ANALYSIS THE QUALITY OF UNDERWATER IMAGES USING INDIAN KNOWLEDGE SYSTEM

Prof. Aarti A. Kadwe
College Of Management And Computer Science, Yavatmal
cmcs.aartikadwe@gmail.com

Prof. Minal S. Shende
College Of Management And Computer Science, Yavatmal
cmcs.minalshende@gmail.com

Abstract
Underwater imaging plays a very important role in marine research and ecological studies, particularly in the context of the Indian Knowledge System (IKS). However, the quality of underwater images is often compromised due to light absorption, scattering, turbidity, and non-uniform lighting, which lead to reduced visibility, poor color contrast, and noise. This paper explores various image enhancement techniques inspired by traditional Indian scientific approaches and modern computational methods. The proposed methodology involves channel extraction, white balancing, and histogram equalization to improve image quality, color accuracy, and contrast. The study integrates principles from the IKS, such as traditional optical methods, to optimize underwater image processing. By enhancing image quality, this research aims to contribute to better interpretation and analysis the underwater images, particularly for applications in marine archaeology and biodiversity conservation.
Keywords: *Underwater Image Processing, White Balancing, Histogram Equalization, Image Enhancement*

1. Introduction

Underwater images are essential for documenting and studying marine ecosystems, submerged archaeological sites, and traditional water systems in India. However, image quality is significantly affected by environmental factors such as light scattering, refraction, and turbidity. Water absorbs different wavelengths of light at varying rates, leading to color distortions, reduced contrast, and blurriness. Additionally, noise and limited visibility make it difficult to extract meaningful information from these images.

The Indian Knowledge System (IKS) has long included scientific methods related to optics, water management, and natural image enhancement. Ancient Indian texts, including those on optics and light propagation, provide valuable insights that can be adapted to modern image enhancement techniques. This paper integrates traditional knowledge with contemporary computational techniques, focusing on enhancing underwater image quality using methods like channel extraction, white balancing, and histogram equalization. By improving underwater imagery, this study aims to support research in marine ecology, archaeology, and conservation.

2. Literature Review

Several researchers have explored underwater image enhancement techniques using various methodologies:

1. **Gautam et al. (2020) [1]** proposed a three-stage algorithm using a Point Spread Function (PSF) and Weighted Median Channel Prior (WMCP) to improve underwater grayscale images.
2. **Saha (2019) [2]** implemented Histogram Equalization (HE) to enhance image contrast but noted issues with mean brightness alteration.
3. **Elbehiery (2018)[3]**applied image enhancement techniques such as grayscale manipulation, filtering, and Fast Fourier Transform (FFT) to reduce noise and improve contrast.
4. **Chiang & Chen (2017) [4]** addressed light scattering and color change in underwater images, using dehazing and wavelength compensation techniques to restore visibility.
5. **He et al. (2016) [5]** developed the Dark Channel Prior (DCP) method to remove haze and improve visibility in underwater images.
6. **Galdran et al. (2015) [6]** introduced the Red Channel method to restore lost contrast and correct color distortions in underwater images.
7. **Siddharth Gautam, Tapam Kumar Gandhi, B.K.Panigrahi [7]** proposed three stage algorithm for higher visibility on gray scale images with PSF (Point Spread Function), Color Balancing Module is used to change image to color format and WMCP (Weighted Median Channel Prior) is used for the estimation of scene depth and background light.
8. **Bidyut Saha [8]** proposed the Histogram Equalization methodfor contrast enhancement. It is one of the well-known methods for enhancing the contrast of a given image by the

sample distributionHistogram Equalization (HE) is a simple and effective image enhancement technique. But, it tends to change the mean brightness of the image to the middle level of the permitted range, and hence is not very suitable for a consumer product.

9. **Hussam Elbehiery[9],**thermal image enhancement includes many techniques used in Quality Control, Problem Diagnostics, and Insurance Risk Assessment. Various enhancement schemes are used for enhancing an image, which include gray scale manipulation, filtering and Histogram Equalization (HE), Fast Fourier Transform, which results in highlighting interesting detail in images, removing noise from images, making images more visually appealing, edge enhancement, and increasing the contrast of the image.
10. **J. Chiang, Y. Chen [10],**Light scattering and color change are two major sources of distortion for underwater photography. Light scattering is caused by light incident on objects, reflected and deflected multiple times by particles present in the water before reaching the camera.
11. **K. He., J. Sun, X. Tang [11]** proposed a simple but effective image prior—dark channel beforeremoving haze from a single input image. The dark channel prior is a kind of statistics of outdoor haze-free images. It is based on a key observation—most local patches in outdoor haze-free images contain some pixels whose intensity is very low in at least one-color channel.

3. Problem Statement

- Underwater images experience with blurriness, low contrast, color distortion, and noise due to environmental effect such as light scattering and refraction. These issues make it difficult to understand and interpret marine research data, archaeological findings, and biodiversity assessments. Conventional image enhancement techniques have limitations, including excessive contrast enhancement and color distortion.
- This research aims to develop an improved image enhancement technique using principles from the Indian Knowledge System combined with modern computational methods. By addressing the challenges of noise, contrast, and color correction, this study seeks to improve the clarity and usability of underwater images.

4. Objectives

- To analyze the impact of environmental factors on underwater image quality.
- To develop a contrast enhancement technique incorporating IKS principles and computational methods.
- To enhance underwater images using channel extraction, white balancing, and histogram equalization.
- To reduce noise and improve image clarity while preserving natural color balance.
- To apply these enhancement techniques for better visualization in marine research and archaeological documentation.

5. Software Used

The proposed system is implemented using:

- **MATLAB**: For image processing, enhancement, and visualization.

6. Algorithm

1. **Input Image Acquisition**: Capture an underwater image using a high-resolution camera.
2. **Preprocessing**: Remove unwanted distortions using noise filtering techniques.
3. **Channel Extraction**: Separate RGB color channels to analyze individual color components.
4. **Grayscale Conversion**: Convert the image into a grayscale format for contrast analysis.
5. **White Balancing**: Adjust the color balance to correct distortions caused by water depth.
6. **Histogram Equalization**: Enhance image contrast by stretching intensity values.
7. **Post-processing**: Apply sharpening and smoothing filters to refine the enhanced image.
8. **Output Image**: Generate the final processed image with improved visibility and contrast.

7. Proposed Work

The proposed methodology integrates traditional Indian optics with computational image enhancement techniques. The key components include:

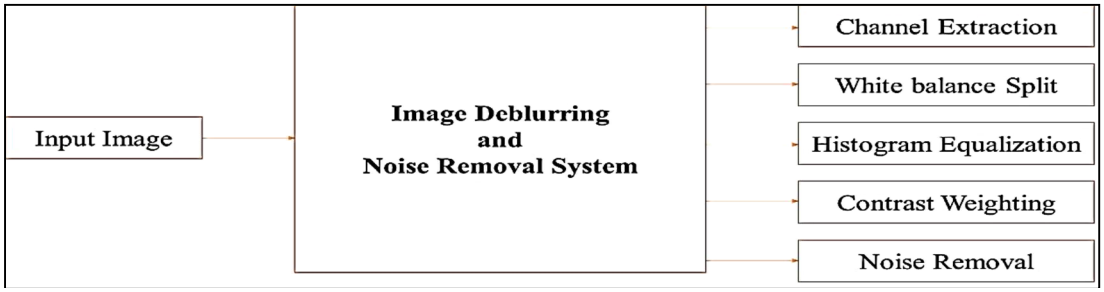

Fig 7.1 Proposed System Architecture

1. Image Preprocessing

- Reducing noise and blurriness using filters.
- Correcting distortions caused by water refraction.

2. Channel Extraction

- Separating the Red, Green, and Blue (RGB) channels.
- Analysing individual channels to enhance clarity.

3. White Balancing

- Adjusting color components using traditional principles of light reflection and absorption from Indian optical science.
- Ensuring accurate color representation without oversaturation.

4. Histogram Equalization

- Enhancing image contrast using histogram adjustment techniques.
- Preserving natural brightness levels to avoid artifacts.

5. Implementation and Testing

- Comparing the enhanced image with the original to validate improvements.
- Testing performance using image quality metrics such as Peak Signal-to-Noise Ratio (PSNR) and Structural Similarity Index (SSIM).

8. Result

Separate each channel in the input image i.e. red channel, green channel and blue channel

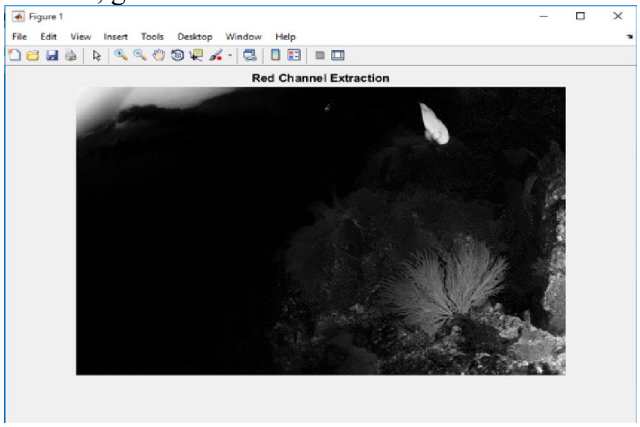

Fig.8.1 Red Channel

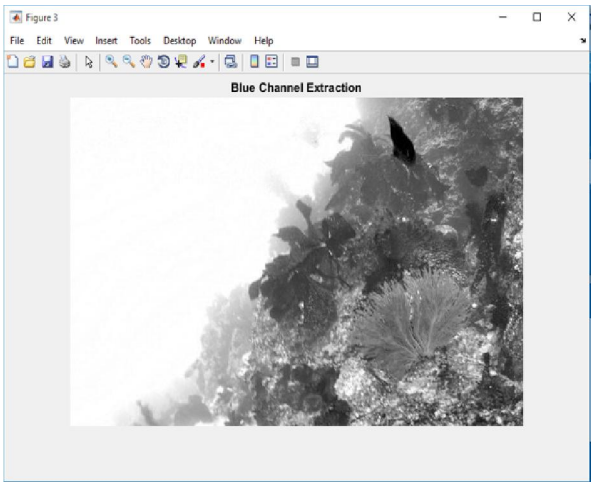

Fig.8.2 Blue Channel

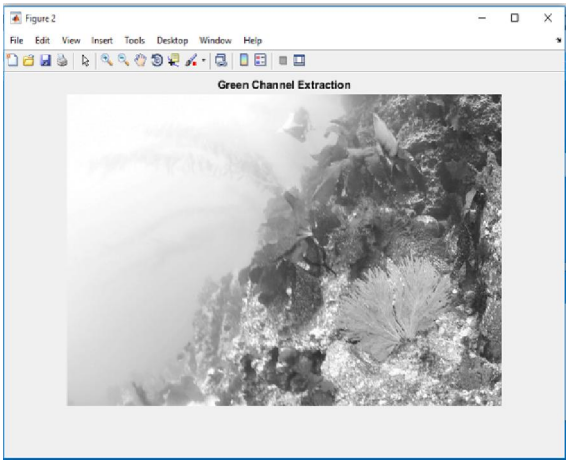

Fig.8.3 Green Channel

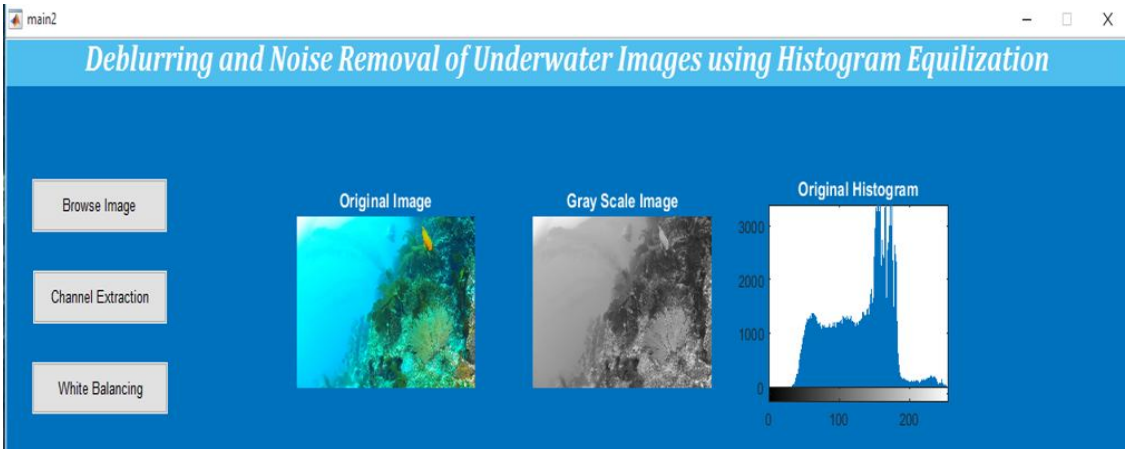

Fig.8.4 Gray Scale Image and Histogram

Ones the channels are extracted then image is converted to gray scale using rgb2gray() and histogram is plotted using imhist() in matlab.

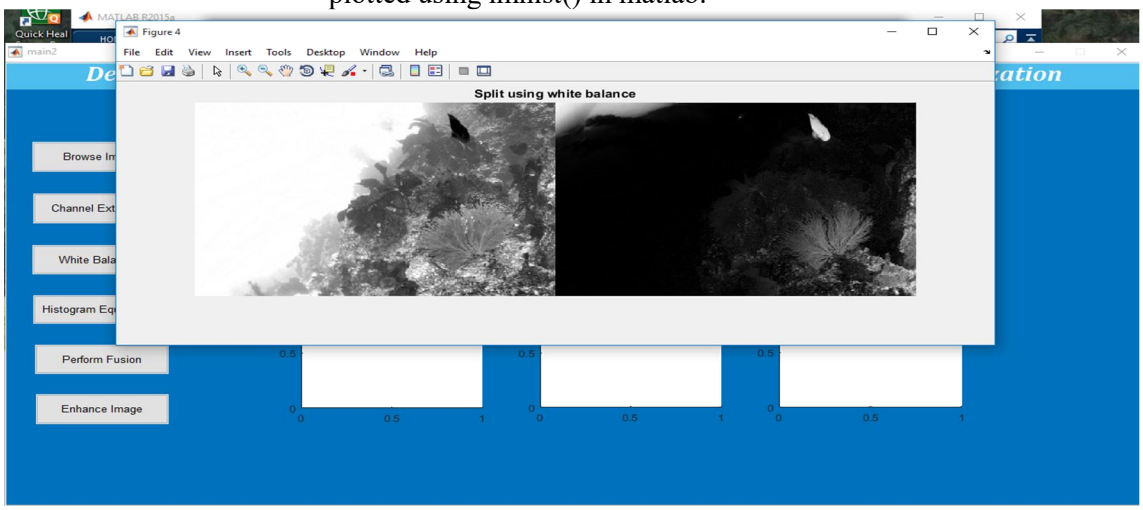

Fig.8.5 White Balance Image

Ones the image is converted to gray, we extract the variations of image using white balance split. Color balance is used on gray scale to perform this function.

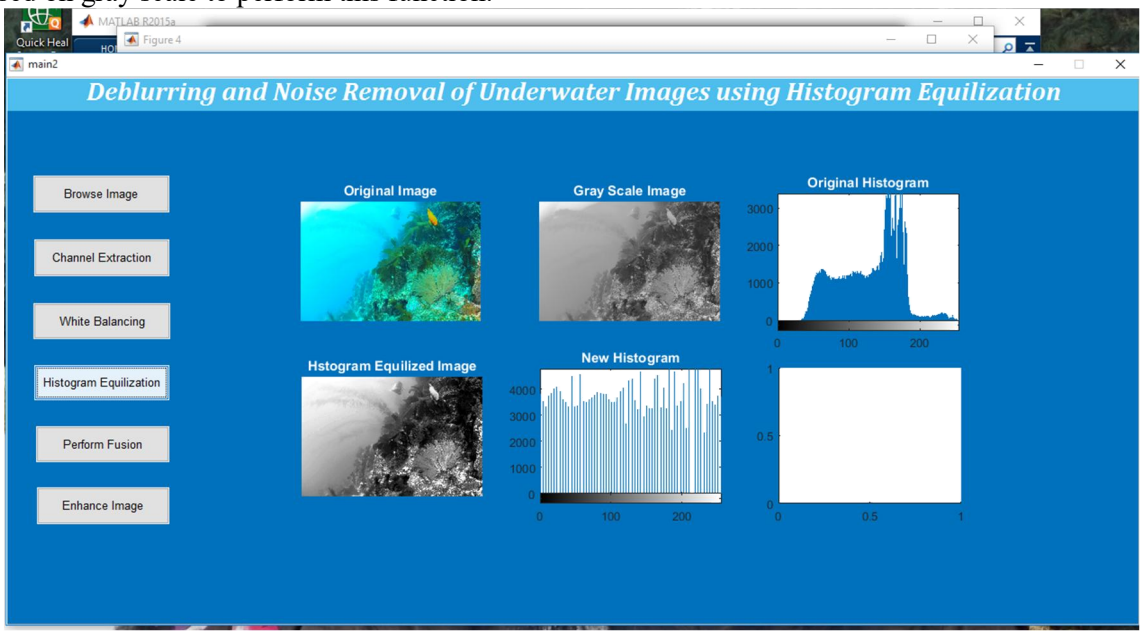

Fig.8.6 Histogram Equalization

Based on white balance split the gray scale image is then converted to enhanced gray image using histogram equalization. It is performed using histeq().

9. Conclusion

This paper presents an approach to enhancing underwater image quality by combining the Indian Knowledge System with modern image processing techniques. The proposed methodology effectively reduces noise, improves contrast, and restores color accuracy using channel extraction, white balancing, and histogram equalization. By integrating traditional Indian optical concepts with computational enhancements, this research contributes to better visualization and interpretation of underwater images. Future work can focus on refining deep-learning-based restoration methods while incorporating additional elements from ancient Indian water science for further improvements.

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