is a visual sensation's feature that indicates how closely a region appears to match a particular colour. The hue and saturation level don't have any kind of effect when value is at max or min intensity level. CLAHE is applied on V and S components [2].

9. Integrated color model

The integrated color model is principally established on color harmonizing by contrast improvement is RGB color space and color adjustment in HSI model [14]. In integrated color model first step is to diminish the color cast by the equalization of all the color values present. In the second step an improvement is applied to the contrast amendment to broaden the histogram values of the red color. The green and blue colours go through the second stage once more. In the last step of the model, the saturation and intensity components of the HSI color model is applicable for contrast adjustment to enhance the true color and for dealing with the issue of uneven illumination.

DATASET USED

We have selected three images for our project. The following figure shows the images and their corresponding reference images provided in the dataset.

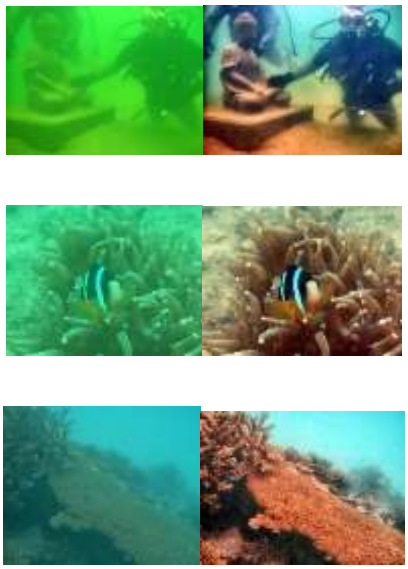
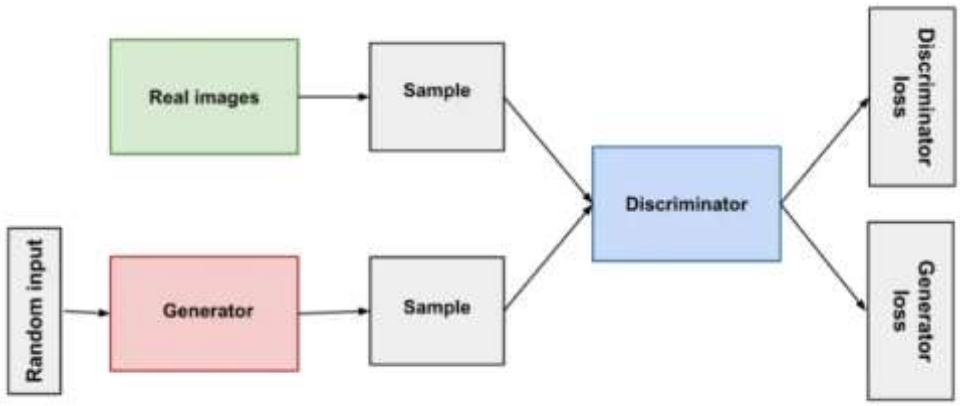


Fig 2: Images (left) and their corresponding Reference Images(right)

GAN ARCHITECTURE



A GAN's architecture is made up of two primary parts. The generator is a neural network that generates data instances, and the discriminator attempts to determine their authenticity. A data instance's perceived authenticity—that is, whether it reasonably fits into the initial training set of data—is

determined by the discriminator model. In an effort to trick the discriminator, the generator model trains on additional data and generates outputs that seem reasonable. Because the generator and discriminator have opposing goals—one model seeks to identify fakes, while the other attempts to imitate reality—this architecture is adversarial. These two elements train in tandem, gradually enhancing their skills. They are able to pick up on and replicate complicated picture, audio, and video training data.

Torch GAN

Torch GAN is a Pytorch-based GAN design and development framework. It provides the basic building blocks for common GANs and allows users to customize their models for advanced research. The TorchGAN modular structure enables users to test popular GANs on their data and plugin new architectures and loss functions with older versions. It provides various logging backends to help visualize training projects.

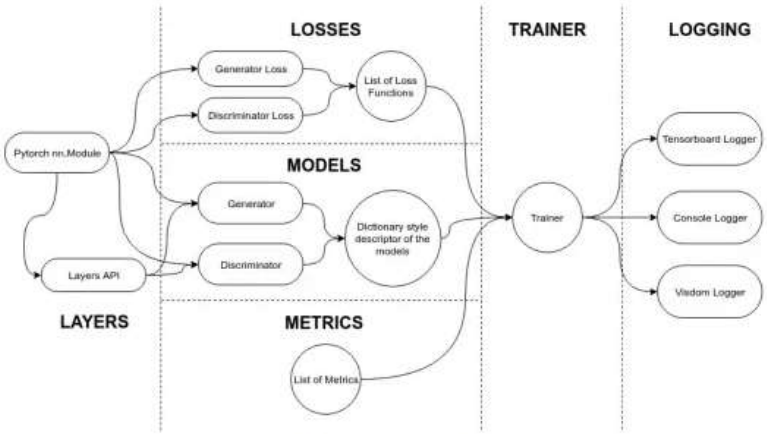
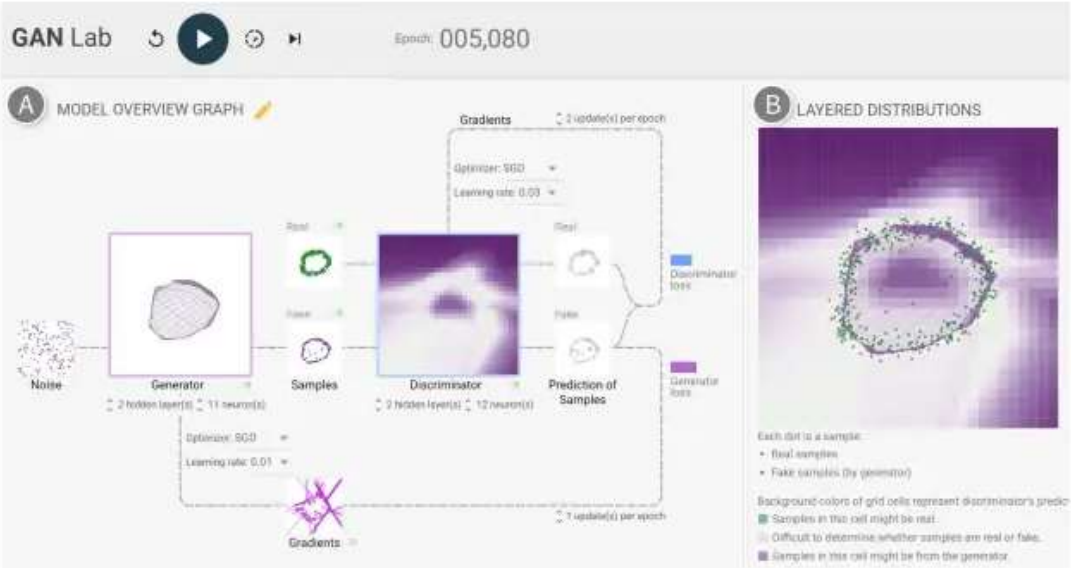


Figure 2: Overview of TorchGAN Design

GAN Lab

GAN Lab is an interactive, user-friendly tool for visualizing and experimenting with GANs. It allows users to visualize the inner workings of GAN models while training them for 2D data distributions. GAN Lab uses TensorFlow.js, a GPU-accelerated, in-browser deep learning library. It uses JavaScript to implement the entire GAN experiment, including visualization and training. Users can run GAN Lab with just a web browser. This implementation approach makes deep learning more accessible to the general public.



IMPLEMENTATION

GANs can produce high-quality, realistic images that are indistinguishable from real photos. Although the power to create artificial reality worries some, generative technology has many valuable applications.
Various applications for the creation of realistic images include:

- **Face recognition**—the portrait generating capability can also help smartphones recognize their owners' faces in different conditions.
- Pattern recognition---Using a particular artistic style as a guide, a GAN may create new art work.
- Content creation---A GAN may produce a variety of content types to finish presentations or fill in the gaps in photos.
- For example: adding facades to buildings, recreating natural landscapes, generating apparel, and rendering fully-furnished interiors.
- Virtual reality---GANs enable the creation of incredibly detailed HD virtual worlds, which are helpful for games and simulations.
- Unstructured data search---A GAN may recognise related photos based on compressed representations when it is utilised with an unstructured data repository.
- Predictive imagery---GANs can be used to make people appear older in pictures.
- Text-based image generation—GANs can create new images based on the descriptions in a text. A supervised learning approach can be used to label GAN-generated images in order to train the neural network. After that, the GAN can use words created by hand to create visuals that correspond to the descriptions.

SYSTEM STUDY

FEASIBILITY STUDY

This phase involves analysing the project's viability and presenting a business proposal that includes a very basic project design and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to make sure the business won't be burdened by the suggested method. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are,

- ECONOMICAL FEASIBILITY
- TECHNICAL FEASIBILITY
- SOCIAL FEASIBILITY

TYPES OF TESTS

Unit Testing

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. Validation should be done on all internal code flows and decision branches. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is an intrusive structural test that depends on an understanding of its structure. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

Functional Test
Functional tests offer methodical proof that the functions being tested are available in accordance with the technical and business requirements, system documentation, and user manuals.

Focus of functional testing is on the following areas:

- Valid Input : identified classes of valid input must be accepted.
- Invalid Input : identified classes of invalid input must be rejected.
- Functions : identified functions must be exercised.
- Output : application outputs that have been identified must be exercised.
- Systems/Procedures : it is necessary to call upon integrating systems or procedures.

Functional test preparation and organisation are centred on requirements, important features, or unique test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Additional tests are identified and the efficacious value of current tests is ascertained prior to the completion of functional testing.

System Test

System testing ensures that the entire integrated software system meets requirements. It puts a setup to the test in order to guarantee dependable outcomes. The configuration-oriented system integration test is an illustration of a system test. System testing emphasises pre-driven process connections and integration points and is based on process flows and descriptions.

Unit Testing

Although it is fairly uncommon for coding and unit testing to be undertaken as two separate phases, unit testing is typically carried out as part of a combined code and unit test phase of the software lifecycle.

Integration Testing

The process of incrementally integrating two or more integrated software components on a single platform to identify interface flaws that lead to failures is known as software integration testing.
The purpose of an integration test is to verify that software applications or system components, or even higher up, company-level software applications, function together flawlessly.
Test Results: Every test case that was previously specified was successful. No flaws were found.

Acceptance Testing

Acceptance Testing Any project's testing phase is crucial, and it involves a lot of end user input. It also guarantees that the system satisfies the functional specifications.

Test Results: Every test case that was previously specified was successful. No flaws were found.

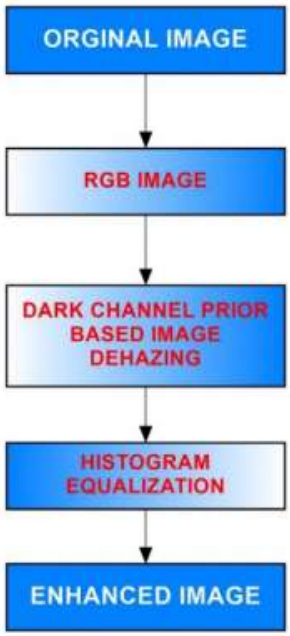


Fig 3: Block diagram of the Process

Result

Fig 4: (left to right) Original Image, Averaging based Fusion Enhanced Image, PCA Based fusion Enhanced Image

CONCLUSIONS:

In this paper different underwater image enhancement techniques are reviewed and studied. Each of the solutions under examination significantly improves the underwater photos.The issue of the uneven light illumination is likewise disregarded by the vast majority of the scientists. But no method paid attention on L*A*B color space using CLAHE for enhancing the underwater images. The presented strategies have ignored the methods to lessen the noise issue, which is available in the resultant pictures of the current image improvement procedures.

FUTURE SCOPE :

In future work, we will apply CLAHE on L*A*B color space and compare the results on different color spaces.

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