Digital Image Processing Lab

Presentation On

Underwater Image Enhancement

-by Team Pixel

Guided By

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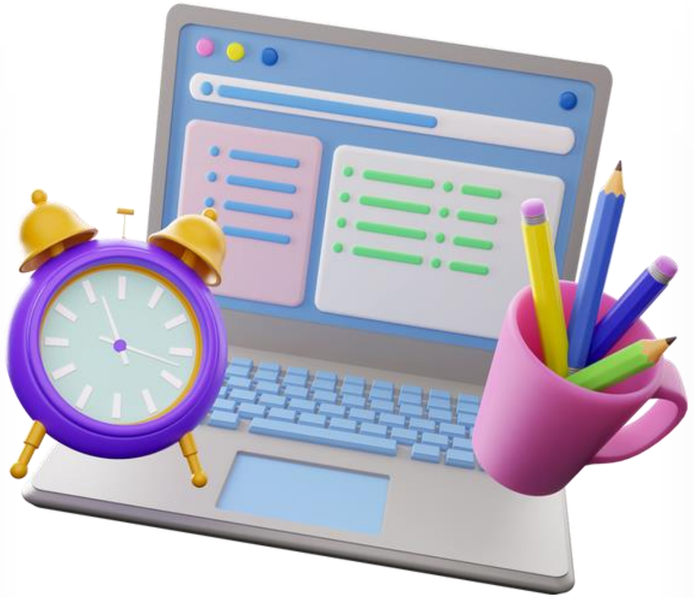

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Problem Statement

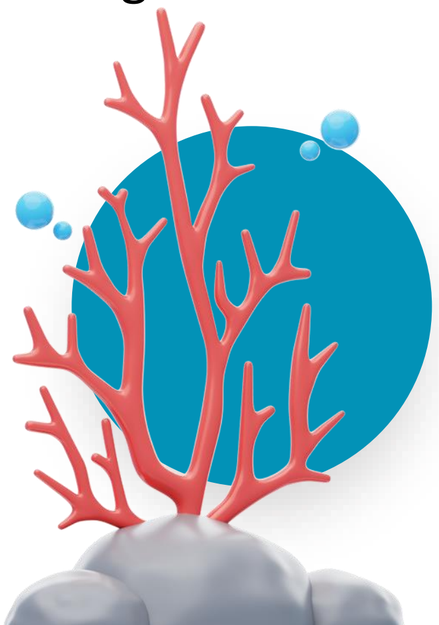
Underwater images often suffer from poor visibility, low contrast, and color distortions due to the unique properties of water. As light travels through water, it is absorbed and scattered more than in air, leading to loss of colors, especially red wavelengths, and an overall bluish-green tint. Particles in the water further scatter light, causing haziness and reduced contrast.

These issues pose significant challenges for applications that rely on clear underwater imagery, such as marine biology research, underwater surveillance, archeology, and recreational diving photography.

Objective

The objective of our project underwater image enhancement is to restore and improve the visual quality of underwater images by addressing color distortion, increasing contrast, and reducing haze effects.

This enhancement is essential for better analysis, feature extraction, and object recognition in underwater environments.



Operations

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 using global histogram equalization.

4.Sharpening Image

The next step is to perform unsharp masking to sharpen the color corrected image.

5.Fusion

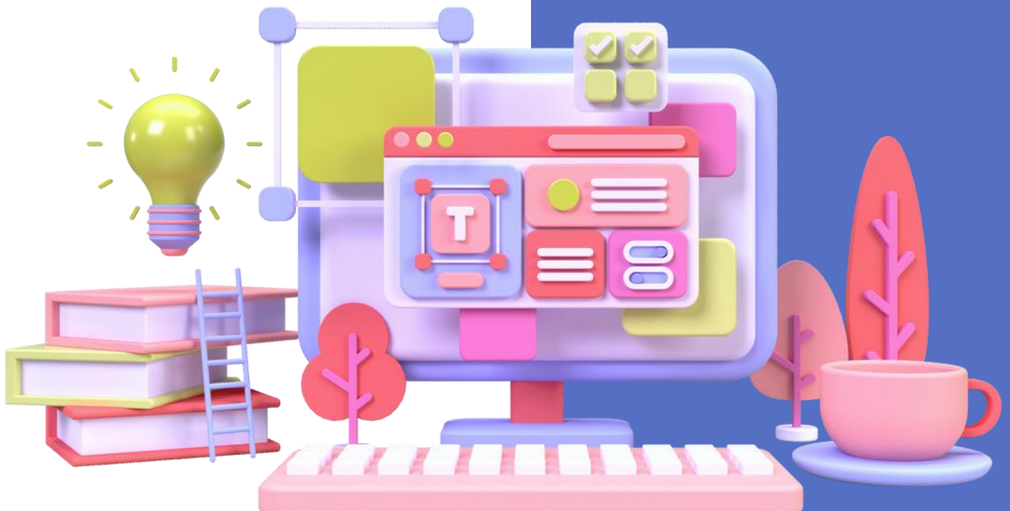
- Perform averaging-based fusion of sharpened image & contrast enhanced image
- Perform PCA-based fusion of sharpened image & contrast enhanced image.

Evaluation

Here, **Mean Squared Error (MSE)** and **Peak Signal-to-Noise Ratio (PSNR)** metrics are calculated for the PCA fused and average fused images. This metrics quantify the quality of the enhancement by measuring how similar the fused images are to the reference image in terms of noise and signal strength.

Used Tools & Technologies

- **Editor:** Jupyter Notebook , Pycharm
- **Language:** Python3
- **Framework:** Streamlit(Python framework)



User Activity Diagram

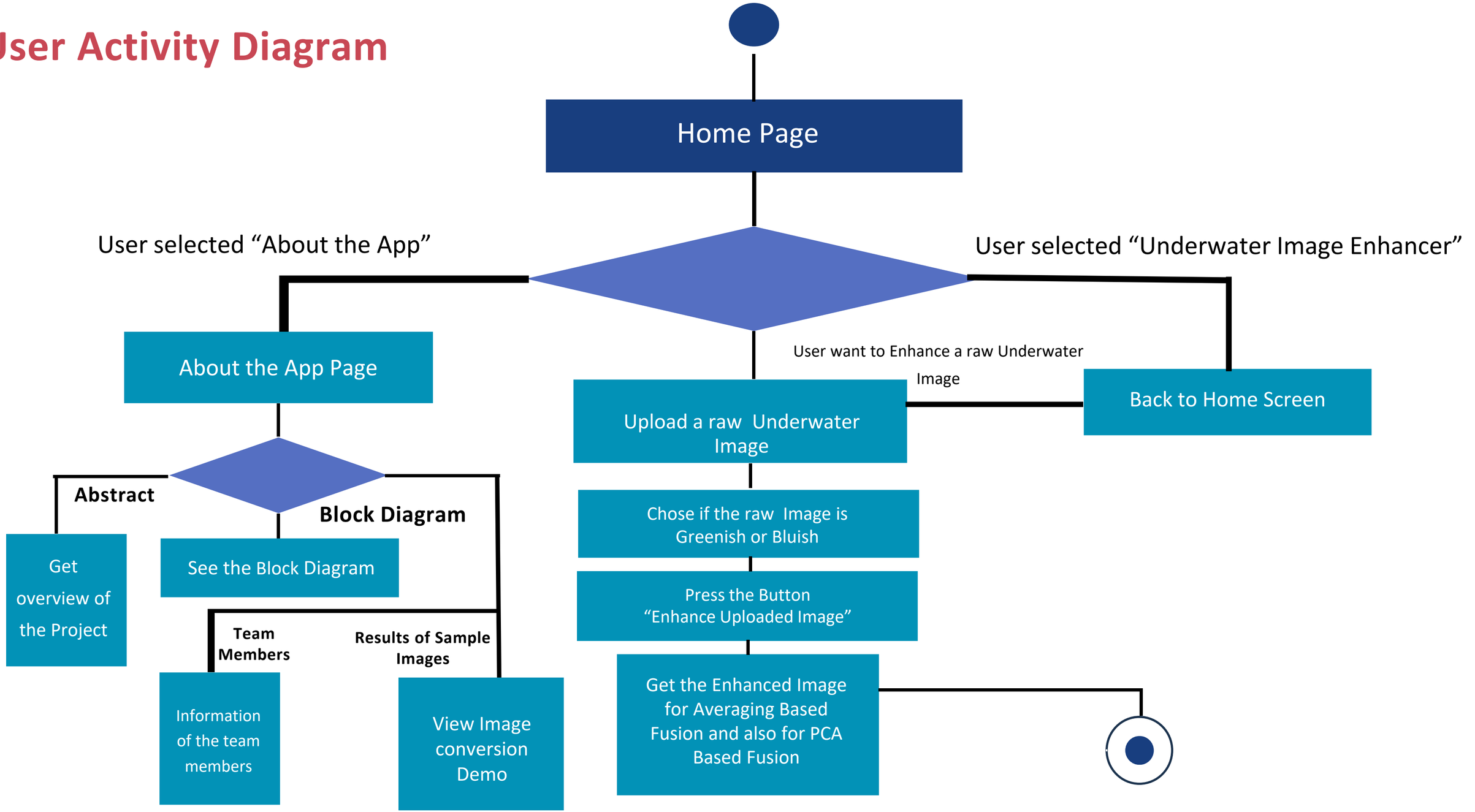


Figure: User Activity Diagram

Use Case Diagram

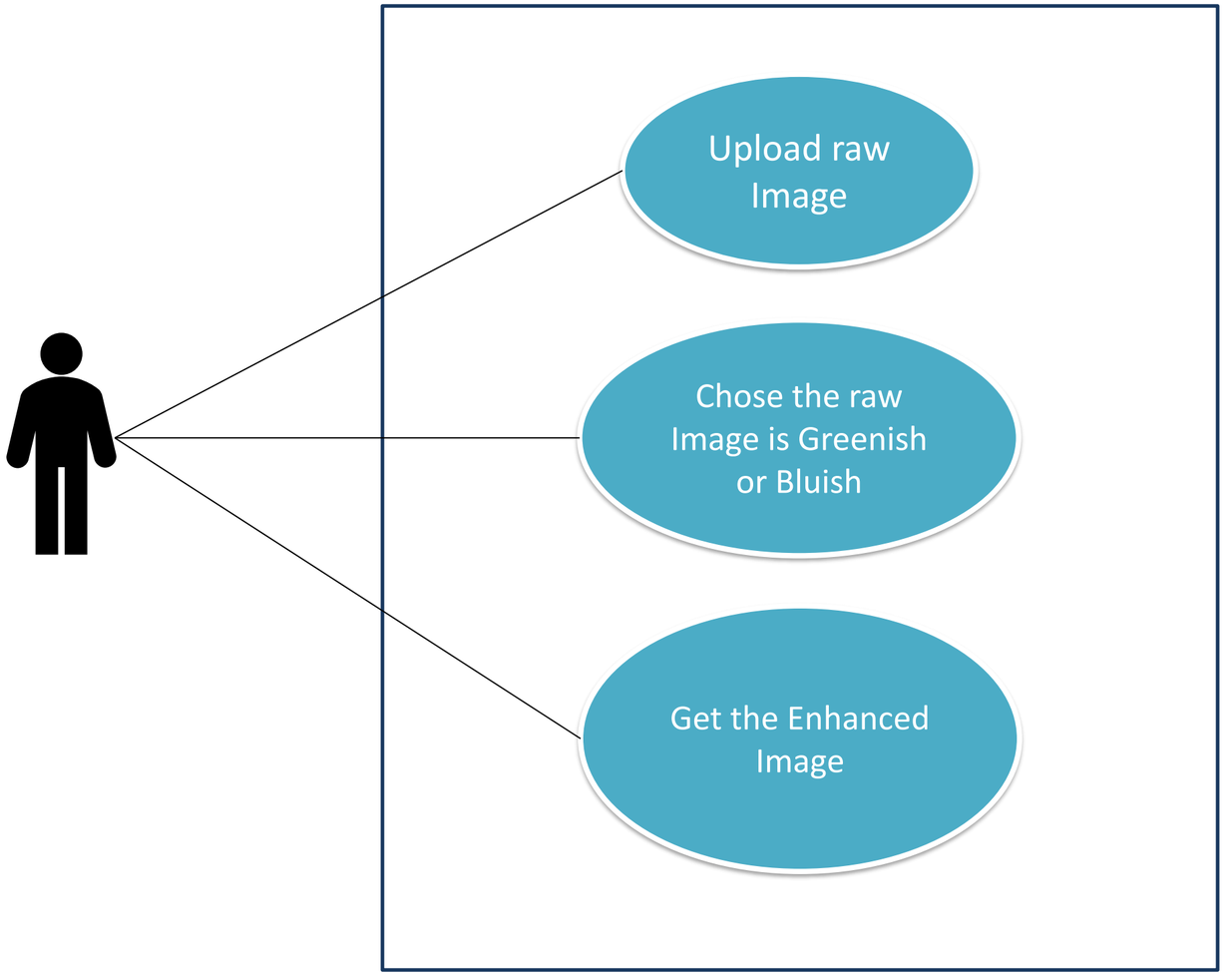
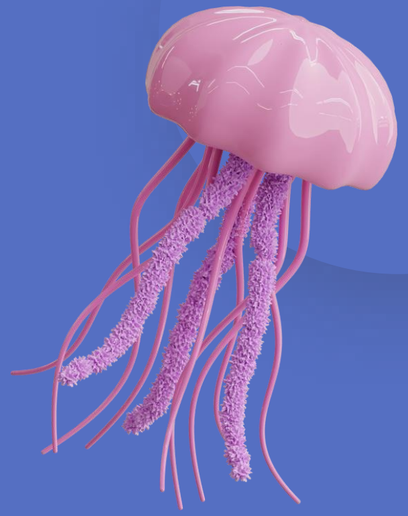


Figure: Use Case Diagram

Implementation



localhost:8501

Deploy

Select from dropdown

About the App

Welcome!

Underwater Image Enhancement Web App

Abstract

Block Diagram

Results On Sample Images

Team Members

underWaterImageWebApp

localhost:8501

Deploy

Select from dropdown

Underwater Image Enhancer

Underwater Image Enhancement Web App

Please upload a RGB underwater image file

Drag and drop file here

Limit 200MB per file • JPG, PNG, JPEG

Browse files

under6.jpg 126.9KB

Uploaded Image

underWaterImageWebApp

localhost:8501

Deploy

Select from dropdown

Underwater Image Enhancer

Enhance Uploaded Image

Compensating Red/Blue Channel Based on Green Channel...

White Balancing the compensated Image using Grayworld Algorithm...

Enhancing Contrast of White Balanced Image using Global Histogram Equalization...

Sharpening White Balanced Image using Unsharp Masking...

Performing Average Based Fusion of Sharped Image & Contrast Enhanced Image...

Performing PCA Based Fusion of Sharped Image & Contrast Enhanced Image...

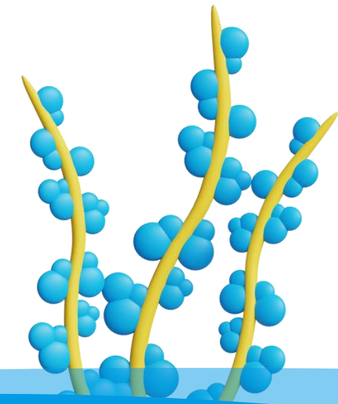
Enhanced Image Using PCA Based Fusion

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