Underwater Image Enhancement and uneven illumination correction using Image Processing methodology.

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***Abstract*— An underwater image contains lots of noise and blurriness therefore it is quite difficult to see with normal human eyes. absorption and scattering of light are the one of the prime reasons for color shifting and degradation in underwater images. Since the sharpness and contrast of the image is not balanced we have to apply several enhancement techniques that would increase the intensity of image which will lead to clear visibility. The aim of any image enhancement techniques is to generate the output image such that it is easily interpretable to human eyes as it is to machines. previously lots of other methods were also discussed like GANs (generative Adversarial Network) but these types of techniques mainly depend significantly on types of training data. Since there are very few training data available in terms of underwater images training examples which lead to less number of ground truths and hence the model has to heavily depend on synthetic training examples. In this scenario methods using GAN's are very helpful. Some of the techniques like Grey World hypothesis which assumes the average color in a particular image is a scene is achromatic is used in color correction models which adopt the linear stretching transformation to improve the color of underwater scenes. In this project we are using photograph fusion after GAN architecture result. Generating a new snapshot by mixing two or extra unique graphics is known as Photograph Fusion. It can be done through the use of a detailed algorithm. A single fused snapshot utilizing a set of input pics which are assumed to be registered is produced. This approach is known as photograph fusion. The entered image would be multi-sensor, multimodal, multifocal or multi-temporal. This project tries to enhance underwater image by one of the most photo fusion procedures and photograph enhancement systems. First, the input image is pre-processed. Then for sharpening the image HWD transform is applied. After that, using a high-pass filter the low frequency background is removed. Then based on the intermediate color channel histograms are mapped to reduce the gap between the inferior and dominant color channels. Then Wavelet fusion is applied followed by adaptive local histogram specification process. The resultant images processed through the proposed approach could be further used for detection and recognition to extract more valuable information. This process of image enhancement is to process the input image in any such means that the output image is more compatible for interpretation by the humans as well as by way of machines.**

Keywords—Wavelet fusion, Image processing, HWD transform, High pass filter, Homormorphic filter, Convolutional Neural Network (CNN), Color trapping.

I. INTRODUCTION

Image enhancement is the technique for processing the input underwater image to result it in a proper and dearly visible image which can further used for better viewing. This technique enhance and alter the contents quality and visibility
of image for the observer. With Image enhancement techniques what we want to achieve is getting a clear

noise free bright image which contains all the details in terms of excelled pixels which can be further used for some research purposes. One of the major challenges in underwater image reconstruction is loss of information and generality as it may happen that image enhancement techniques may reduce the information. Almost every image enhancement techniques deals with operations like contrast stretching, noise clipping process, pseudo-coloring, noise filtering technique. One of the reason why Image quality is poor is because of light. This blurring effect comes in to the pictures because of refraction of light when it entered into water and then it is absorbed and scattered , the reason for this is change in the refractive index of water as being denser than air [2]. Under water images lose their properties not only because of light but also living water organisms. Image enhancement in underwater image is quite challenging task as during enhancement process vital information may get lost or eliminate. This process includes features like edge and contrast to increase photographs for the research and study. It includes contrast stretching, noise clipping and filtering and pseudo colouring technique. Basically "Qualitative objective approach" is used for obtaining enhance image [6]. Various active features have been amplified by various detected features.

Existing image enhancement algorithms concludes that image have poor quality because of nature of light. As light behave differently in different medium, when it enter into the water it got refracted and got absorbed and further scattered as the water is denser than air, results in light drops and multidirectional scattering of light. Scattering of light ultimately cause reduction in colour contrast ratio [5]. These effects changes in water in case of underwater image, not only nature of water but also the organism and other material present in water effects the quality of image. Wavelength of light is different according to different colour present in Water e.g. Red, Blue and Green colour.

II. EXISTING METHODS

For underwater Image processing there were many previous methods. One of the basic techniques all methods follows is:" *By increasing the factors of the pixels, the underwater object can be visible clearly in the underwater images"*. This is called Image sharing or enhancement

Various Previous discussed techniques are-

Image Enhancement methods: It concentrates on increasing the contrast and correcting for color bias. Usually based on pixel intensity redistribution and expanding the dynamic range of the image histogram using color models like RGB or HSV[2]. Some of the Popular techniques histogram equalization, contrast limited adaptive histogram equalization (CLAHE).

1. *Physics-Based Image Restoration:* Various deep learning techniques are proposed. GANs are the most popular one. But this type of problem requires a huge amount of relevant data to train the model. Non availability of this type of underwater image along with appropriate labels creates a problem during model training.
2. *IFM-free underwater image enhancement methods:* It improves the contrast and color of images, mainly based on pixel intensity re-distribution, even without considering the underwater imaging principle particles.
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III. LIMITATIONS OF PREVIOUS WORK

There were various limitations in previous methods. Some of the common problems are :

1. *Image deraining*:
   Based on the statistical properties of rainy streaks lots of conventional algorithms are proposed but they do not consider the physical formation model that's why the results are not that much good [4]. Also the result is variant with reflex properties of water and give much sophisticated result than the other techniques.

2. *Image dehazing*:
   One of the most important reasons for success of any dehazing method is designing an effective set of handcrafted features for estimating transmission maps. Due to issues in creating a set of features the previous methods failed to produce significant results.

3. *Image super-resolution and low-level vision tasks:*
   Super Resolution Convolutional Networks (SRCNN) are introduced to solve this problem but SRCCN are not that much effective in restoring the image details.

IV. METHODOLOGY

Basic steps used in underlying image enhancement model are shown in figure 1 as-

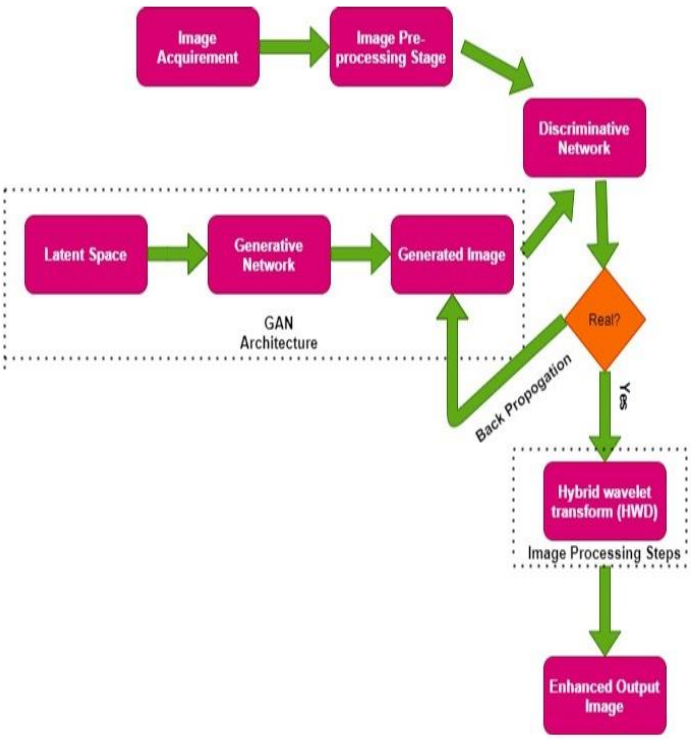


Figure 1

1. *Image Acquirement:*
   In Image Acquirement phase, an image which is captured in underwater system load into the system model. Input image may consists of all the three primary colours i.e. Red, Green and Blue. Some pixel P(x,y) of the image may contains the inconsistent data in comparison of their neighbour pixel due to the loss in data by the virtue of scattering medium. All these inconsistencies, missing data, noise, hazing have to be corrected. So for these our input image goes to second stage where we applied some standard image processing techniques to minimizes these above effects.

2. *Image Pre-processing stage:*
   In this stage, many image processing techniques are apply on the input image which is totally based on the input image properties. Firstly as we discussed above, input image consists of all three colour channels i.e. Red, Green and Blue. So we have to convert it into the gray scale image which has pixel range of 0 to 255 exhibit from 8 bit colour level. Then input image may suffered from uneven illumination. So for this Homomorphic filtering is apply on image and then gaussian modesting technique is apply. Input image may suffers from low contrast. So to enhance this Histogram equalization is used in global. For denoising median filtering and gaussian convolution is used[3]. Non-Linear filters are generally used for this because they can preserve edges and more powerful in comparison to the linear filters due to able to minimize the noise without blurring the edges.

3. *GAN Detection phase:*
   One of the methods that are very useful for image restoration is Generative Adversarial Network GAN. In order to maintain the consistency of output of GANs, a discriminative network is introduced in the proposed model. A general GAN network learning algorithm is learning by adversarial learning process.

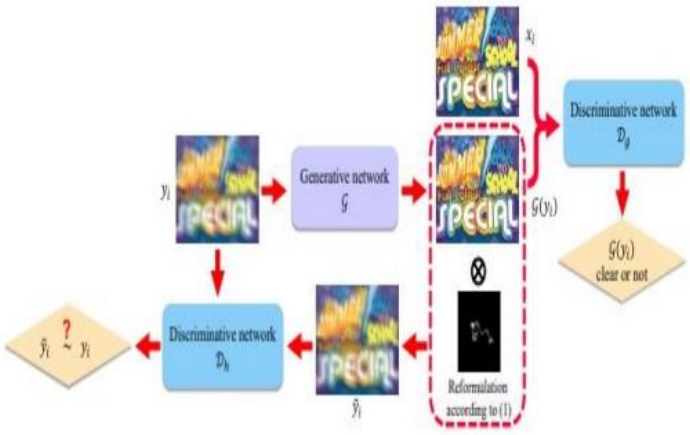


Figure 2

It can be viewed as a min max game where each component is trying to maximize its utility function and by doing so it is minimizing other component's utility value. The Generator is trying to generate some fake images and wants to fool the discriminator on the h discriminator needs to identify those fake images from true images. The discriminator is essentially a binary classifier. The idea is that the generative

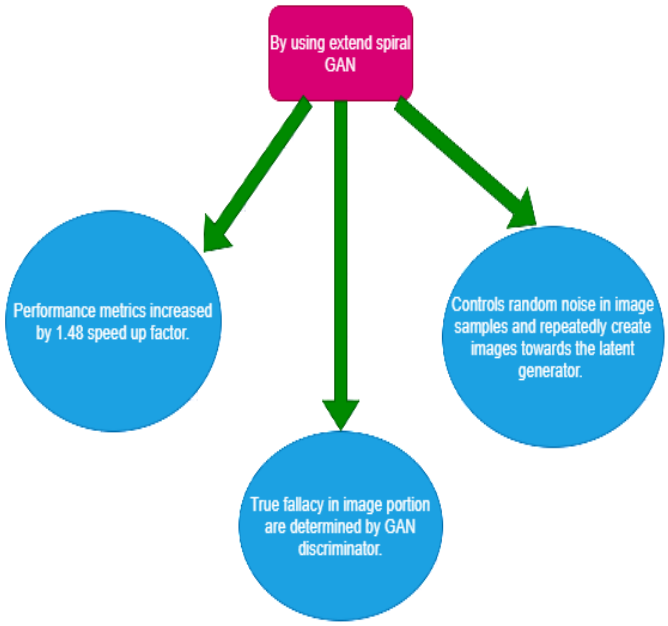
network learns the mapping function G and generates the intermediate deblurred image $G(y_i)$ from the input y_i then the image degradation model is applied. The discriminative network Dh takes the blurred image y_i and the regenerated image y_i in the form of inputs to classify whether the generated results satisfy the blur model or not. The other discriminative network Dg takes the ground truth xi and the intermediate deblurred image $G(y_i)$ in the form of inputs in order to cross check whether $G(x_i)$ is correct or not.

It is a technique mainly used for deep neural networks. There are various advantages to use this network because it generalizes with limited amount of data and simulates new scenes from that limited data set and conceives it into more realistic. Basically here GAN architecture uses mainly 2 components i.e. Generator and Discriminator. The task of generator is to produce new sample dataset image so that the agent can not distinguish between the fake and the real image while the task of discriminator is to detect the fake dataset image by using the previous word learning experience. Basically we use GAN architecture mainly due to 3 reasons-

a. We have limited dataset of underwater images. and the training of the algorithm to apply image processing methods i.e. HWD transform & Photo fusion we required large data samples so for this We use GAN which can simulated the whole process.

b. Image processing tool may takes time so we improve and optimize the existing algorithm be using GAN. Here we are not apply the HWD & Photo fusion process on whole image rehension rather we divided an image into small chunks or modules and then discriminator determines that whether specified module necessary requires the transform or not if it requires then we apply the Hybrid wavelength transform and photo fusion and if it not necessary then it simply ignores that module [3]. So by this Time complexity is increases to a large extent.

c. In GAN architecture a residual multiscale dense block is generated and this learning can improve the performance as well as loss information which is needed in Hybrid wavelength transform & Photo fusion. The discriminator component births to new computationally light spectral normalization for non saturating decomposition of underwater image.



4. *Hybrid Wavelength Transform (HWD) & Photo fusion:*

For sharpening the image we use the HWD transform and then we apply a high pass filter to remove low frequency background. and then wavelet fusion is applied on the image by adaptive histogram equalization process to reduce the gap between dominant and inferior color channel [5] . Photo fusion is applied on the certain image portion generated by true residue fallacy label by the GAN discriminator.

V. PROPOSED METHOD

Basic steps used in underlying proposed image enhancement method are shown in figure 3 as-

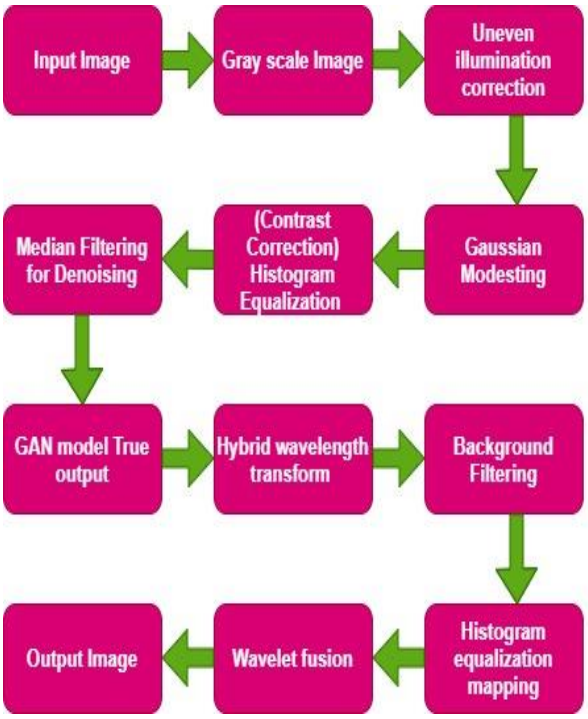


Figure 3.

Specified image enhancement method includes various steps in order to accomplish this task. We are considering an input image on which some pre-processing need to be done. Then image sharpening is done by applying HWD transform on the pre-processed image. After performing HWD transform resultant image will be pass through high pass filter in order to remove low intensity background. Next step is to perform histogram mapping, the major task is to map grayscale image to RGB color channel. Histogram mapping step will be followed by wavelet fusion and adaptive histogram specification.

1. *Pre-Processing:*
   In pre-processing step the input image will be converted to grey scale image. Basically it is converting 3D pixel value(R, G, B) to 1D pixel value. The main purpose of grey scale transformation is to extract features of image such as edge detection.

2. *Uneven illumination correction:*
   In this stage we are applying homomorphic or stretching algorithms to corrects the uneven illumination in the image by formulating log illuminance – reflectance model of the image.

3. *Removal of low intensity Background signal:*
   This step includes the Butterworth filter or gaussian modest technique. The Butterworth filter will be used as high pass filter. Butterworth high pass filter is applied to remove low intensity background signals. This work is done to convert image into natural logarithm domain before applying Fast Fourier transformation (FFT) on it.

4. *Histogram Equalization Mapping:*
   After removal of low intensity background from image. We will perform histogram mapping on image [7]. Initially we converted image into greyscale image. In this step the greyscale image will be mapped to RGB color channels.

5. *Median Filtering for Denoising:*
   On pre-processed image, HWD transform will be performed. HWD transform stands for hybrid wavelet transform and directional filter banks. In this step initially we will apply conventional discrete wavelet transform (DWT) and then directional filter banks will be applied on the detail sub bands. DWT and directional filter banks are applied on image to perform denoising on image signal. DWT are not good at representation of directional information such as edges and some kind of textures. Thus directional filters are used along with DWT to preserve directional information of image.

6. *GAN architecture true output line:*
   In this stage, GAN architecture generator creates the samples images so that discriminator can not determines the real or fake ones. where as the discriminator uses rehash mapping to determine the true fallacy in the image where only the correction needed and enables the hybrid wavelength transform line for wavelet fusion.

7. *Advance Histogram specification:*
   Histogram specification is mainly used to enhance the some specific areas of an image. Histogram equalization method gives us

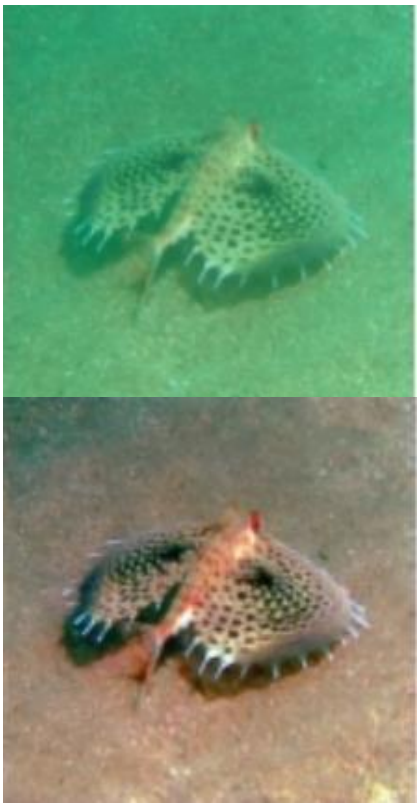
uniform distribution over the intensity distribution. It is an automatic process. But if there is need to focus on some specific areas which requires to get some specific intensity distribution then the need to use histogram specification arises. In our method it is used to enhance contrast and visibility of image. The histograms which are generated will consist of two independent images which will have under and over enhanced effects.

VI. RESULTS

In this paper, we have implemented the project *Underwater image enhancement and uneven illumination correction.* This project is developed using python and matlab. We used matlab language for some standard inbuilt image processing functions and for solving complex physics rules. and by the help of python we implement a GAN architecture that increases the time complexity and optimized the overall program. We downloaded some sample underwater images from the internet and run our project script to generate the enhanced images. These results are shown below-

Test Image-1

Test Image-2



Test Image-3

Test Image-4

VII. CONCLUSION

In this project we used GAN architecture so that we increase the performance metrics and can only determine the true fallacy in image so that we can correct it using image processing standard functions. We have successfully implement wavelet fusion on the true fallacy portion of the image generated by GAN architecture. We also restored the image and enhanced its colors based on the surrounding pixels and by agent color modelling. Some of the work is still left for the future as it is one of the research needed topic we will try to implement physics based bright channel prior for underwater environment and we can rectifying scattering component by evaluating these dark channel priors and numeralizes it with our existing method.

VIII. REFERENCES

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