An Image Processing Based Technique for De-Noising & Enhancement Of Underwater Images Using Adaptive Wavelet Transform And Histogram Equalisation

Miss. Pratiksha V. Chafle[1] , Prof. P. R. Badadapure[2], Mr. Bhavekar G.S[3], Mr. Akshay V.Chafle[4]
[1]Assistant Professor, Electronics Dept, Dr.D.Y.Patil Science and Computer Science, College, Pune University, Akurdi, Pune, (MH), India
[2] HOD,Dept. of EnTc Engg, ICOER Wagholi, Pune (MH) India ICOER Pune, Pune University, (MH), India
[3] Assistant Professor, IT Dept, Dr.D.Y.Patil Art, Commerce and Science College, Pune University, Akurdi, Pune (MH), India
[4] UG Student, EnTc Dept, Sipan College Of Engineering, Amarvati, SGBAU University,(MH),India
Email – pratuschafle@gmail.com, gbhavekar@gmail.com

***Abstract**: Visual information is transmitted in the form of digital images is becoming a major method of communication in the modern age but still the images obtained after transmission is often corrupted with noises so the received images needs processing before it can be used in application. Our motive is that to remove the noise from images that is underwater images, underwater images include various types of noises like random noise, speckle noise, Gaussian noise, salt and pepper noise, Brownian noise etc. Image De-noising is involved manipulation of images data to produce a visually high quality, images processing of improving the quality of images by improving its features. The underwater image processing area has received considerable attention within the last decades so using some special type of filter it is possible. The filter we will employ is a bilateral filter for smoothing the images. It is required because of several researchers like forensic department, geologist, argeologiest and underwater marine lab and underwater inside hydro lab and so on, for their research activity. So due to that underwater image de-noising is very important factor for several domains. So there are various methods or algorithm are available for de-noising of images like spatial domain filtering, nonlinear filtering, wavelet domain, etc. So using wavelet transform one have numerous advantages like, wavelet offer a simultaneous localization in the time and frequency domain also using fast wavelet transform it is computationally very fast and one of the most important advantage of wavelet transform that it is separate the fine detail in a signal and very small wavelet can be used to isolate very fine detail in a signal while very large wavelet can identify course detail.*

***Key Words:** Underwater images, Image De-noising using adaptive wavelet transform, Image Enhancement using histogram equalization method, peak signal to noise ratio. Mean Square Error, Entropy, Correlation.*

1. INTRODUCTION:

Digital Picture Processing (DIP) contain the change of digital data for enlarge the picture factor with the help of computer. The processing helps in enlarge clarity, sharpness and details specialty of interest towards data extraction and further investigation. Noise is a concern while convert pictures through all variety (types) of electronic conversation. The most common noises in undersea pictures are random noise, speckle noise, salt and pepper noise, Gaussian noise, Brownian noise etc. are one of the common not easy in picture processing in sea. Even enhanced resolution photo is required to have some noise in it. For a enhanced-resolution photo a simple box blur may be compatible, for the reason that even a very small property like cloth texture or eyelashes will be reoccurred by a enhance number of group of picture elements. In order to deal with undersea picture processing, so firstly the main physics of the light propagation in the sea medium to be consider. Physical speciality of the medium source degeneration reaction not occurs in normal undersea pictures taken in air.

Undersea pictures are significantly show by their poor picture visibility for the reason that light is statistical attenuated as it swing in the sea and the scenes result badly contradict and hazy. Light depletion end point the picture visibility distance at about 20 meters in clear sea and 5 meters in turbid sea. The light attenuation execution parameter is creator by irregular and exhaustion. The irregular and exhaustion technique of the light in sea influence the overall method of undersea imaging arrangement. Forward irregular leads to daze of the picture speciality. On the other hand, backward irregular end point the disparity of the pictures, reserve the scene and generating a significantly shade that superimposes itself on the picture. Irregular and exhaustion speciality are due not only to the sea itself but also to other constitute just as dissolved organic material.

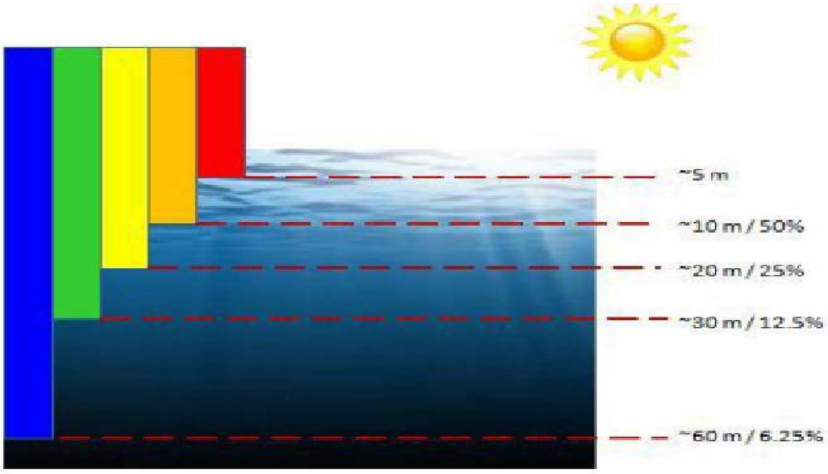


Fig 1.1:Water Level in Sea

The occupation of the floating particles known as "marine snow" increases irregular and exhaustion reaction. The visibility area can be enhanced. With synthetic lighting but these sources not only suffer from the not easy described earlier, but in inclusion tend to shiny the scene in a random fashion, generating a shiny spot in the middle of the picture with a badly shiny area around it. Finally, as the quantity of light is enlarge when light is go wide, colours reduce one by one connected to their wavelengths. The blue colour go through the expanded in the sea for the reason that of its shrink wavelength, making the undersea pictures to be control necessarily by blue colour. The wavelet is more approved for the reason that it has very important speciality like as,

1) No essential to block the picture
2) More rough under communication errors
3) Facilitates advanced communication of the picture (Scalability)

Fig.1.2: Noisy Image

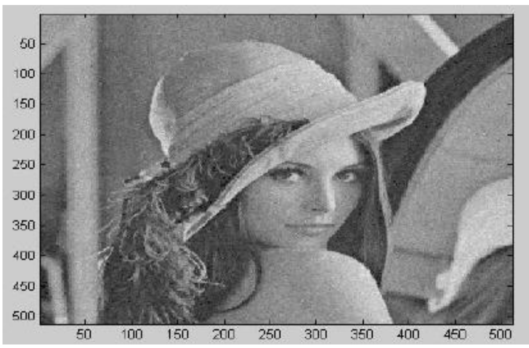


Fig.1.3: De-noising Image

Picture de-noising: Bring forward unwanted noise in order to recover the original picture.

- Wavelet transform occurs us with one of the process for picture de-noising.
- Wavelet transform, for the reason that of its superior localization speciality, has very quickly become a required picture and signal processing tool for a various applications, including de-noising and enhancement.

Wavelet de-noising struggle to bring forward the noise occur in the signal while contain the signal property, unconcerned of its frequency content different variety of noise have their own property and are basic in undersea pictures in various ways.

Block diagram:

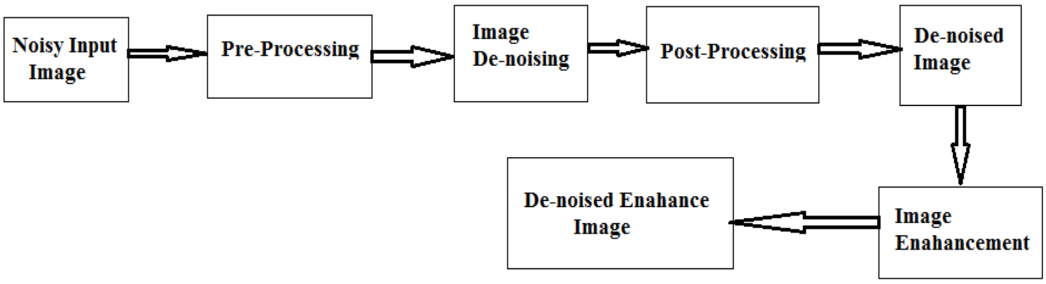


Fig 2.1: Block diagram

1. In order to acquire better de-noising reaction, some pre-processing should be finished earlier wavelet threshold de-nosing. The pre-processing involved two steps, the first step, we cause homomorphic filtering method to bring forward balance disparity and the random shinning. The second step, we execute Gaussian low-pass filtering for make uniform picture. Then we investigate the soften picture with the Butterworth filtered picture.
2. In the wavelet de-nosing, the most significant steps are the choosing of a convenient threshold and efficient threshold function, which have direct effects on the execution of a wavelet de-nosing algorithm. This system causes soft threshold system for the reduce calibration wavelet coefficients, takes further dissolving for other wavelet coefficient and takes efficient enhancement and mixing threshold conversion for each sub band after being dissolve.
3. In Post-Processing investigate the data catch by camera while taking the photo to enhance the undersea picture. There are mostly two things that are complete in post processing.
   i. An algorithm is run on all current data of picture element and minor changes are activated to picture element data.
   ii. Manually choosing and reconstitution the picture element data with total new data.
4. Again picture De-noising will be complete.
5. After picture de-noising picture enhancement is complete using CLAHE technique. In this visual quality of picture increases and clearly visible picture is acquired.

2. METHOD:

2.1. Image De-noising:

A desirable advance to deal with undersea pictures is to remember the picture transmission in sea as a linear method. Picture restoration intention at recovering the original picture from the inspected picture using accurate information about the point spread function (PSF) and the noise speciality. Electronic communication, noises which is originate by several factors i.e. Low disparity, Definite range visibility, Random lighting, Daze, Colour diminished Shiny antiquity. The comparison of well-known picture de-noising method is caused and a new method using the decision placed advance has been caused for the bring forward noises. This technique can firstly store picture element while suppressing noise. The main approach of these methods is at first received and then calculates with several simulation results using MATLAB. Most of the previously well-known system is applicable for the de-noising of pictures perverted with less noise density. Here a new system has been occured which shows better realization than those already being occur caused that system is Adaptive conversion system. The comparisons are finished placed on visual clarity concern with Peak Signal to Noise Ratio (PSNR) of several filtered pictures that necessary maximum as desirable associated with undersea picture. The picture restoration intention to catch a downgraded picture using a classic of the degradation. These techniques are rigorous but them essential many classic parameters which are only hardly known in tables and can be leave variable. Another necessary parameter essential is the intensity calculates of a given object in the scene. The search for profitable picture de-noising technique still is a valid objection, at the crossing of functional investigation and data. In spite of the elegance of the currently suggested system, most algorithms have not yet reached a desirable level of appropriateness. All show an outstanding acquirement when the picture classics correspond to the algorithm acceptance, but fail in ordinary and bring forward picture fine architecture.

2.2. Image Enhancement:

These techniques initiate total abstraction of the picture creation method, and no a priori information of the environment is necessary. They are usually simpler and faster than the picture restoration techniques. Regarding colour correction, as intensity maximized, colour diminishes one by one be connected with their wavelength. First all, red colour depart at the intensity of 3m approximately. At the intensity of 5 m, the orange colour is lost. Most of the yellow goes off at the intensity of 10m and finally the green and purple depart at further intensity. The blue colour goes through the expanded in the sea for the reason that of its shortest wavelength. The undersea pictures are therefore control by blue-green colour. Also the light source several will influence the colour perception. As a reaction, a strong and random colour cast will symbolize the typical undersea pictures. Picture enhancement causes qualitative instinctive principle to afford a more visually pleasing picture and they do not build on any physical classic for the picture formation. These types of access are usually simpler and rapid system. Here the scope is to give the researcher, in undersea department particular who is not an technician in the area and who has a specific not easy to noises in pictures and visual clarity, the implication of the acquire system spotlighting on the imaging circumstances for which they were developed (lighting circumstances, intensity, environment where the access was tested, quality assessment of the results) and considering the classic attribute and acceptance of the approach itself.

System Design:

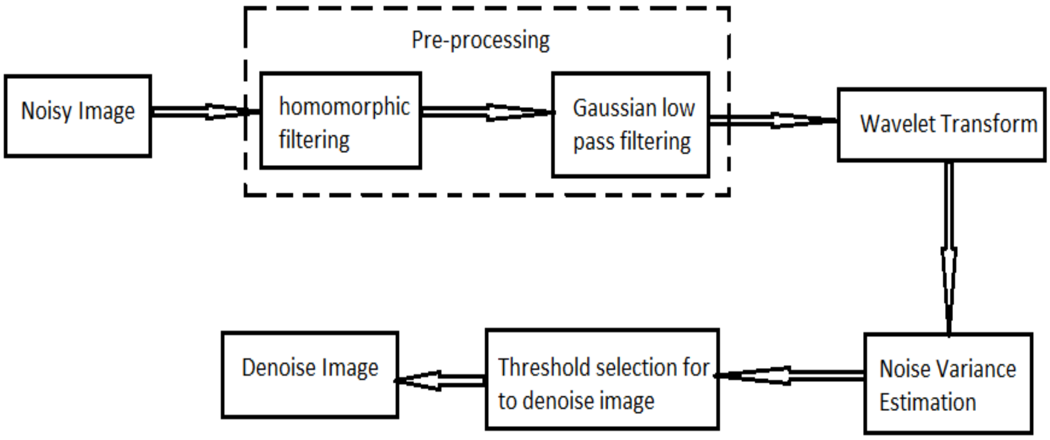


Fig 4.1: The process of Image de-noising

3. IMAGE DE-NOISING:

The pre-processing contain two steps, the first step is to adopt Homomorphic filtering technology to bring forward balance disparity and the random shiny. This step can appreciate the intention to increases the shiny changes, maintain details, sharpen the edge details, and remove the noise in the picture. The filter function H (u, v) can be select as follows.

$$H1\ (u, v)\ =\ (r\ H - r\ L).(1 -\ exp\ (-(\frac{u^2 + v^2}{2\delta_w^2}))) + r\ L$$

Where,
r_{H} - the maximum coefficient values
r_{L} - minimum coefficient values
δω -controls the cut-off frequency.

If the picture classic is placed on shiny-reflectance, then frequency concern method are not as easy to complete. The main reason is that reflectance and shiny components of the classic are not bring forward. To be able to progress appearance of an picture by disparity enhancement and simultaneous shininess range shrink it is important to apart two components. An picture can be classic mathematically in terms of reflectance and shiny as follow:

$$f(x,y) = I(x,y)\, r(x,y) \qquad (1)$$

But as we know that, To accomplish separable ability, first map the classic to natural log concern and then take the Fourier transform of it.

$$z(x,y) = ln\{ f\ (x,y)\}$$

$$= ln\{i(x,y)\} + ln\{r(x,y)\} \qquad (2)$$

Then,

$$Z(u,v) = I\ (u,v) + R(u,v) \ (3)$$

Now, if we process Z(u,v) by means of a filter function H(u,v) then,

$$S(u,v) = H(u,v)I(u,v) + H(u,v)R(u,v)$$

Taking inverse Fourier transform of S(u,v) brings the result back into natural log concern,

$$s(x,y) = F - 1\{H(u,v)I(u,v)\} + F - 1\{H(u,v)R(u,v)\} \qquad (4)$$

By letting,

$$i'(x,y) = F - 1\{H(u,v)\ I(u,v)\} \quad and$$

$$r'(x,y) = F - 1\{H(u,v)\ R(u,v)\} \qquad (5)$$

Now, to get back to spatial concern, we need to get inverse transform of natural log, which is exponential,

$$s(x,y) = i'(x,y) + r'(x,y) \qquad (6)$$

$$g(x,y) = exp[s(x,y)]$$

$$= exp[i'(x,y)]\,.\,exp[r'(x,y)]$$

$$= io(x,y)\, ro(x,y) \qquad (7)$$

Where $i_o(x, y)$ is illumination and $r_o(x, y)$ is reflectance components of the output picture. This process is placed on a certain case of a class of method known as homomorphic systems. The block diagram for homomorphic filtering is as follows:

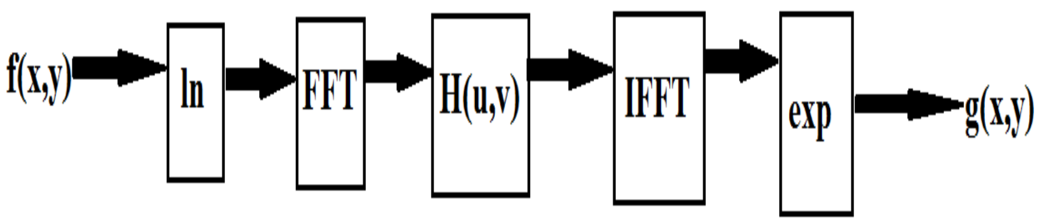


Fig 4.2: Process of Homomorphic filtering

The second step is given to Gaussian low-pass filtering for make uniform the picture. It is caused for soft the textures & minimize antiquity by removing small picture property developed by Homomorphic filtering. Low-pass filtering is the attribute of the picture make uniform, which let tackle the maximum frequency parts of signal and the minimum frequency parts of signal approach. For the reason that of the picture edge in high frequency parts, so it often results a certain destruction to detail in the picture softly process. The technique of Gaussian low-pass filtering can divert the defects. Using the illustration of a Gaussian low-pass filtering is as follows.

$$H1\,(u,v)\ = e^{-D^2(u,v)/2D_0^2} \tag{8}$$

Here $D\,(u,\ v)$ is the distance of after Fourier transform form the origin.

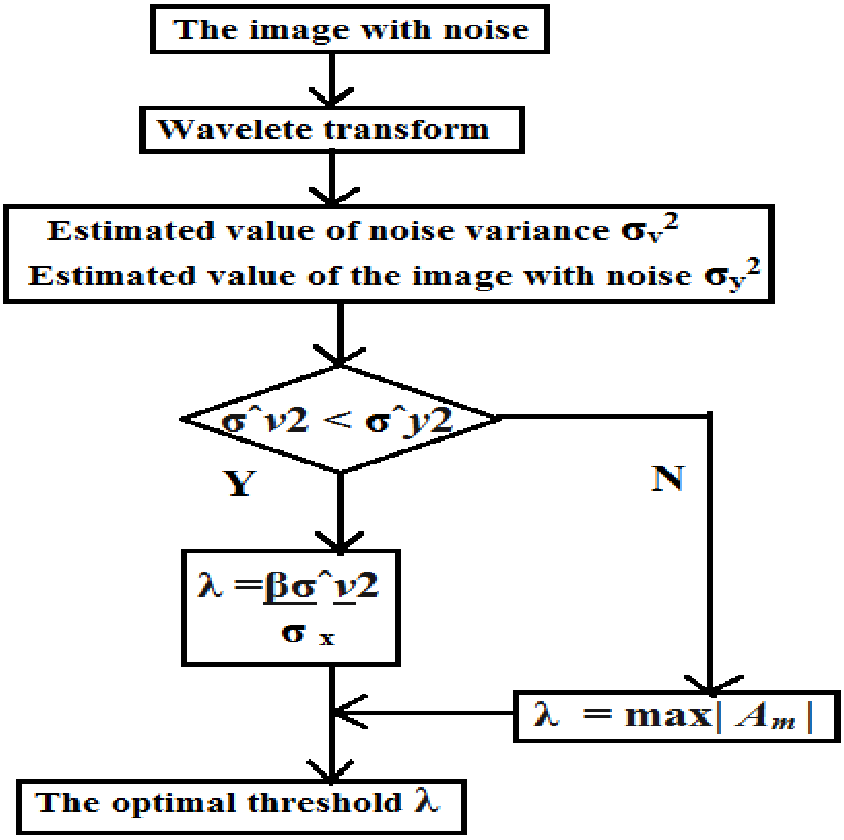


Fig.4.3: Adaptive Threshold Flowchart.

4. IMAGE ENHANCEMENT:

Histogram Equalization:

For a given picture X, the probability density function (X k) is denoted as by following term function.

$$p\ ([(X)])k\ = \frac{n^k}{n} \tag{9}$$

Let, For k = 0, 1……………, L – 1,

Where nk -number of times that the level ,Xk appears in the original picture X and n - total number of samples in the original picture. Note that p (Xk) is combine with the histogram of the orignal picture which reoccurs the number of picture elements that have a specific intensity Xk. In fact, a plot of nk vs. Xk is known histogram of X. Placed on the probability density function, the cumulative density function is denoted as

$$C(x)\sum_{j=0}^{k} p(X_j) \tag{10}$$

Where Xk = x, for k = 0, 1, L – 1. Note that c(XL-1) = 1 by definition. HE is a scheme that maps the input picture into the entire dynamic range, (X0, XL-1), by using the cumulative density function as a transform function. Let's denote a transform function f(x) placed on the cumulative density function as

$$f(x) = X0 + (Xl - 1 - X0)c(x) \quad (11)$$

Then the output picture of the HE, Y = {Y(i, j)}, can be expressed As

$$Y = f(X) \quad (12)$$

$$= \{f(X(i,j)/X(i,j)\epsilon X\}$$

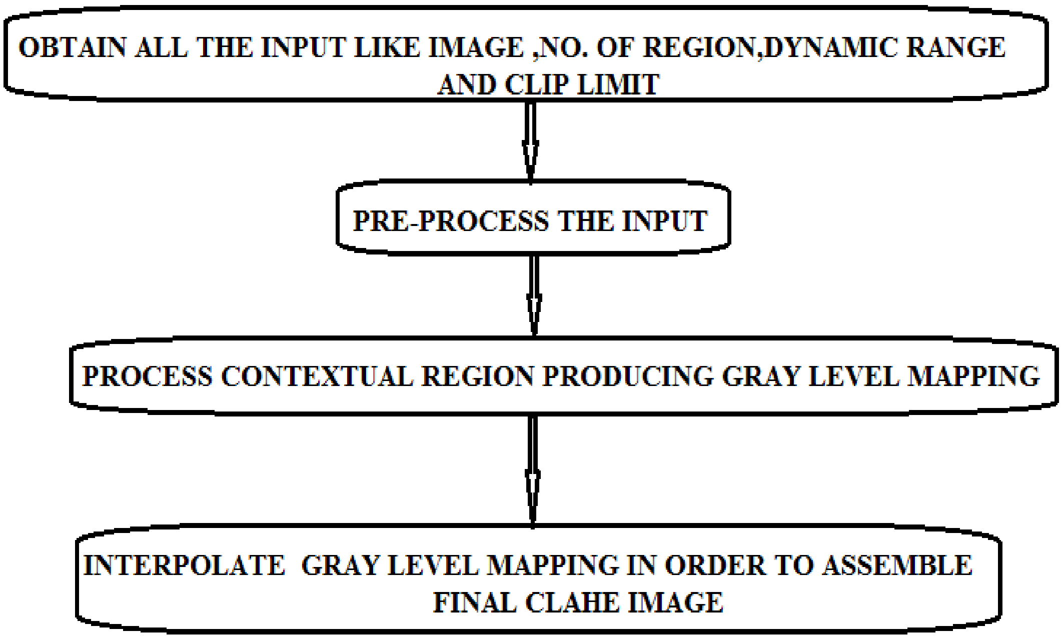


Fig. 4.4: Flow chart for CLAHE

5. FINDINGS:

The four parameters are caused for the execution calculates the undersea pictures are as follows:

1. **MSE:** The Mean Square Error (MSE) expresses the aggregate squared error between the shrink and the original picture. Minimum the value of MSE, minimum the error. The MSE is calculating by using the following equation:

$$MSE = (\sum M,N - [I1(m,n) - I2(m,n)]2)/(M * N) \quad (12)$$

2. **RMSE:** The Root Mean Square Error (RMSE) is a frequently caused to measure the difference between values conclude by a classic and the values actually noted from the environment that is being design. These distinct differences are also known as residuals, and the RMSE serves to accumulate them into a single measure of anticipating power.

$$RMSE = \sqrt{}(MSE(\emptyset)) = \sqrt{}(E(\emptyset - \emptyset)2) \quad (13)$$

3. **PSNR:** Estimate peak signal-to-noise ratio (PSNR) between pictures. This ratio is often caused as a factor measurement between the original and a shrink picture. The larger the PSNR, the better the quality of the reconstructed picture.

$$PSNR = 10\, log10\, (\frac{R\,2}{MSE}) \quad (14)$$

Where, R is the maximum inconstancy in the input picture data type

4. **Correlation:** Estimate the correlation coefficient between a picture and clean picture. Digital picture correlation is a visible method that occupies picture registration and tracking method for accurate 2D and 3D measurements of variation in pictures.

6. RESULTS:

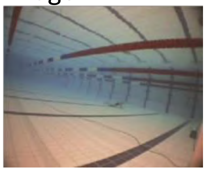
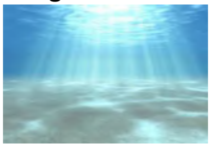
Proposed Method Results	
image 1 	PSNR 133.6286 MSE 16.6745 Correlation 0.9636 Entropy 6.1213
Image 2 	PSNR 140.543 MSE 6.0735 Correlation 0.9619 Entropy 6.78597
Image 3 	PSNR 135.19 MSE 71.4768 Correlation 0.9905 Entropy 7.54695
Image 4 	PSNR 136.1165 MSE 46.6429 Correlation 0.9779 Entropy 7.5806
Image 5 	PSNR 138.0663 MSE 19.003 Correlation 0.9870 Entropy 7.4681

Table.1.Showing Different Result on the PSNR Value

7. CONCLUSION:

At present, scientists are eager to explore the underwater world. However, the area is still lacking in image processing analysis and methods that be used to improve the quality of underwater images. Underwater image de-noising and enhancement techniques provide a way to improve the object identification in underwater environment. The proposed Algorithm not only removes noise, but also it improve peak signal to noise ratio and resultant image get a better visual effect. There is a lot of research started for the improvement of image quality, but limited work has been done in the area of underwater images. As our proposed method is applied on only Gray scale and RGB colour images, so the further research will apply on other image

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