Underwater Image Enhancement by using Image Processing Techniques

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***Abstract*—** *Underwater images suffer from color casts and low contrast due to wavelength- and distance-dependent attenuation and scattering. To solve these two degradation issues, we present an underwater image enhancement network by using Matlab. In matlab we can use some steps to enhance the image by using Image Processing techniques of the system. As a result, our method can effectively improve the visual quality of underwater images by exploiting multiple color spaces embedding and the advantages of both physical model-based and learning-based methods. Finally, to enhance the images and then to calculate some performance metrics of the System.*

I. INTRODUCTION

Underwater images inevitably suffer from quality degradation issues caused by wavelength- and distance-dependent attenuation and scattering. Typically, when the light propagates through water, it suffers from selective attenuation those results in various degrees of color deviations. Besides, the light is scattered by suspending particles such as micro phytoplankton and non-algal particulate in water, which causes low contrast. An effective solution to recover underlying clean images is of great significance for improving the visual quality of images captured in water and accurately understanding underwater world. The quality degradation degrees of underwater images can be implicitly reflected by the medium transmission that represents the percentage of the scene radiance reaching the camera. Hence, physical model-based underwater image enhancement methods mainly focus on the accurate estimation of medium transmission. With the estimated medium transmission and other key underwater imaging parameters such as the homogeneous background light, a clean image can be obtained by reversing an underwater imaging physical model. Though physical model-based methods can achieve promising performance in some cases, they tend to produce unstable and sensitive results when facing challenging underwater scenarios. This is because 1) estimating the medium transmission is fundamentally ill-posed, 2) estimating multiple underwater imaging parameters is knotty for traditional methods, and 3) the assumed underwater imaging models do not always hold.

Acquiring clear images in underwater environments is an important issue in ocean engineering. The quality of underwater images plays a pivotal role in scientific missions such as monitoring sea life, taking census of populations, and assessing geological or biological environments. Capturing images underwater is challenging, mostly due to haze caused by light that is reflected from a surface and is deflected and scattered by water particles, and color change due to varying degrees of light attenuation for different wavelengths. Light scattering and color change result in contrast loss and color deviation in images acquired underwater. For example, in Fig. 1, the haze in the school of Carangid, the diver, and the reef at the back is attributed to light scattering, whereas color change is the reason for the bluish tone appearing in the brown coral reef at the bottom and the yellow fish in the upper-right corner. Haze is caused by suspended particles such as sand, minerals, and plankton that exist in lakes, oceans, and rivers. As light reflected from objects propagates toward the camera, a portion of the light meets these suspended particles. In the absence of blackbody radiation, the multiscattering process along the course of propagation further disperses the beam into homogeneous background light. Since abundant resources are contained in oceans, rivers and lakes, underwater imaging has been an important and valuable research field that receives much attention for a few decades of Unlike natural image processing, underwater image processing is more challenging due to complicated physical properties of underwater environment, and underwater images easily suffer from color distortion and contrast degradation generated from the absorption and scattering when light is traveling in water. The light captured by the camera is mainly constituted by three components: the direct component (light reflected from the object that has not been scattered in water), the forward scattering component (light reflected from the object that has been scattered at small angles), and the backward scattering component (light reflected not from the target object but from floating particles). An underwater image can be viewed as a linear superposition of the three components. However, the forward scattering component leads to the blurred structures of underwater images whereas the backward scattering component veils underwater image edges and details. Meanwhile, color distortion of underwater images usually results from absorption of different wavelengths at different rates.

Main Contribution

- First, to collect the dataset based on the underwater images.
- Next, to apply the Pre-Processing techniques, to improve the image quality of the system.
- Next, to extract the image based on the RGB and HSV of the system.
- Next to apply the machine learning algorithm like multi-fusion techniques are used to enhance or improve the image quality of the system.
- Finally, the output shown the enhanced image output of the system.

1.1 Image Processing:

Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too.

Image processing basically includes the following three steps:

- Importing the image via image acquisition tools;
- Analysing and manipulating the image;
- Output in which result can be altered image or report that is based on image analysis.

There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre-processing, enhancement, and display, information extraction. Digital image processing is the use of a digital computer to process digital images through an algorithm. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of multidimensional systems. The generation and development of digital image processing are mainly affected by three factors: first, the development of computers; second, the development of mathematics (especially the creation and improvement of discrete mathematics theory); third, the demand for a wide range of applications in environment, agriculture, military, industry and medical science has increased. Digital Image Processing means processing digital image by means of a digital computer. We can also say that it is a use of computer algorithms, in order to get enhanced image either to extract some useful information. A image is defined as a two-dimensional function, **F(x,y),** where x and y are spatial coordinates, and the amplitude of **F** at any pair of coordinates (x,y) is called the **intensity** of that image at that point. When x,y, and amplitude values of **F** are finite, we call it a **digital image**. In other words, an image can be defined by a two-dimensional array specifically arranged in rows and columns. Digital Image is composed of a finite number of elements, each of which elements have a particular value at a particular location. These elements are referred to as picture elements, image elements, and pixels. A Pixel is most widely used to denote the elements of a Digital Image.

1.2 Types of an image

- **BINARY IMAGE–** The binary image as its name suggests, contain only two pixel elements i.e 0 & 1,where 0 refers to black and 1 refers to white. This image is also known as Monochrome.
- **BLACK AND WHITE IMAGE–** The image which consist of only black and white color is called BLACK AND WHITE IMAGE.
- **8 bit COLOR FORMAT–** It is the most famous image format. It has 256 different shades of colors in it and commonly known as Grayscale Image. In this format, 0 stands for Black, and 255 stands for white, and 127 stands for gray.

- **16 bit COLOR FORMAT–** It is a color image format. It has 65,536 different colors in it. It is also known as High Color Format. In this format the distribution of color is not as same as Gray scale image.

1.3 Machine Learning

Machine learning (ML) is a type of artificial intelligence (AI) that allows software applications to become more accurate at predicting outcomes without being explicitly programmed to do so. Machine learning algorithms use historical data as input to predict new output values. Recommendation engines are a common use case for machine learning. Other popular uses include fraud detection, spam filtering, malware threat detection, business process automation (BPA) and predictive maintenance. Machine learning is important because it gives enterprises a view of trends in customer behavior and business operational patterns, as well as supports the development of new products. Many of today's leading companies, such as Facebook, Google and Uber, make machine learning a central part of their operations. Machine learning has become a significant competitive differentiator for many companies. Machine learning (ML) is the study of computer algorithms that can improve automatically through experience and by the use of data. It is seen as a part of artificial intelligence. Machine learning algorithms build a model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications, such as in medicine, email filtering, speech recognition, and computer vision, where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks. A subset of machine learning is closely related to computational statistics, which focuses on making predictions using computers; but not all machine learning is statistical learning. The study of mathematical optimization delivers methods, theory and application domains to the field of machine learning. Data mining is a related field of study, focusing on exploratory data analysis through unsupervised learning. Some implementations of machine learning use data and neural networks in a way that mimics the working of a biological brain. In its application across business problems, machine learning is also referred to as predictive analytics.

1.3.1 Types of Machine Learning

- **Supervised learning:** In this type of machine learning, data scientists supply algorithms with labeled training data and define the variables they want the algorithm to assess for correlations. Both the input and the output of the algorithm is specified.
- **Unsupervised learning:** This type of machine learning involves algorithms that train on unlabeled data. The algorithm scans through data sets looking for any meaningful connection. The data that algorithms train on as well as the predictions or recommendations they output are predetermined.
- **Semi-supervised learning:** This approach to machine learning involves a mix of the two preceding types. Data scientists may feed an algorithm mostly labeled training data, but the model is free to explore the data on its own and develop its own understanding of the data set.
- **Reinforcement learning:** Data scientists typically use reinforcement learning to teach a machine to complete a multi-step process for which there are clearly defined rules. Data scientists program an algorithm to complete a task and give it positive or negative cues as it works out how to complete a task. But for the most part, the algorithm decides on its own what steps to take along the way.

1.3.2 Main Parts of Machine Learning

- **A Decision Process:** In general, machine learning algorithms are used to make a prediction or classification. Based on some input data, which can be labelled or unlabeled, your algorithm will produce an estimate about a pattern in the data.
- **An Error Function:** An error function serves to evaluate the prediction of the model. If there are known examples, an error function can make a comparison to assess the accuracy of the model.
- **An Model Optimization Process**: If the model can fit better to the data points in the training set, then weights are adjusted to reduce the discrepancy between the known example and the model estimate. The algorithm will repeat this evaluate and optimize process, updating weights autonomously until a threshold of accuracy has been met.

1.4 Image enhancement:

Image enhancement is the process of digitally manipulating a stored image using software. The tools used for image enhancement include many different kinds of software such as filters, image editors and other tools for changing various properties of an entire image or parts of an image. Some of the most basic types of image enhancement tools simply change the contrast or brightness of an image or manipulate the grayscale or the red-green-blue color patterns of an image. Some types of basic filters also allow changing a color image to black and white, or to a sepia-tone image, or adding visual effects. More sophisticated types of image enhancement tools can apply changes more specifically to certain parts of an image. Professional packages like those offered by Adobe allow designers to do a more specialized or professional kind of image enhancement or to pursue results for graphic design projects where the actual image is changed into a stylized or otherwise embellished version of itself. More advanced types of image enhancement tools also include features like Wiener filters for actual de-blurring of images and other complex resources for restoring or clarifying images that may be in poor condition, due to sub-optimal image capture conditions, aging or other causes.

1.4.1 Techniques of IE

- **Spatial domain** — enhancement of the image space that divides an image into uniform pixels according to the spatial coordinates with a particular resolution. The spatial domain methods perform operations on pixels directly.
- **Frequency domain** — enhancement obtained by applying the Fourier Transform to the spatial domain. In the frequency domain, pixels are operated in groups as well as indirectly.

1.5 Algorithm used:

Mutiscale Image Fusion

A novel multiscale image fusion system based on contrast enhancement, spatial gradient information and multiscale image matting is proposed to extract the focused region information from multiple source images. The basic idea behind a multiscale analysis is to embed the original signal into a family of derived signals, thus allowing the analysis of different representation levels and, further, the choice of the ones exhibiting the interest features. Multiscale representations or multiresolution analysis/algorithms can be described as a class of design methods in representation theory where the data are subject to repeated transformation to extract features associated with different scales of the system.

Existing multiscale exposure fusion (MEF) algorithms cannot preserve relative brightness in an image fused from two large-exposure-ratio images if high-light regions in the dark image are darker than shadow regions in the bright image. In the literature of image processing I saw there is also Multi-resolution analysis of image which is at different level of images. Whereas in Multi-scale it seems that size of images are not changed instead it gets more blur and edges are getting more clear of the objects. Multiscale decomposition offers an efficient tool for extracting information from an image at different levels of resolution (scales). This type of representation is largely used for image compression, image description, image segmentation, and image registration.

II. PROBLEM STATEMENT

- In our Existing method, to extract the Satellite Image by using some machine learning techniques.
- Some method can be used to process the image to extract some information based on image.
- The approach is based on edge detection method. But they provide some drawback to overcome this drawback we implement the Proposed method to show the results.

Drawbacks

- Image are predicted by using long process of testing.
- Inaccurate.
- Low Performance.

III. DEVELOPMENT PROCESS

3.1 Requirement Analysis and Specifications

The requirement engineering process consists of feasibility study, requirements elicitation and analysis, requirements specification, requirements validation and requirements management. Requirements elicitation and analysis is an iterative

process that can be represented as a spiral of activities, namely requirements discovery, requirements classification and organisation, requirement negotiation and requirements documentation.

3.2 Input Requirement and Output Requirements

Input Design

The input design is the link between the information system and the user. It comprises the developing specification and procedures for data preparation and those steps are necessary to put transaction data in to a usable form for processing can be achieved by inspecting the computer to read data from a written or printed document or it can occur by having people keying the data directly into the system. The design of input focuses on controlling the amount of input required, controlling the errors, avoiding delay, avoiding extra steps and keeping the process simple. The input is designed in such a way so that it provides security and ease of use with retaining the privacy. Input Design considered the following things:

- What data should be given as input?
- How the data should be arranged or coded?
- The dialog to guide the operating personnel in providing input.
- Methods for preparing input validations and steps to follow when error occur.

Objectives

1. Input Design is the process of converting a user-oriented description of the input into a computer-based system. This design is important to avoid errors in the data input process and show the correct direction to the management for getting correct information from the computerized system.

2. It is achieved by creating user-friendly screens for the data entry to handle large volume of data. The goal of designing input is to make data entry easier and to be free from errors. The data entry screen is designed in such a way that all the data manipulates can be performed. It also provides record viewing facilities.

3. When the data is entered it will check for its validity. Data can be entered with the help of screens. Appropriate messages are provided as when needed so that the user will not be in maize of instant. Thus, the objective of input design is to create an input layout that is easy to follow

Output Design

A quality output is one, which meets the requirements of the end user and presents the information clearly. In any system results of processing are communicated to the users and to other system through outputs. In output design it is determined how the information is to be displaced for immediate need and also the hard copy output. It is the most important and direct source information to the user. Efficient and intelligent output design improves the system's relationship to help user decision-making.

1. Designing computer output should proceed in an organized, well thought out manner; the right output must be developed while ensuring that each output element is designed so that people will find the system can use easily and effectively. When analysis design computer output, they should Identify the specific output that is needed to meet the requirements.

2. Select methods for presenting information.

3. Create document, report, or other formats that contain information produced by the system.

The output form of an information system should accomplish one or more of the following objectives.

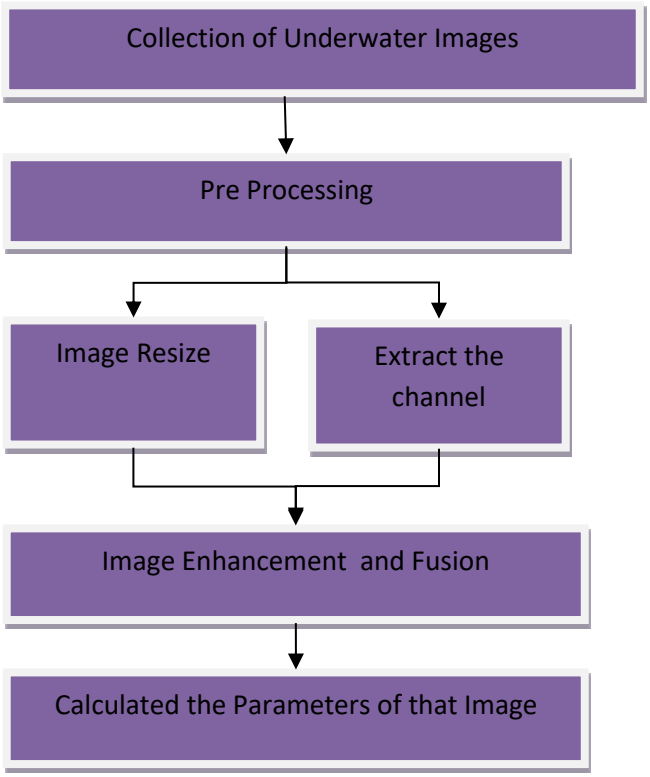
- Convey information about past activities, current status or projections of the
- Future.
- Signal important events, opportunities, problems, or warnings.
- Trigger an action.
- Confirm an action.

IV. PROPOSED METHOD

- In our proposed method, the Paper implemented to improve the quality of image by using Image Processing Techniques.
- Steps are Collection of Image, Preprocessing, Extracted the Images based on the RGB and HSV model, and Image Enhancement techniques are used in the Proposed method of the system.
- All are steps can be derived the matlab Function to process it.
- We show results based on the measuring the performance of our system. Experimental results prove the effectiveness of our method.

4.1 Advantages

- Better Performance.
- Robust
- Efficient.



Modules Used

- **Input Image:** A Collection of data is called datasets. In this study, we can collect the Underwater Images datas to show the results.
- **Preprocessing:** Data cleaning, smoothing, grouping or Filtering the image. Data can require preprocessing techniques to ensure accurate, efficient, or meaningful analysis. Data cleaning refers to methods for finding, removing, and replacing bad or missing data. Here, the Gaussian method is used in the Preprocessing techniques. A Gaussian filter is used to reduce the noise in the input image of the system.
- **Conversion of RGB:** The main purpose of the RGB color model is for the sensing, representation, and display of images in electronic systems, such as televisions and computers, though it has also been used in conventional photography. An RGB image, sometimes referred to as a true colour image, is stored as an m-by-n-by-i data array that

defines red, green, and blue colour components for each individual pixel. RGB stands for red, green, blue. The RGB color model is additive: red, green, and blue light are added together in varying proportions to produce an extensive range of colors. In MATLAB, an RGB image is basically a M*N*3 array of colour pixel, where each colour pixel is associated with three values which correspond to red, blue and green colour component of RGB image at a specified spatial location.

- **Image Fusion:** Image fusion refers to the process of combining two or more images into one composite image, which integrates the information contained within the individual images . The result is an image that has a higher information content compared to any of the input images. The advantages of image fusion include image sharpening, feature enhancement, improved classification, and creation of stereo data sets. Multisensor image fusion provides the benefits in terms of range of operation, spatial and temporal characteristics, system performance, reduced ambiguity and improved reliability.
- **Image Enhancement:** Image enhancement is the procedure of improving the quality and information content of original data before processing. Common practices include contrast enhancement, spatial filtering, density slicing etc. Image enhancement techniques improve the quality of an image as perceived by a human. These techniques are most useful because many satellite images when examined on a colour display give inadequate information for image interpretation. The goal of image enhancement is to improve the usefulness of an image for a given task such as providing a more subjectively pleasing image for human viewing. In image enhancement, little or no attempt is made to estimate the actual image degradation process, and the techniques are often ad hoc.

V. APPLICATION AND FUTURE ENHANCEMENT

- It finds use in inspection of underwater infrastructure and detection of any man-made objects.it is also used to understand marine biology research, for environmental evaluation, for the research of monuments submerged in water and for underwater navigational monitoring in submarines.
- Underwater image enhancement is the area of image processing and it is considered as a dynamic sector. Obtaining the objects visibility at short or long distance in underwater scenes is very challenging and a difficult task.
- The atmospheric light is the main hurdle to process the UW images from bad conditions of visibility under the water, light attenuation and light scattering due to entire reasons which the UW images faces a lot and influence their contrast and visibility which they comprise originally.
- It has examined different techniques applied for underwater image processing and explained how they enhance the quality of the underwater image.

VI. CONCLUSION

The goal of this research is to introduce a system for enhance the image from Underwater images. The main goal is to use Matlab software to improve the Quality of image based on the image processing procedures. The best technique for Enhance the image by using matlab function to process it. Finally, performance measures can be computed to display the outcomes.

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