iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** XII **Month of publication:** December 2023

DOI: https://doi.org/10.22214/ijraset.2023.57286

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue XII Dec 2023- Available at www.ijraset.com

Underwater Image Restoration System

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Abstract: ***Underwater imaging poses significant challenges due to light absorption, scattering, and color distortion. This paper introduces an innovative underwater image restoration system designed to enhance the visibility and analytical capabilities of underwater imaging. The proposed system employs advanced image processing techniques to address the inherent issues associated with underwater photography.***
The methodology involves the development of a model that accounts for the optical properties of water, including attenuation and scattering. By leveraging this model, the system corrects color distortions and enhances contrast, leading to improved clarity in underwater images. Additionally, a novel algorithm is employed to reduce the impact of particulate matter, such as suspended sediments, contributing to a clearer representation of the underwater scene.
The system incorporates machine learning approaches for adaptive filtering, allowing it to dynamically adjust parameters based on environmental conditions. This adaptability enables the restoration system to perform effectively across a range of underwater scenarios, from clear to turbid waters.
Experimental results demonstrate the effectiveness of the proposed system in restoring underwater images, showcasing notable improvements in visibility and detail. The application of the system extends beyond visual aesthetics, providing enhanced data for underwater analysis, object recognition, and environmental monitoring.
This underwater image restoration system contributes to the advancement of underwater exploration, marine research, and various underwater applications by providing a reliable and efficient solution for improving the quality of underwater images, ultimately aiding in a more accurate understanding of the underwater environment.
Keywords: Underwater Imaging, Image Restoration, Visibility Enhancement, Light Attenuation, Scattering Correction Color Distortion, Underwater Analysis

I. INTRODUCTION

The exploration and analysis of underwater environments play a pivotal role in various scientific, industrial, and recreational domains. However, the inherent challenges associated with underwater imaging, such as light absorption, scattering, and color distortion, often hinder the acquisition of clear and visually informative images. These challenges are particularly pronounced in diverse underwater scenarios, ranging from clear tropical waters to turbid coastal regions. In response to these challenges, this paper introduces an advanced Underwater Image Restoration System aimed at improving the visibility and analytical capabilities of underwater imagery. The significance of clear and accurate underwater images cannot be overstated, as they are essential for tasks ranging from marine research and environmental monitoring to underwater archaeology and industrial inspections. The proposed system leverages sophisticated image processing techniques and incorporates a model that accounts for the optical properties of water. By addressing issues such as attenuation and scattering, the system aims to correct color distortions and enhance contrast, thereby significantly improving the overall quality of underwater images. The outcomes of this research promise not only aesthetically pleasing underwater images but also a wealth of information for underwater analysis, object recognition, and environmental monitoring.

II. LITERATURE REVIEW

In “Automatic Red-Channel underwater image restoration” Adrian Galdran, David Pardo, Artzai Picón , Aitor Alvarez-Gila. This paper propose a Red Channel method, where colors associated to short wavelengths are recovered, as expected for underwater images, leading to a recovery of the lost contrast. Results show that this technique handles gracefully artificially illuminated areas, and achieves a natural color correction and superior or equivalent visibility improvement when compared to other methods(1)
“Recent advances in underwater image restoration technique based on polarimetric imaging” Hu Haofeng, Li Xiaobo, Liu Tiegen. This paper, discusses the basic principle of underwater image restoration technique based on polarimetric imaging and the methods of polarization information processing. They also reviewed the recent advances of representative improved approaches in underwater image restoration technique based on polarimetric imaging(2)

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"Underwater Image Restoration Based on Image Blurriness and Light Absorption" Yan-Tsung Peng, Pamela C Cosman. This paper proposes a depth estimation method for underwater scenes based on image blurriness and light absorption, which can be used in the image formation model (IFM) to restore and enhance underwater images.(3)

"Deep Underwater Image Restoration and Beyond" Akshay Dudhane, Praful Hambarde, Prashant Patil, Subrahmanyam Murala. This Paper, proposes a novel end-to-end deep network for underwater image restoration. The proposed network is divided into two parts viz. channel-wise color feature extraction module and dense-residual feature extraction module.(4)

"Underwater image restoration based on a new underwater underwater image formation mode" They proposed a technique for underwater image restoration to enhance the visual quality of the image. The authors introduced a new model for the creation of underwater images that takes into account light and imaging characteristics. The medium transmissions of the three channels of an underwater image are then predicted using a medium transmission estimate approach for underwater images based on joint priors.(5)

"Self-Tuning Underwater Image Restoration" Emanuele Trucco and Adriana T. Olmos Antillon. Based on a simplified version of the Jaffe–McGlamery underwater image formation model. Optimal values of the filter parameters are estimated automatically for each individual image by optimizing a quality criterion based on a global contrast measure. (6)

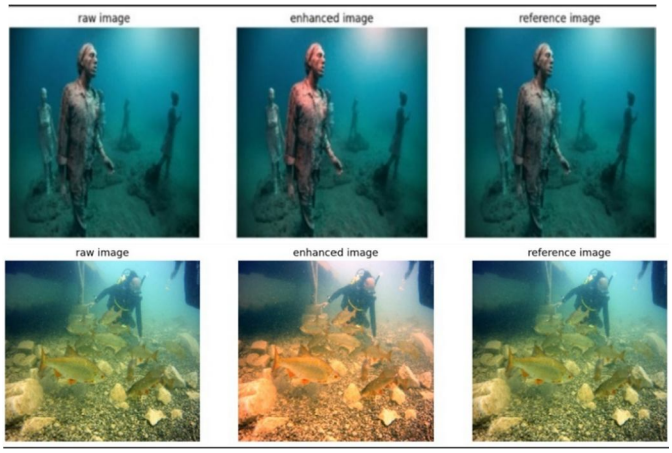
"Periodic integration-based polarization differential imaging for underwater image restoration" Qinyan Huang, Weixian Qian. They propose an innovative underwater image restoration technique based on the periodic integration of polarisation pictures in order to get rid of the interferences of inconsistent polarisation direction and image noise in standard PDI systems. To perform underwater picture restoration, the technique substitutes one or two pairs of orthogonal polarisation images with the integration of a number of polarisation images in PDI system.(7)

"Improving Visibility and Fidelity of Underwater Images Using an Adaptive Restoration Algorithm"
Jun-Kai Guo, ChiaChi Sung, Herng-Hua Chang. It Consists of two major phases: visibility restoration and fidelity restoration. First they have used haze removal technique to dehaze underwater images. After that they have equalize the color mean in each RGB channel to balance the color. Then transform the color space from RGB to HSV. Then adjust V channel according to the brightness value of RGB to enhance the contrast.(8)

III. PROPOSED SYSTEM

The proposed Underwater Image Restoration System is a comprehensive solution to address the challenges inherent in underwater imaging. It integrates advanced image processing techniques, adaptive filtering, and machine learning to enhance the quality of underwater images. Key components include a model to account for water's optical properties, color correction, and contrast enhancement algorithms, as well as innovative methods to mitigate the impact of particulate matter. The system's adaptability is ensured through machine learning, allowing real-time adjustments based on environmental conditions. The system undergoes thorough performance evaluation, aiming not only to restore image aesthetics but also to provide a practical tool for scientific analysis, object recognition, and environmental monitoring in diverse underwater scenarios. The user-friendly interface enhances accessibility for researchers and practitioners in the field.

IV. RESULTS



V. CONCLUSION

This paper has presented an innovative Underwater Image Restoration System designed to tackle the challenges associated with underwater imaging, including light absorption, scattering, and color distortion. The significance of clear and accurate underwater images cannot be overstated, as they are fundamental for various applications, ranging from scientific research to industrial inspections.

The proposed system leverages advanced image processing techniques, adaptive filtering, and machine learning approaches to enhance the visibility and analytical capabilities of underwater imagery. By addressing the optical properties of water, including attenuation and scattering, the system corrects color distortions and improves contrast, leading to a clearer representation of the underwater scene.

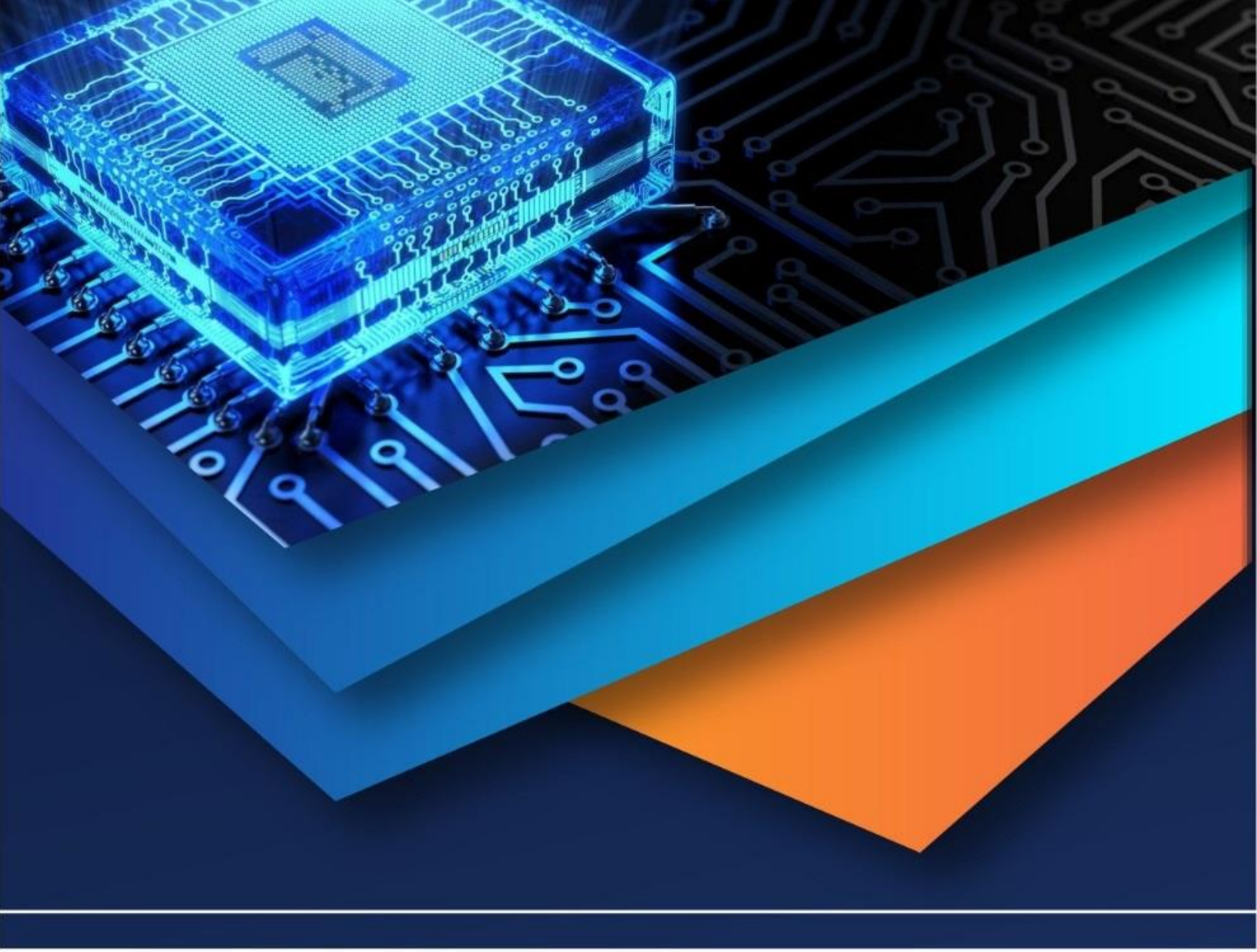
The adaptability of the system is a key feature, as it incorporates machine learning algorithms for adaptive filtering. This enables the system to dynamically adjust parameters based on the specific environmental conditions, making it effective across a spectrum of underwater scenarios, from clear tropical waters to turbid coastal regions.

Experimental results have demonstrated the effectiveness of the Underwater Image Restoration System in significantly improving image quality, and showcasing enhanced visibility and detail. Beyond aesthetic improvements, the system holds great promise for advancing underwater analysis, object recognition, and environmental monitoring.

Looking forward, ongoing research in this field should continue to address the remaining challenges, such as real-time processing constraints, varying water conditions, and the development of more robust algorithms. The integration of multi-sensor systems and the exploration of novel imaging technologies are potential directions for future advancements in underwater imaging.

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