Color Balance and Fusion for Underwater Image Enhancement

Digital Image Processing Project

Under Guidance of -
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INTRODUCTION

- The research paper provided an efficient approach for enhancing underwater photographs that have deteriorated due to medium scattering and absorption. It does not need any special equipment or understanding of the underwater environment.
- Enhance a wide variety of underwater photographs with great accuracy (e.g., different cameras, depths, and light conditions).
- Recover crucial features and edges that have faded over time.
- The dark portions of our upgraded photographs and movies are better exposed, the overall contrast is increased, and the edges are sharper.

MOTIVATION

Three types of problems are involved in underwater image photography :

Research Works

- inspection of underwater infrastructures like cables & underground connections
- detection of man made objects
- control of underwater vehicles
- marine biology research
- archeology

Image Degradation

- poor visibility, foggy appearance & contrast degradation (due to attenuation of the propagated light ,absorption and scattering effects in the medium)

Image Capturing

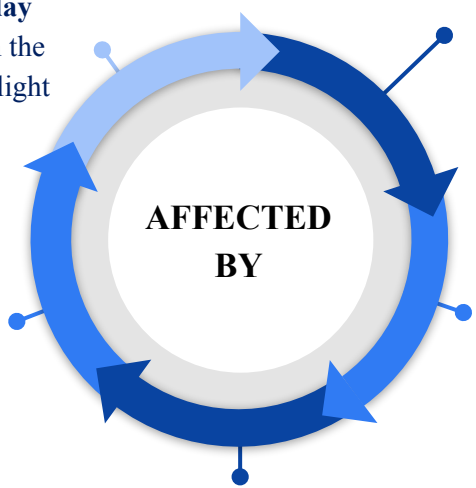
- Objects at a dist. of more than 10m are unperceivable in sea water
- colours are dimmed because

BACKGROUND KNOWLEDGE

Light Propagation in Underwater

1. The time of the day
impacts the change in the angle of incidence of light

2. The shape of the interface
between air and water
(rough vs calm seam)



3. Variable amount of light available under water
the density of particles is several hundreds of times denser in seawater than in normal atmosphere

5. Diving location
directly impacts the available light,

- seas and oceans - green blue
- casts tropical waters - cyan,
- reefs- high visibility

4. The floating particles existing in
the underwater medium also cause the scattering of the incident rays of light.

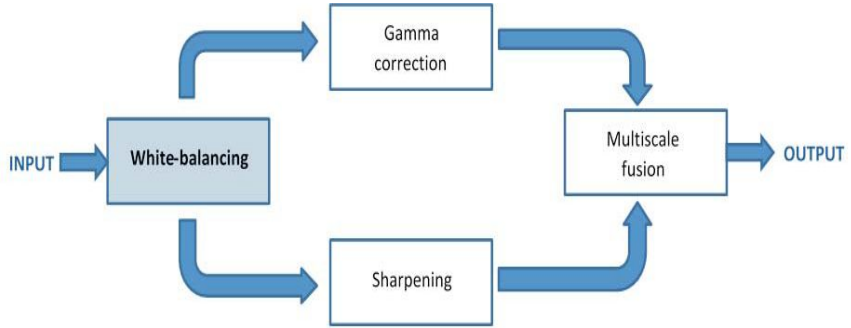
PROPOSED METHOD

- It is a single-image technique (using a standard camera) that does not require any special hardware or understanding of the underwater environment.
- The method essentially involves the fusion of multiple inputs, which are then merged by adjusting the contrast and sharpening a white-balanced version of the initial input image.
- The white balancing stage removes the color caused by the

  underwater light scattering phenomenon,

  giving the image a more realistic appearance.
- The fusion process is implemented

  at several scales, resulting in artifact-free mixing.



1. White Balancing :

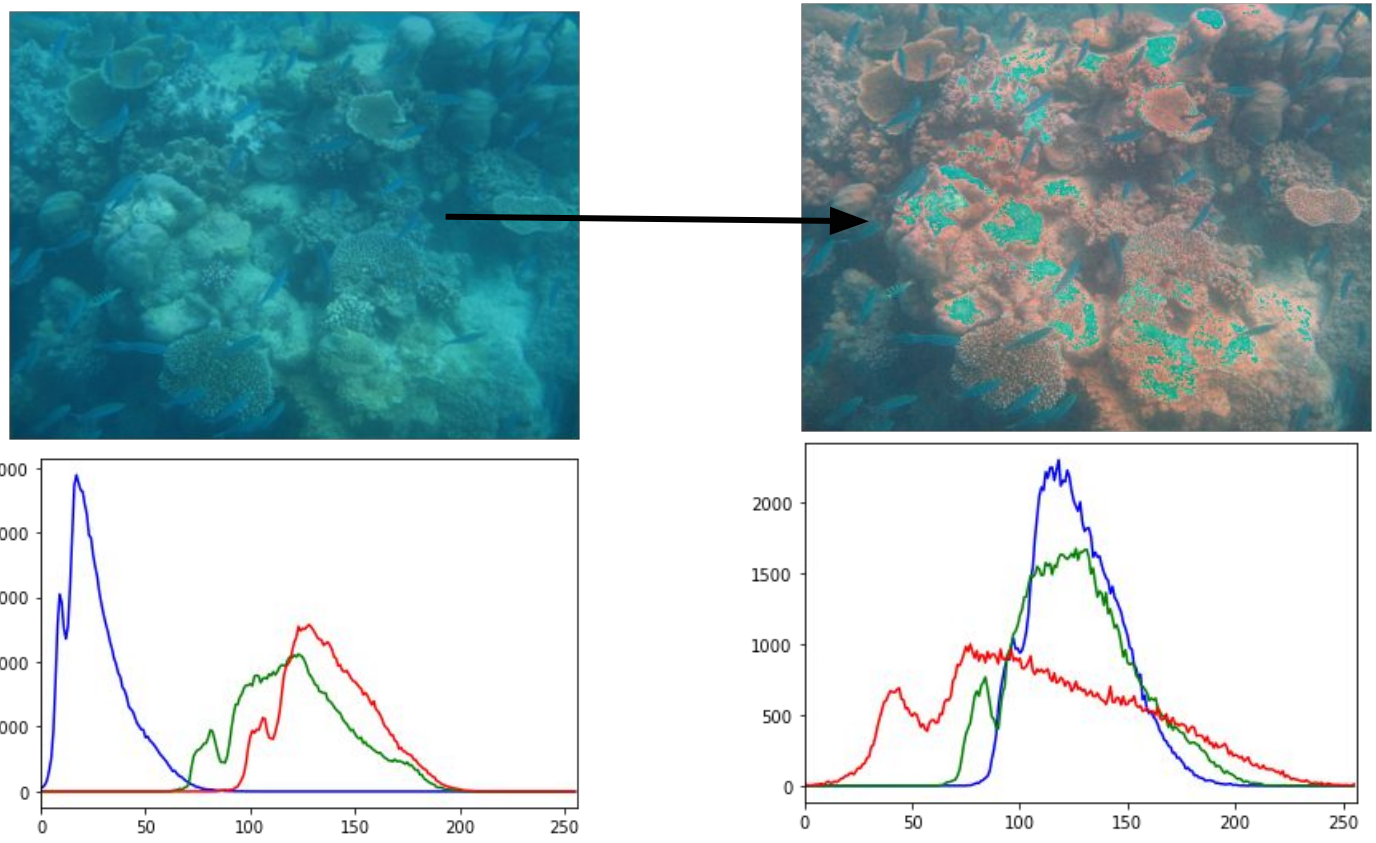
- White balance (WB) is the process of removing unrealistic color casts, so that objects which appear white in person are rendered white in our photo.
- Important problem is the green-bluish appearance that needs to be rectified.

Gray world algorithm

To compensate for the loss of red channel, we build on the four following observations/principles:

1. The green channel is relatively well preserved under water, compared to the red and blue ones.
2. We compensate the red attenuation by adding a fraction of the green channel to red.
3. All the channels have same mean value.
4. Avoid the reddish introduced by the Gray-World algorithm in the over-exposed regions appearance .

White Balancing:



2. Gamma Correction :

Gamma correction controls the overall brightness of an image. Images which are not properly **corrected** can look either bleached out, or too dark.

- Gamma correction aims at correcting the **global contrast** as
  - white balanced underwater images tend to *appear too bright*.
  - correction increases the difference between darker/lighter regions
  - with the cost of a loss of details in the under-/over-exposed regions.

3. Sharpening

To compensate with the loss of under-/over exposed region, we derived sharpening.

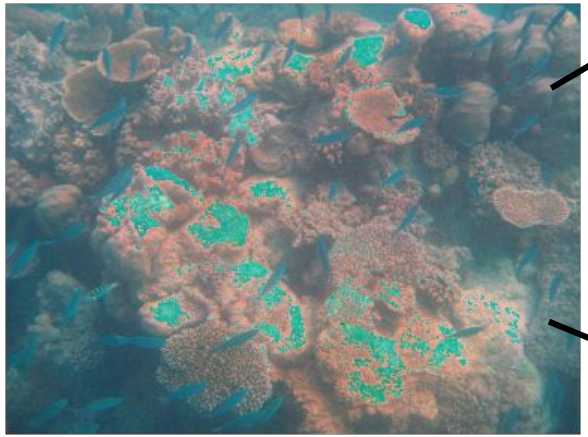
Image sharpening refers to any **enhancement** technique that highlights edges and fine details in an **image**.

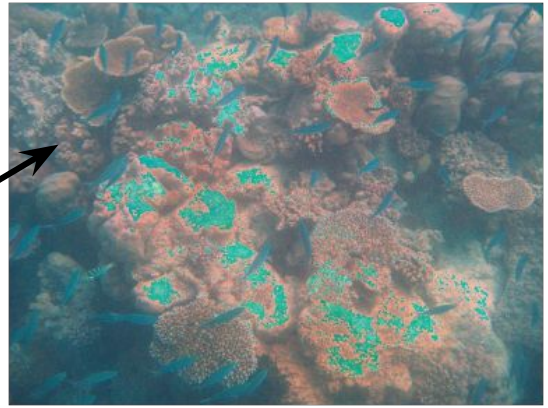
- widely used in printing and photographic industries for increasing the local contrast and **sharpening** the **images**.
- It increases the contrast along the edges where different colors meet.

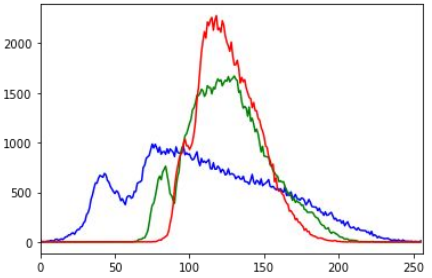
Unsharp masking:

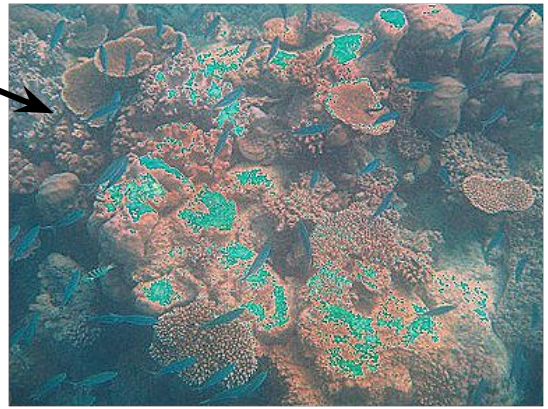
- An image is sharpened by subtracting a blurred (unsharp) version of the image from itself. Do not be confused by the name of this filter: an unsharp filter is an operator used to sharpen an image.

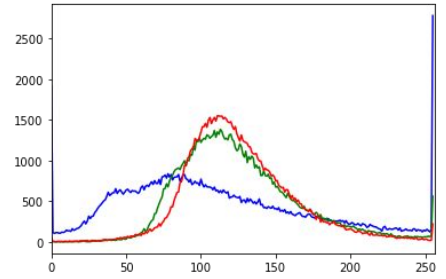
Gamma Correction

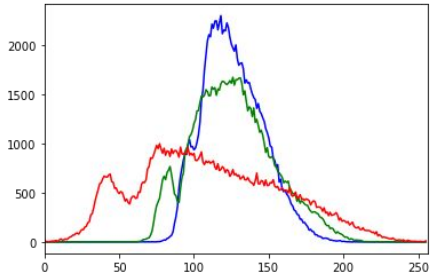










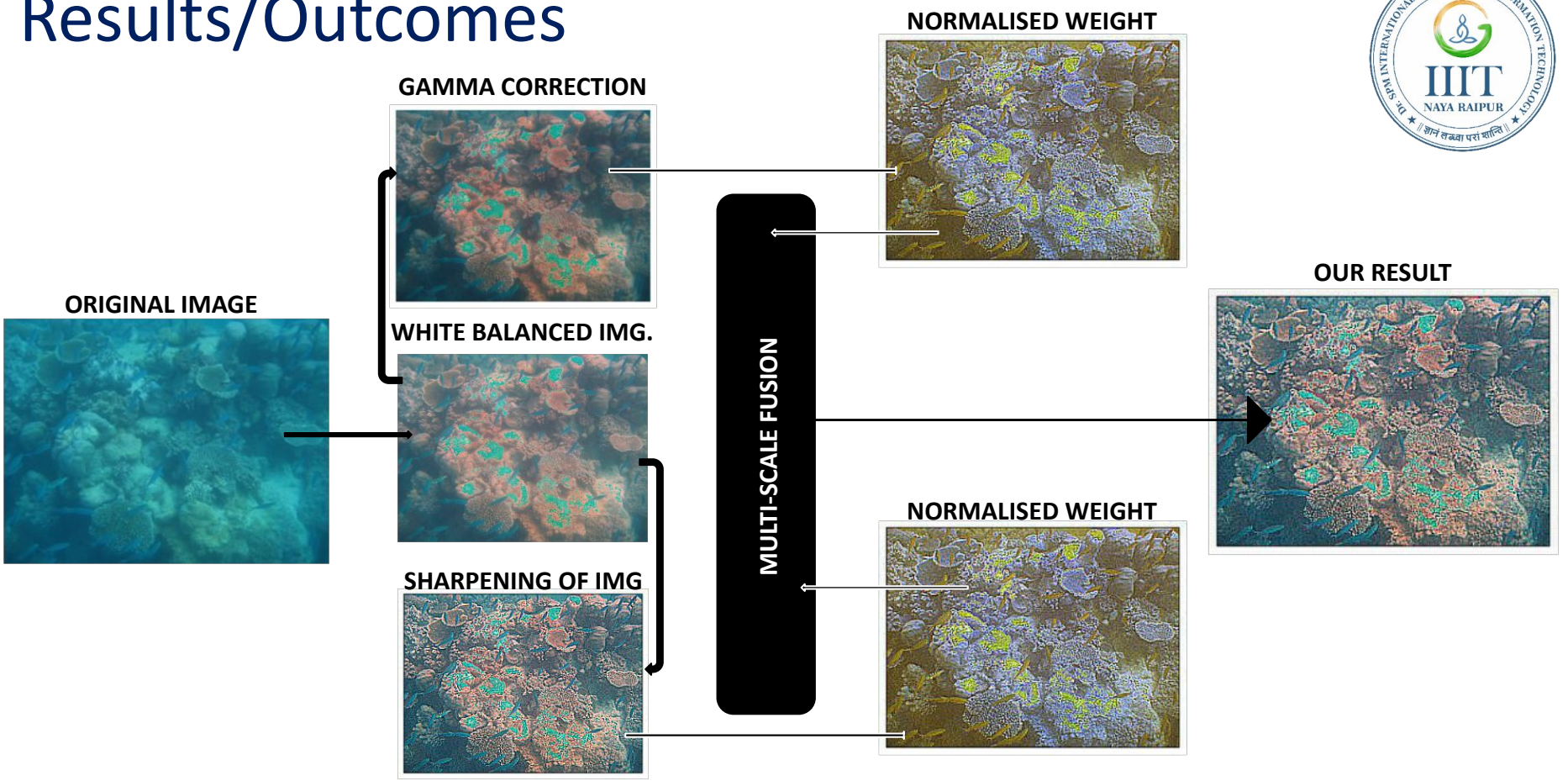


Sharpening

4. Multi-Scale Fusion :

- Image fusion is the combination of two or more images.
- retaining the important features from each of the original images.
- in order to obtain a more accurate, more comprehensive, more reliable image description of the same scene.
- Image Fusion using wavelet transform.

Results/Outcomes

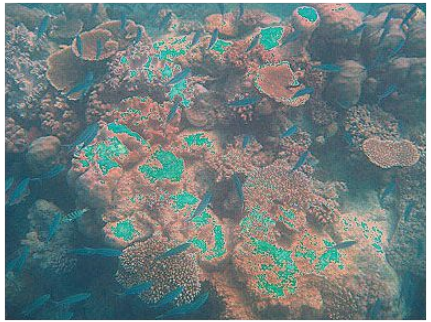


RESULTS:

Underwater images:



Output images:



REFERENCES

Journal :

1. Color Balance and Fusion for Underwater Image Enhancement.IEEE Transactions on Image Processing (Volume: 27, Issue: 1, Jan. 2018)

Links :

1. https://www.cambridgeincolour.com/tutorials/white-balance.htm
2. https://www.cambridgeincolour.com/tutorials/gamma-correction.htm

Thank You

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