A Novel Appraoch for Underwater Image Enhancement using Pretrained neural network denoising and Fusion Technique

Mohammad Moiz Ashrafi
M.Tech Scholar
Department of Computer Science and Engineering,
School of Engineering & IT
MATS University, Aarang, Raipur (C.G.), India

Apurv Verma
Assistant Professor
Department of Computer Science and Engineering,
School of Engineering & IT
MATS University, Aarang, Raipur (C.G.), India

Dr. Abhishek Badholia
Associate Professor(HOD)
Department of Computer Science and Engineering,
School of Engineering & IT
MATS University, Aarang, Raipur (C.G.), India

ABSTRACT

Image enhancement also features the visibility as one or part of an image. Current camera systems often fail due to the underwater visibility that results from light scattering, light emissions, absorption, and uncontrolled water particles. As well as a proper idea of the structures and their structure, henceforth it is important for building a better image enhancement which can be used by camera systems in an underwater environment.Henceforth conclude that de-noising is required for under water image enhancement which will significantly improve the quality of underwater image. In this research we have proposed the use of pretrained deep convolution neural network for de-noising of image. Further for image enhancement we will apply multiscale fusion approach, in which gaussian pyramid, laplacian pyramid weighted, exposedness weight calculated, and fusion applied, eventually output image quality validated by calculating pcqi, ssim, niqe, brisque parameters and denoising efficiency evaluated through PSNR and SSIM parameter. Eventually Achieved significant improvement in output image quality.

Keywords*:* PCQI, MSE, SSIM, NIQE, PIQE

I. INTRODUCTION

Image enhancement uses qualitative subjective approach to produce a more visually pleasing image. They do not rely on any physical model for the image formation. These approaches are usually simpler and faster than deconvolution methods. The existing research shows that underwater images raise new challenges and impose significant problems due to light absorption and scattering effects of the light and inherent structureless environment. Exploring, understanding and investigating underwater activities of images are gaining importance for the last few years. Scientists are keen to explore the mysterious underwater world. However, this area is still lacking in image processing analysis techniques and methods that could be used Researchers have tried to employ various different enhancement techniques.

There are various techniques of underwater image enhancement some of them are as follows:

- Contrast-limited adaptive histogram equalization (CLAHE)
- Image enhancement by adjusting image intensity value or color space
- Image Enhance by enhancing contrast using histogram equalization
- Gamma Correction

We did experimental analysis for some image enhancement techniques, implementation done on Matlab 2019a.

CLAHE


```
pcqi =

    0.8417
```

Adjust image intensity values


```
pcqi =

    0.7768
```

Enhance contrast using histogram equalization


```
pcqi =

    0.7835
```

Adjust image colormap (Gamma Correction)


```
pcqi =

    0.9105
```

Adjust image colormap (Gamma Correction)


```
pcqi =

    0.8003
```

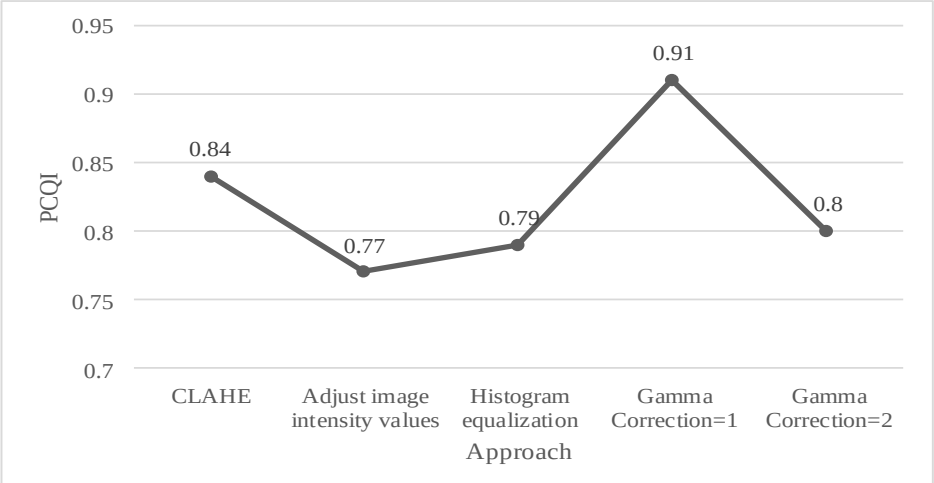


Fig.1 Comparison of Image Enhancement Techniques based on PCQI value

Further in next section of this paper we will give a tabular comparison among earlier study in this field, in section III we will discussion some bottle necks towards research, in section-IV we will discuss proposed method, in section V we will detail about experimental evaluation at last we will conclude our research.

II. LITERATURE SURVEY

S. No.	Author/Title/ Publication Year	Approach Used	Description
1.	Md Jahidul Islam et. al. / Fast Underwater Image Enhancement for Improved Visual Perception / arXiv 2019	Conditional generative adversarial network-based model	Proposed model can be used as an image processing pipeline by visually-guided underwater robots in real-time applications
2.	RafałProtasiuk et. al. / Local Color Mapping Combined with Color Transfer for Underwater Image Enhancement / IEEE 2019	Local color mapping and color covariance mapping	Proposed method performs favourably to all other methods including ones that are tailored to correcting underwater images by explicit noise modelling.
3.	Codruta O. Ancuti et. al./ Color Balance and Fusion for Underwater Image Enhancement/2018 IEEE	Combining white balancing and image fusion	Blending of two images that are directly derived from a colorcompensated and white-balanced version of the original degraded image.
4.	László Neumann et. al./ Fast Underwater Color Correction Using Integral IMAGES / arXiv 2017	Ruderman-opponent color space	Presents a fast enhancement method for color correction of underwater images. The method is based on the gray-world assumption applied in the Ruderman-opponent color space

III. PROBLEM STATEMENT & METHODOLOGY

Image enhancement recovers the visibility of one aspect or component of an image.Current camera systems often fail as a result of deprived visibility underwater rising from light scattering, light refraction, absorption, and uncontrolled particles in underwater. As well the correct conception of components and their arrangement, henceforth vital to create a sophisticated image enhancement and processing.

For denoising of image, we have proposed the use of Deep neural network. In this method of denoising we will use built-in pretrained CNN. As in this research we are taking input as 3D image (RGB image), so noise can be removed by treating each channel or plane separately.

Train a Denoising Network Using Built-In Layers

- Create an Image Datastore object that stores original images.
- Create a denoising Image Datastore object that generates noisy training data from the original images. Use the Patch Size=50 and Channel Format ('grayscale') so that the size of the training data matches the input size of the network.
- Get the predefined denoising layers using the dnCNN Layers.
- Train the network, specifying the denoising image data store as the data source for train Network. For each iteration of training, the denoising image data store generates one mini-batch of training data by randomly cropping original images from the Image Datastore.

Above steps used for training deep neural network for image denoising. Further we will elaborate our fusion technique.

Proposed Algorithm

1. Input Under water Image.
2. Apply DNN based De-noising.
3. White balance
4. Create color transformation structure
5. Apply device-independent color space transformation

6. Apply Contrast-limited adaptive histogram equalization
7. Create color transformation structure
8. Apply device-independent color space transformation
9. Calculate laplacian contrast weight
10. Calculate Local contrast weight
11. Calculate the saliency weight
    a. Read image and blur it with a 3x3 or 5x5 Gaussian filter
    b. Perform sRGB to CIE Lab color space conversion (using D65)
    c. Compute Lab average values
    d. Finally compute the saliency map and display it.
12. Calculate the exposedness weight.
13. Calculate the normalized weight
14. Calculate the gaussian pyramid with level=5
15. Calculate the laplacian pyramid with Level=5
16. Fusion of all weight calculated
17. Generate enhanced image.

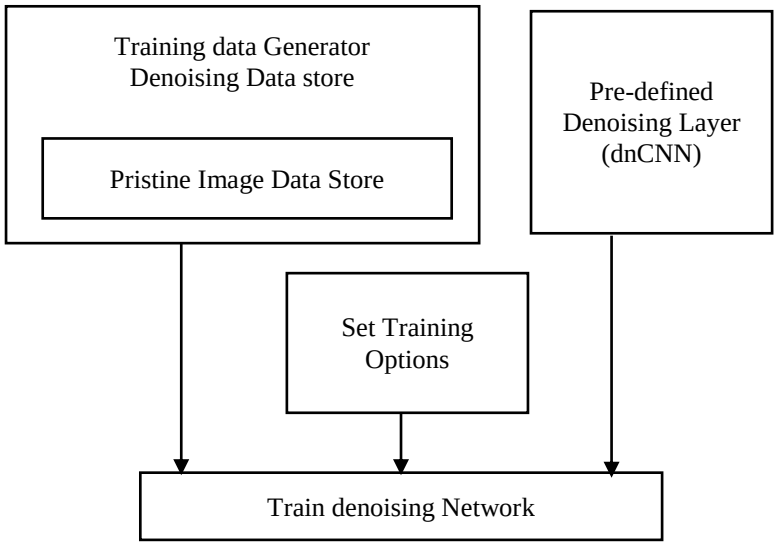


Fig.2 Training of Deep Neural Network

Train a network that detects a larger variety of noise, such as non-Gaussian noise distributions, in single-channel images.

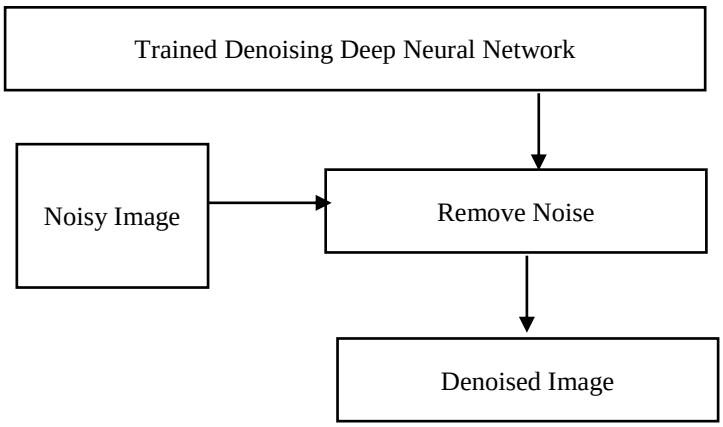


Fig.3 Image Denoising Workflow

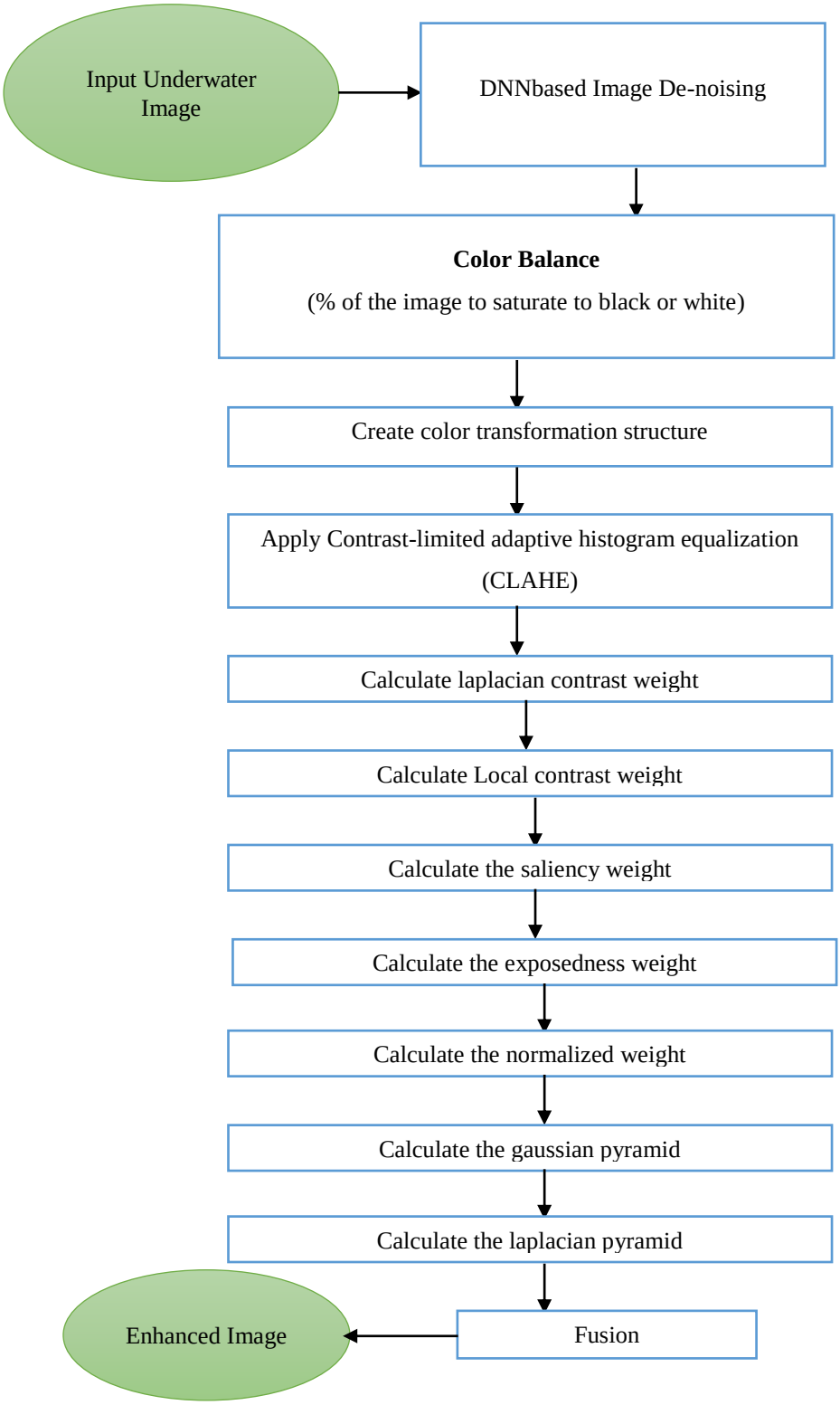


Fig.4 Proposed Layout

Histogram equalization: Histogram equalization is a method in image processing of contrast adjustment using the image's histogram. Histogram equalization is best method for image enhancement. It provides better quality of images without loss of any information. For color images Cumulative distribution function(cdf) should be replaced by "cumulative histogram". This cdf

shows that the minimum value in the subimage is 52 and the maximum value is 154. The cdf of 64 for value 154 coincides with the number of pixels in the image. The cdf must be normalized to [0,255]. The general histogram equalization formula is:

$$h(v) = \text{round}(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-1))$$

where cdf is the minimum non-zero value of the cumulative distribution function (in this case 1), M × N gives the image's number of pixels (for the example above 64, where M is width and N the height) and L is the number of grey levels used (in most cases, like this one, 256).

$$h(v) = \text{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-2)\right) + 1$$

The equalization formula for the example scaling data from 0 to 255, inclusive, is:

$$h(v) = \text{round}\left(\frac{cdf(v) - 1}{63} \times 255\right)$$

IV. Result and Discussion

For implementation of proposed system we have used Matlab 2019a, taken different underwater images as input.

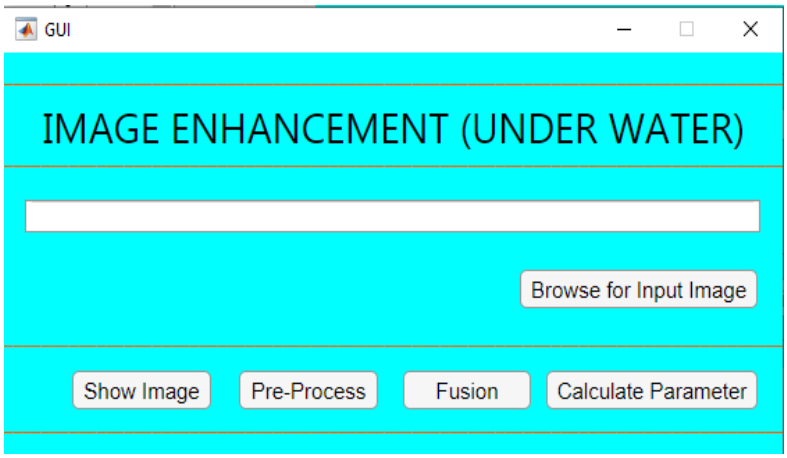


Fig.5 First UI of Proposed System

Step-1 Input Image

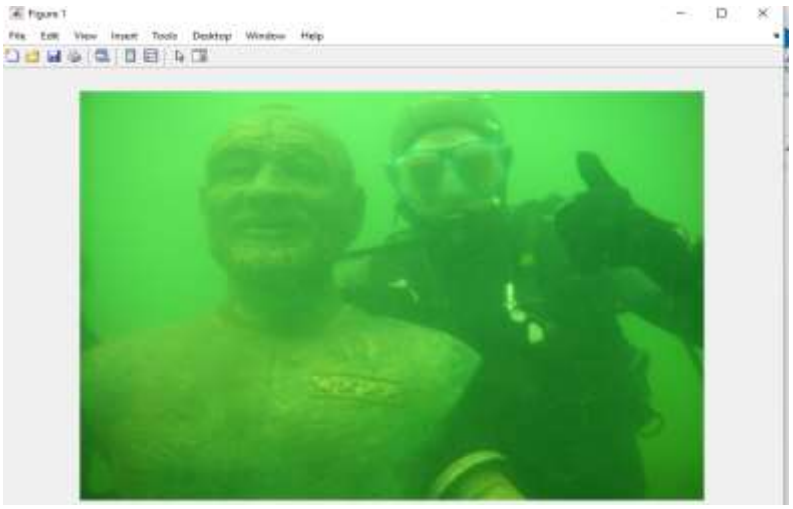


Fig.6 Input Image

Step-2 dnCNN

net.Layers

	1
1	*1x1 ImageInputLayer*
2	*1x1 Convolution2DLayer*
3	*1x1 ReLULayer*
4	*1x1 Convolution2DLayer*
5	*1x1 BatchNormalizationLayer*
6	*1x1 ReLULayer*
7	*1x1 Convolution2DLayer*
8	*1x1 BatchNormalizationLayer*
9	*1x1 ReLULayer*
10	*1x1 Convolution2DLayer*

Command Window

New to MATLAB? See resources for Getting Started.

```
net =

  SeriesNetwork with properties:

    Layers: [59×1 nnet.cnn.layer.Layer]
```

Fig.7 Layer of dnCNN

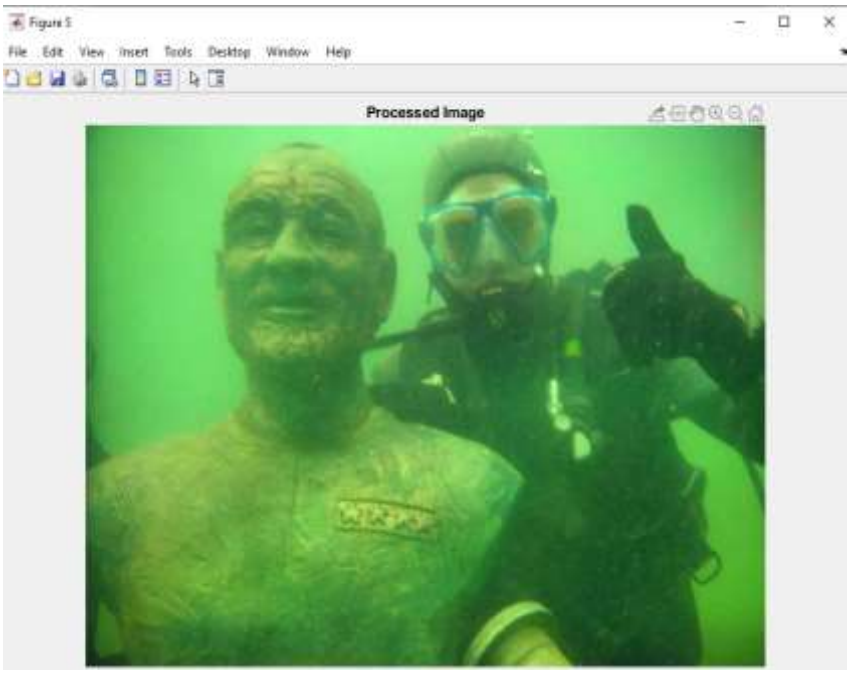


Fig.8 De-noised Image

Step-3 Color Balance

Fig.9 White Color Balance

After calculating different weight fusion performed and fig.10 shows the enhanced image.

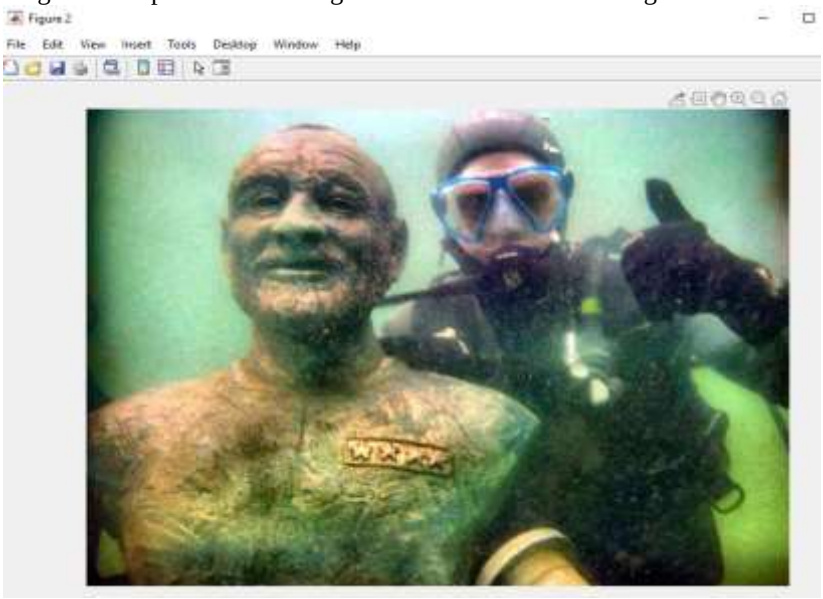
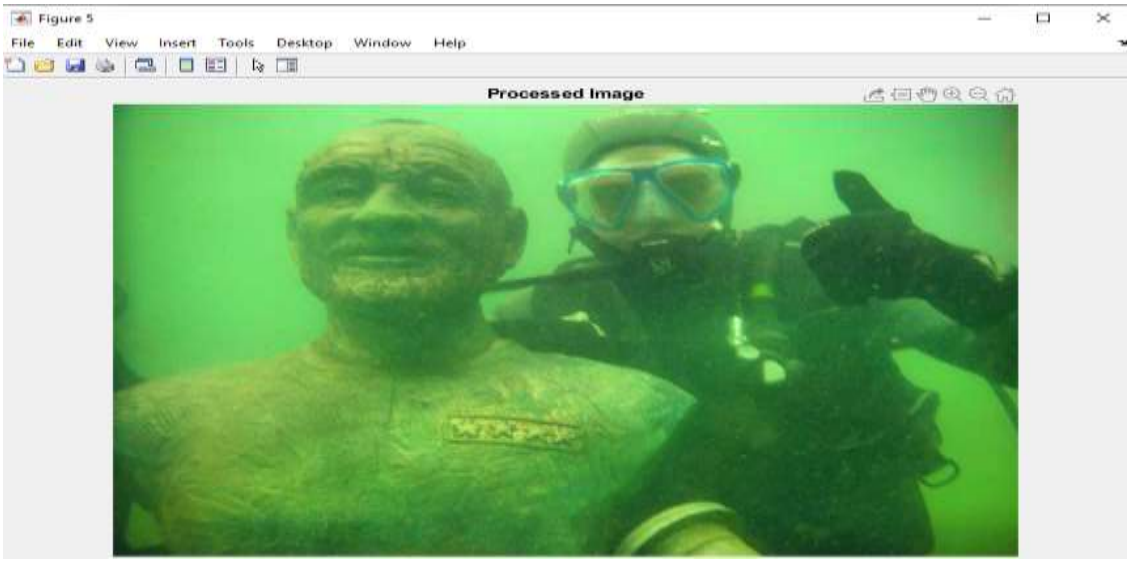


Fig.10 Enhanced Image

We have performed same steps to different images and validated by calculating different image quality parameters as:
1. PIQE: Perception based Image Quality Evaluator
2. NIQE: Naturalness Image Quality Evaluator
3. BRISQUE: Blind/Referenceless Image Spatial Quality Evaluator
4. SSIM: Structural Similarity Index
5. PCQI: A Patch-Structure Representation Method for Quality Assessment of Contrast Changed Images.



Enhanced Image- **Fig.10**
piqeenhances =56.2569, niqeenhance =4.2242
brisqueenhance =39.5395, ssimval =0.3574, pcqi = 1.4932

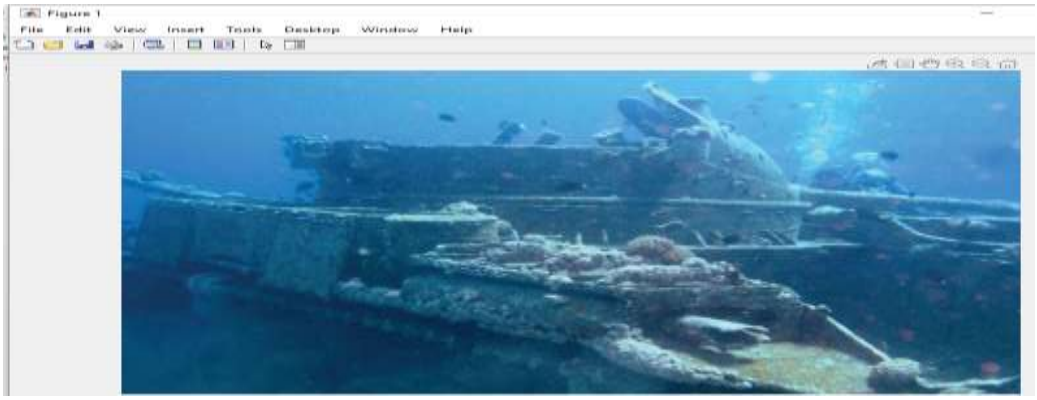
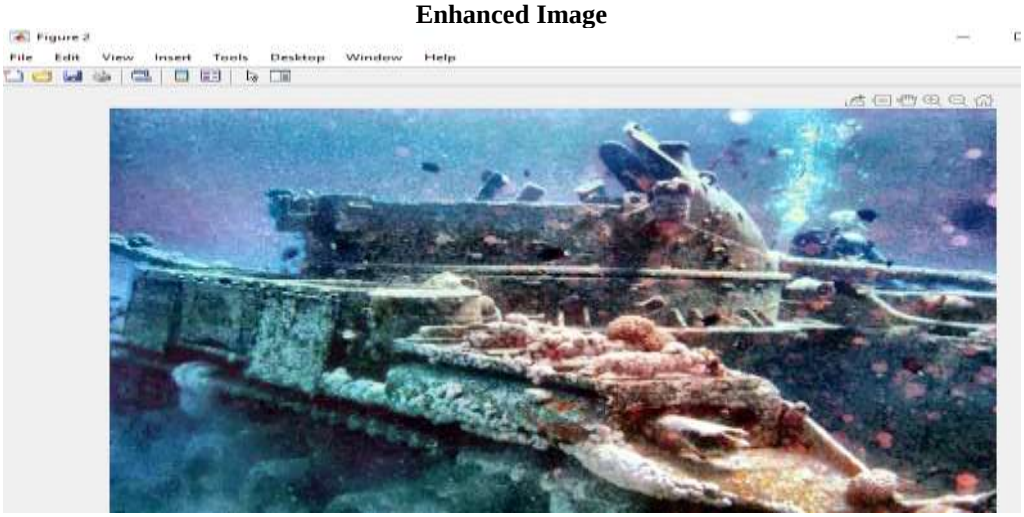


Fig.11 Input Image

Enhanced Image



piqeenhances =18.8029, niqeenhance =2.8878
brisqueenhance =22.4082, ssimval =0.5529, pcqi =1.6177

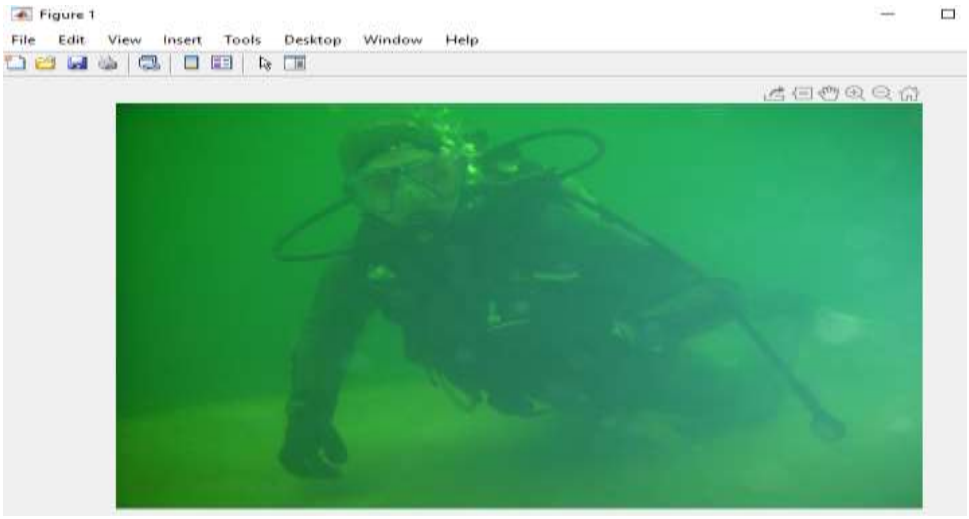
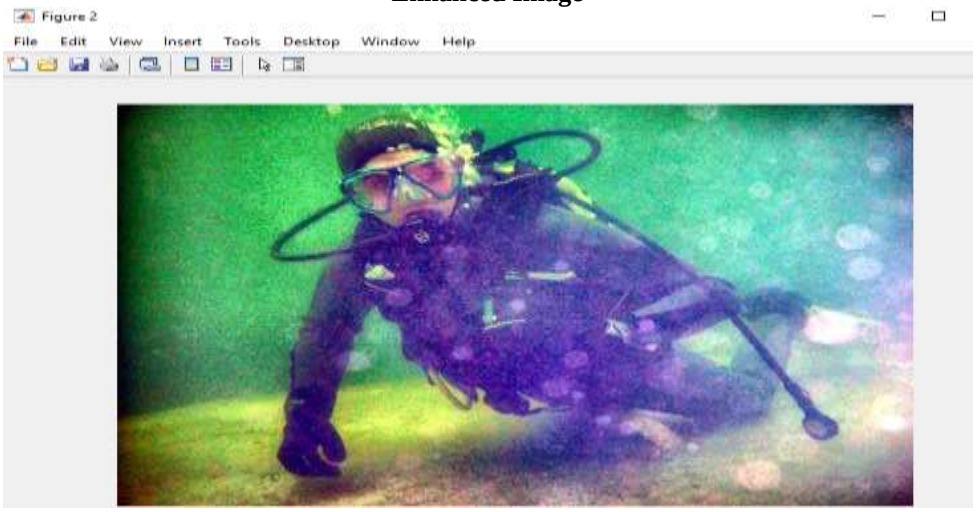


Fig.12 Input Image

Enhanced Image



piqeenhances =19.7602, niqeenhance =4.0921,
brisqueenhance =29.3847,ssimval =0.3692,pcqi =1.5479

V. CONCLUSION

The principal objective of image enhancement is to process a given image so that the result is more suitable than the original image for a specific application. It accentuates or sharpens image features such as edges, boundaries, or contrast to make a graphic display more helpful for display and analysis. In this paper we have applied pretrained DNN (dnCNN) for image denoising and achived better PSNR and SSIM value. After denoising fusion applied achieved better result .Codruta O. Ancuti et. al. (IEEE 2018) has performed image enhancement in diffident images and achieved average PCQI value= 1.3. In our proposed approach we have achieved average PCQI = 1.5.

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