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A study on deep ocean image processing for object detection using pattern recognition

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Abstract-- *Deep ocean imaging and image processing techniques play a vital role in ocean engineering and scientific research. However, the underwater images usually suffer from low contrast, blurring, color fading, noise, and other distortions, due to these factors the identification of objects in the underwater image becomes difficult. In this work, we propose a multi-tiered underwater image processing system by incorporating various image enhancements, restoration and edge detection algorithms. The implementation of these mechanisms enhances the image quality by removing distortions and further this enhanced image is used to obtain patterns with which presence of various underwater species and objects can be analyzed.*

Keywords-- *Underwater Image Processing, Image Enhancement, Image Restoration, Pattern Recognition, Edge Based Matching*

I INTRODUCTION

Submerged image processing is of paramount importance due to the growing demand for naval resources in various applications such as sea bed topography research, monitoring sea life, assessing geological and biological environment. It is a challenging task due to various perturbations present in the water. The light is exponentially attenuated due to scattering and absorption, thus the resultant images poorly contrasted and hazy. The scattering of light is subdivided between forward dispersion and backward dispersion. When the pictures stretch out, the clarity is low and the intensity is diminished by backward dispersion. We need to research the distribution of light in water in order to get underwater pictures of decent accuracy. As light passes through vapor, based on the wavelength of colour, the rate of light loses exponentially. Because the elements are last removed, much of the photos captured under the surface appear blue-green. These limitations influence the overall performance of underwater imaging systems.

We propose an approach, integrating various image enhancement, image restoration and edge detection algorithms to overcome the limitations prevalent in underwater images and further identify underwater objects. Image enhancement is initially carried out by increasing the intensity levels of the image or parts of the image so that the resultant image is of good quality compared to the captured images. The Contrast Limited Adaptive Histogram Equalization (CLAHE) is the enhancement algorithm used here. It prevents the over amplification of

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noise as well as increases the contrast of local regions in the image. Consequently, the Dark Channel Prior (DCP) algorithm is used as an image restoration algorithm as it removes haze, noise and blur from an image. Enhancement and restoration techniques are an important step because the quality of the image should be high in applications like object detection. Finally, the Canny Edge Detection algorithm is applied to detect edges and extract important features of an image which is helpful in image analysis and object detection.

II LITERATURE REVIEW

In [2], Sudhakar et al. postulated various conventional techniques for image enhancement. It described the details of the primitive algorithms which laid down the basis for modern sophisticated algorithms. These enhancement techniques are not only for underwater images nevertheless container likewise be applied to medical pictures, satellite images etc. The proposed methods failed to prove and was challenging to get optimal results.

In [3], advocated a multi-step image processing system to enhance the image quality and reconstruct the image. Enhancement is done using image inpainting and super resolution. But it was[24] found to be deficient to deal with images with complex structure and low resolution.

Model Developments and implementations of image processing have simplified different frameworks used in [4].It explained the feature-based approaches for object recognition. It explained the mathematical basis for template matching algorithms, Besides, it also sited various applications of template matching in computer vision, medical analysis etc.

[5] In Moumita Bhowmik et al., a comparative study of various processes for image enhancement and hybrid algorithm proposed to enhance image quality is described. The methods of histogram equalization and gamma correction have been included to enhance the image. The signal was higher than the noise level. However, the issues also exist with bad comparison and inadequate resolution.

Prior to and Contrast enhancement is suggested in [6] for the Dehazing Algorithm Utilizing Dark Screen. The optical model provides advantages for the haze picture and the dark channel before color adjustments are limited. The process honors conventional methods 'demerits and improves comparison with limited distortion. This strategy Nevertheless, over-stretched illusions are not resolved.

III IMAGE PROCESSING TECHNIQUES

Pattern recognition is the basis for recognition of patterns and regularities. These techniques standardize, explain and visualize the patterns. Pattern recognition is different from pattern matching. Pattern Recognition is carried out in 2 ways: Template matching and Feature detection. It has wide range of applications such as speech recognition, facial recognition, digital image processing, number plate recognition, optical character recognition etc. Pattern recognition is the operation of categorization of the observed data. There are two types of items for recognition which includes concrete items and abstract items. This paper mainly focuses recognition of concrete items. There are three main phases in pattern recognition data acquisition, data preprocessing and decision analysis. In the data acquisition phase, the samples are collected and organized. The second phase deals with

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preprocessing of images using enhancement and restoration techniques. The final phase is carried out by edge-based detection techniques for analyzing the preprocessed images.

Image improvement involves improving the interpretation or interpretability of data in pictures to help explain users or to provide context for certain automated picture processing techniques. The graphical representation of an picture becomes transparent by enhancing its quality, including light, colour, contrast, etc. In image processing strategies there are 2 major groups, i.e. Enhancing representation of the spatial domain and enhancing the picture of the Frequency domain. Both changes are rendered within the image plane itself in Spatial domain methods and the pixel worth modulation is added directly to the image's input pixels. In frequency domain processing, the input picture converts to the frequency domain and executes operations within the transformed frequency domain and returns to spatial format in order to achieve the final result. The strategies of the space domain include the equalization of the histogram, the equalization of the adaptive histogram, the equalization of the histogram structure, etc. Compared to the strategies of frequency fields, these methods are comparatively simpler to grasp and quantify. These methods are often less costly to introduce.

Our implementation is mainly focused on Contrast Limited Adaptive Histogram Equalization (CLAHE). We adopt CLAHE technique rather than the other methods because it is able to increase the contrast of image better than other standard histogram methods. It is an adaptive contrast enhancement technique. It produces optimal equalization by means of maximum entropy. This method is highly useful where the need for brightness is high as in underwater environments or geographic channels. This was created by an adaptive histogram parallel in the contextual area of a pixel in which a histogram is generated. In the view spectrum equal to the severity rank of the local sensitivity histogram, the severity is therefore exploited. It has 2 block and clip size parameters that are used to improve the quality of the file. The clip limit determines the noise limit and the contrast that needs to be enhanced. Based on the clip limit the CLAHE method clips the histogram. The CLAHE method had improved the contrast better in the underwater images as shown.

Image Repair is a clean image from a darkened image. The key goal of restore is the elimination and regeneration of noise. In contrast to development, this is an empirical mechanism that is a discretionary mechanism. It requires engineering decay to recapture the initial picture and executing the reverse cycle. The restored image cannot be described as the actual image but as the approximation of the original object. The restoration techniques are of two kinds Blind and Non-Blind restoration techniques. We adopted Dark Channel Prior (DCP) algorithm in our implementation since it relieves the complexity in the inversion process. Haze removal is a crucial step in our implementation since it upgrades the performance of computer vision processes. The properties of dark pixels are centered on it. The DCP is composed of four major methods, namely ambient light evaluation, map assessment, map processing and image reconstruction. The ambient light is measured roughly from the dark channel during the first phase. The following process deals with the issue of underestimation. The third step focuses on enhancing map refinement efficiency. The image will be restored, and the dehazed picture will be created.

The edges are sudden variations in pixel size, generally induced by an image shimmer or a contrast normally occurring on the boundary between two areas. The main determination of the edge uncovering is to minimize the amount of statistics to be processed by eliminating redundant picture detail, while maintaining a picture structure. It extracts important features of an image such as the curves, lines, corners which is helpful in recognizing objects, limitations and division. In the image segmentation literature, there are many edge detection methods. Sobel Edge Detection, Roberts Edge Detection, and Canny Edge Finding are the most widely employed discontinuity dependent detection techniques. Canny Edge Detection is used in this case as it is immune to noisy environment, enhances the signal with deference to the noise, appropriate for both simple and complex images and also provides an overall improved performance.

IV PROPOSED HYBRID ALGORITHM

Our proposed algorithm works in three different phases.

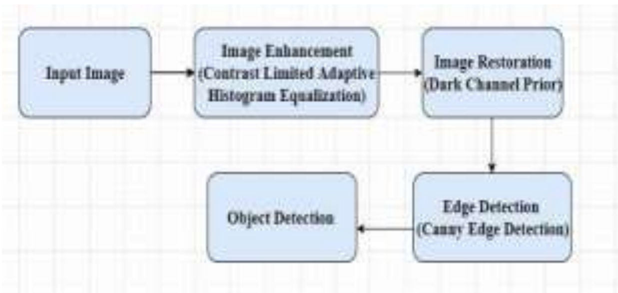

Figure 1: Hybrid Algorithm

The Histogram equalization algorithm for Contrast Dependent Adaptive is used to boost the picture quality. By measuring its average frequency, the color picture is transformed to a gray image. The Dark Channel Prior is recycled for removing haze in the background illuminations of enhanced images. The restored image is given as a input to Canny algorithm to trace the edges.

The proposed algorithm is as follows:

Step 1: Input color image

Step 2: Create a CLAHE object which converts RGB image to gray scale image.

Step 3: Compute dark channel and atmosphere

Step 4: Estimate the transmission and soft matting

Step 5: Recuperate the scene radiance

Step 6: Determine the gradient of the image to detect the density of the edges and direction

Step 7: Non Maximum Supression is carried out to thin edges

Step 8: Double threshold is done to classify the pixels

Step 9: The weak pixels are converted into strong pixels using threshold values.

Step 10: Finally the edge is tracked using hysteresis values

V SIMULATION RESULTS

The findings of our research indicate that the hybrid algorithm is significantly faster than the standard algorithm. The simulation program in Windows 10 operating system is used in Python version 3.5. The subjective picture output was also dramatically improved. It has been clearly shown how the edges of the objects are clearly mapped on the ocean floor.

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Figure 2: Source image

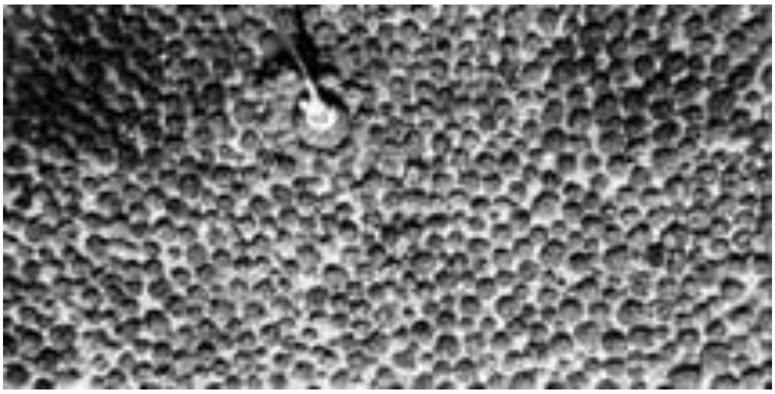

Figure 3: CLAHE enhanced Image

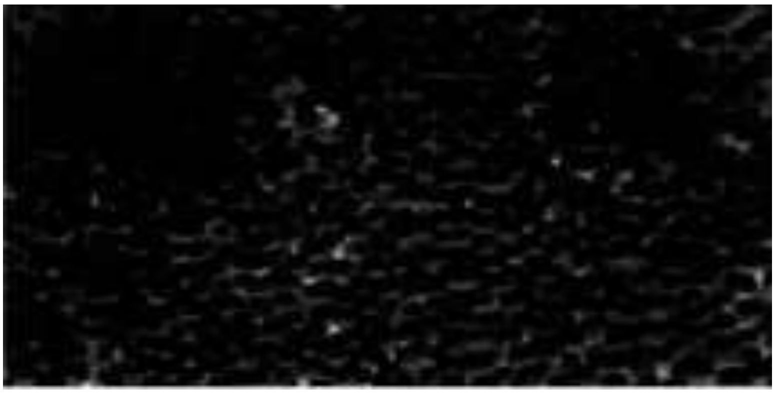

Figure 4: Dark Channel image

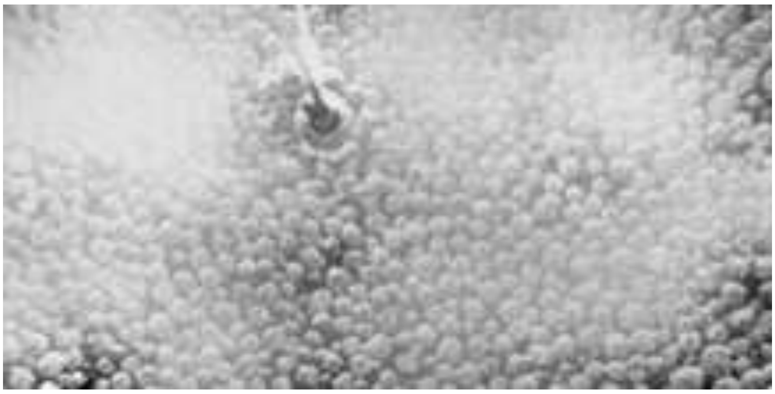

Figure 5: Transmission rate computed image

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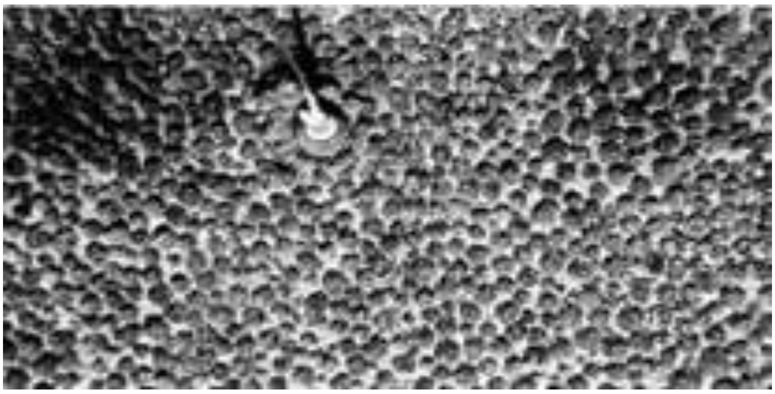

Figure 6: Dehazed Image

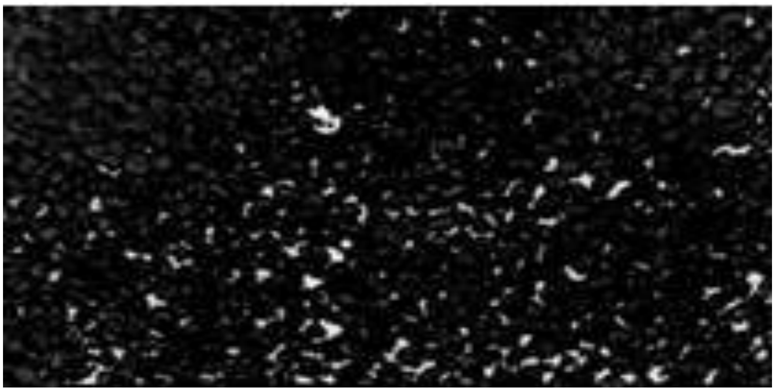

Figure 7: Edge Detected Image

The performance parameters of canny edge detector include Peak Signal to Noise Ratio, Mean square error, Maximum squared error, L2RAT.The below graphs shows the comparative study of aforesaid performance parameters between the traditional algorithm and our proposed algorithm for the considered sample images.

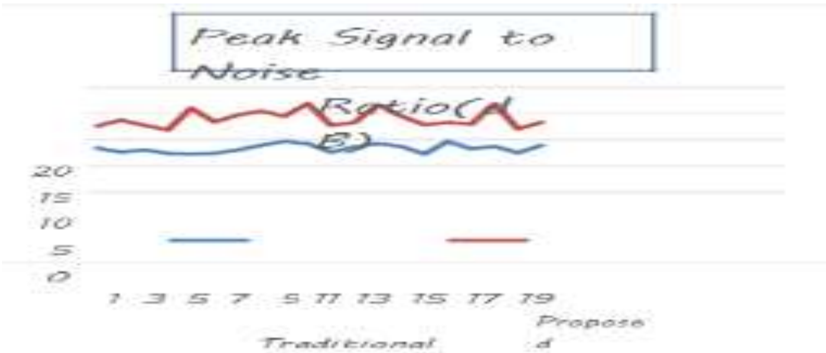

Figure 8: Different between Peak Signal and Noise Ratio

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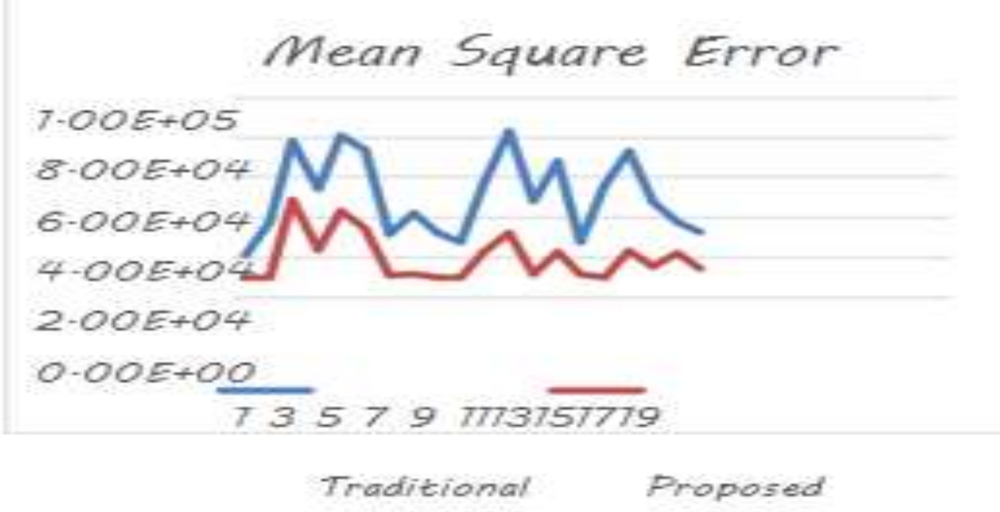

Figure 9: Mean Square Error

VI CONCLUSION

Pattern recognition wreathes a broad scope in various undulated regions. This paper details various effective strategies utilized for processing the underwater images and helps in object detection by automatic segmentation of different shaped objects in the underwater environment. Most of the research based on object detection in deep ocean has been done in very few foreign countries. This hybrid method is also suitable for images taken under blurry, stormy conditions. Through various experiments and comparisons, the proposed system shows extended performance, in terms of speedy processing and quality of output.

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