Problem Statement

Underwater imaging poses significant challenges due to the unique environment in which it occurs. Water absorbs and scatters light in ways that are radically different from air, leading to issues such as color distortion, low contrast, and reduced visibility. These factors hinder the effectiveness of various applications, from marine biology research and underwater archeology to search and rescue operations and underwater robotics.
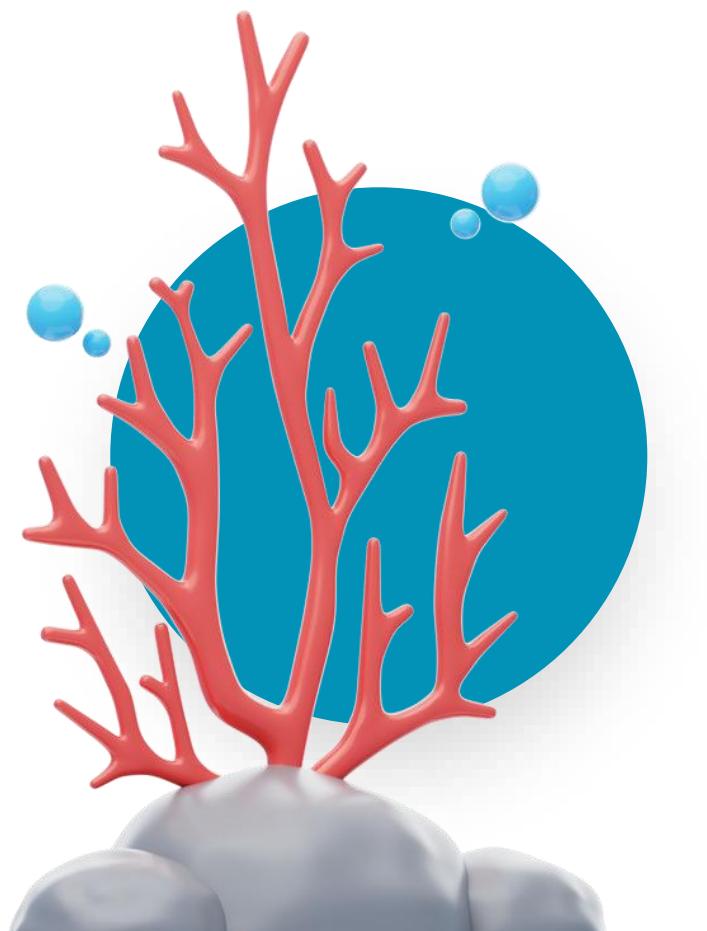
Solution

The goal of this project is to address these challenges by developing advanced techniques for enhancing underwater images. To solve this problem, we've thought of bringing a tool that can remove distortion, balance contrast and increase visibility .

In this project we have applied various operations for noise reduction, color correction and contrast enhancement.

Here are the operations we performed to enhance the quality of images taken underwater-

1.Noise reduction

The first step in the process includes noise reduction by smoothing the image. Compensate image based on flag. Basically, compensating R(Red) and B(Blue) channel.

2.Color correction

Following the noise reduction step, the next step is to perform color correction separately on every color channel. Apply Gray World Algorithm to complete color correction (White balancing using Gray World Algorithm).
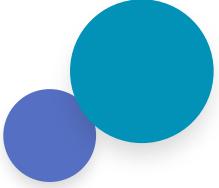
3.Contrast Enhancement

The next step is to perform contrast enhancement in order to improve the visibility of objects in the image. Image fusion refers to combining more than one image to get a high-quality single image. In this case, multi-scale fusion can be used to integrate the color-corrected image and contrast-enhanced image to get a high-quality underwater image. The assessment metrics like PSNR can be incorporated to evaluate the relative quality of the image obtained by this method.
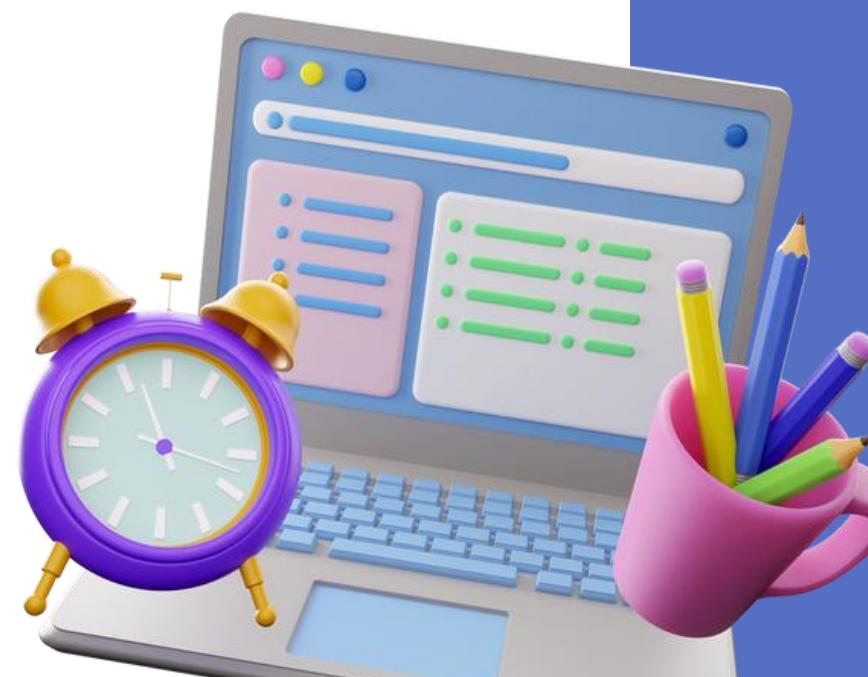
Steps of Contrast Enhancement are-

➢ Image Sharpening Of White Balanced Image

➢ Perform contrast enhancement using Global Histogram Equalization

➢ Perform Unsharp Masking to sharpen the color corrected image

➢ Fusion of sharpened image and contrast enhanced image

  ➢ Perform averaging-based fusion of sharpened image & contrast enhanced image

  ➢ Perform PCA-based fusion of sharpened image & contrast enhanced image

Used Tools & Technologies

- **Editor:** Jupyter Notebook

- **Language:** Python

- **Libraies:** numpy, pandas, opencv-python, opencv-python-headless==4.7.0.72, tqdm, PyQt5<=5.15.9, imutils, matplotlib, scikit-learn, scikit-image, colormath, scipy, ultralytics, Pillow, Pytest-shutil
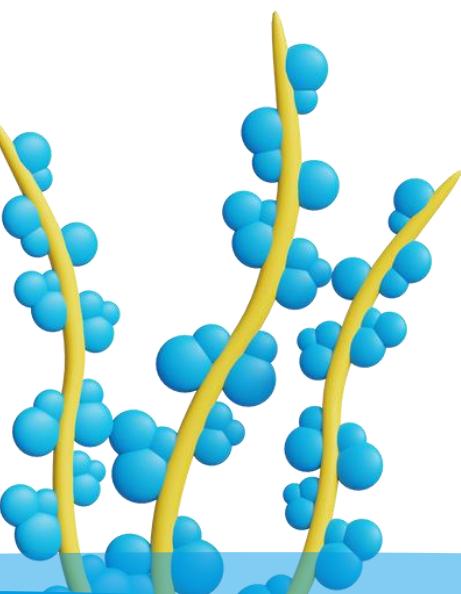
Reference

- Y. Wang, W. Song, G. Fortino, L. Qi, W. Zhang and A. Liotta, "An Experimental-Based Review of Image Enhancement and Image Restoration Methods for Underwater Imaging," in IEEE Access, vol. 7, pp. 140233-140251, 2019, doi: 10.1109/ACCESS.2019.2932130.

- Weidong Zhang, Lili Dong, Tong Zhang, Wenhai Xu, Enhancing underwater image via color correction and Bi-interval contrast enhancement, Signal Processing: Image Communication, Volume 90, 2021, 116030, ISSN 0923-5965, https://doi.org/10.1016/j.image.2020.116030.

Conclusion

Our project has effectively tackled the major challenges of underwater imaging by **improving *color accuracy, contrast, and visibility***. The process we developed significantly enhance the quality of underwater images, making them clearer and more reliable. These improvements benefit various fields such as marine biology, archaeology, and underwater robotics, demonstrating the transformative potential of our approach in enhancing underwater imaging.

THANK YOU