Indian Institute of Technology (BHU) Varanasi

Enhancing Underwater Images and Videos by Fusion

Parallel Computing

- under guidance of Dr. R. Chowdary

Girhe Ankit Gulab (15135027)

Naman Rai (15135048)

Pawan Kumawat (15135051)

Siddharth Raj Patel (15135081)

Department: Mechanical Engineering

Introduction:

Parallel computing is a type of computation in which many calculations or the execution of processes are carried out simultaneously. Large problems can often be divided into smaller ones, which can then be solved at the same time.

Underwater imaging is challenging due to the physical properties existing in such environments. Different from common images, underwater images suffer from poor visibility due to the attenuation of the propagated light. The light is attenuated exponentially with the distance and depth mainly due to absorption and scattering effects. The absorption substantially reduces the light energy while the scattering causes changes in the light direction.

We are using the approach discussed in research paper to design the algorithm and trying parallelize it.

Approach of Paper:

In the paper they proposed an alternative single image based solution built on the multi-scale fusion principles. It consists of three main steps: inputs assignment (derivation of the inputs from the original underwater image), defining weight measures and multiscale fusion of the inputs and weight measures.

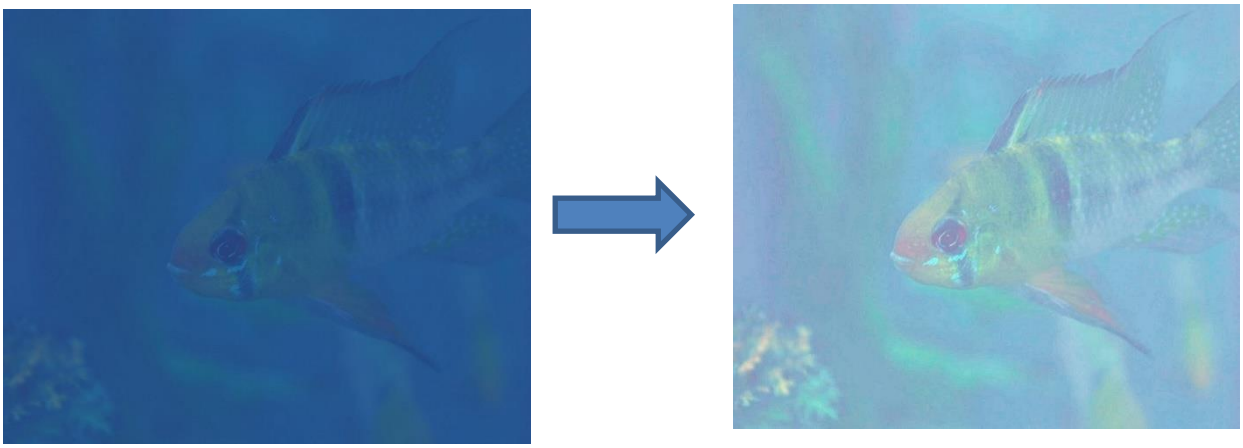
The first input of the fusion process is computed based on this straightforward white balancing operation. The second input is computed from the noise-free and colour corrected version of the original image and is obtained by applying the classical contrast local adaptive histogram equalization.

The enhanced image version is obtained by fusing the defined inputs with the weight measures at every pixel location.

Implementation serially:

Applying white balance and colour balance algorithm.

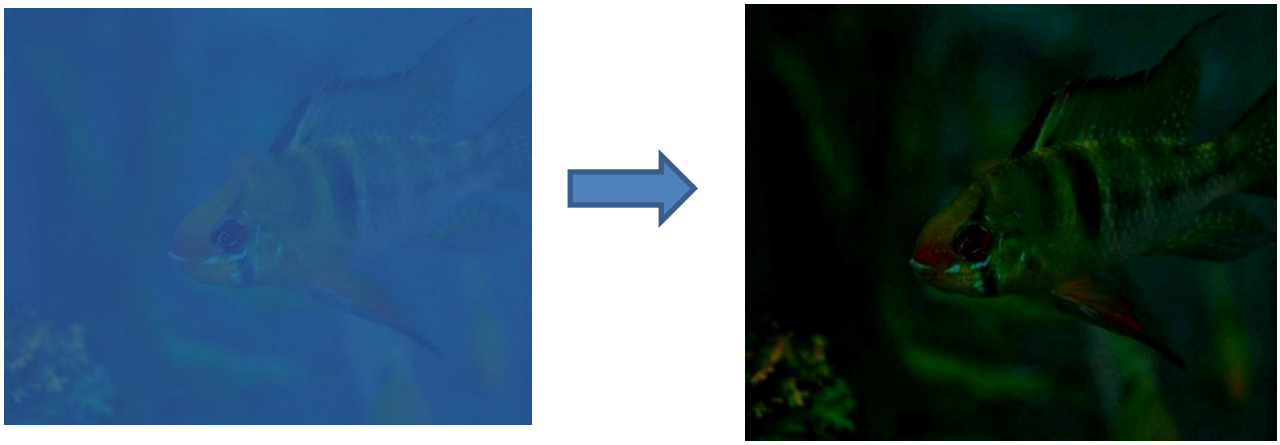
1. White balance (WB): It is the process of removing unrealistic colour casts, so that objects which appear white in person are rendered white in your photo. Then the input image is passed to colour balance algorithm to correct the colours.



Input image

Output image (white balance)

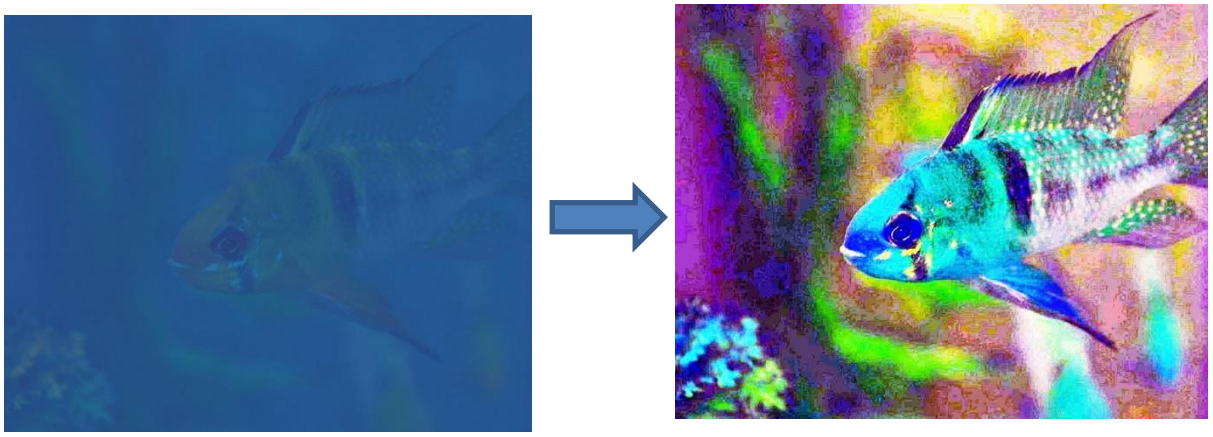
2. Colour balance: In photography and image processing, color balance is the global adjustment of the intensities of the colors. An important goal of this adjustment is to render specific colors – particularly neutral colors – correctly. Hence, the general method is sometimes called gray balance, neutral balance, or white balance.



Input image

Output image (color balance)

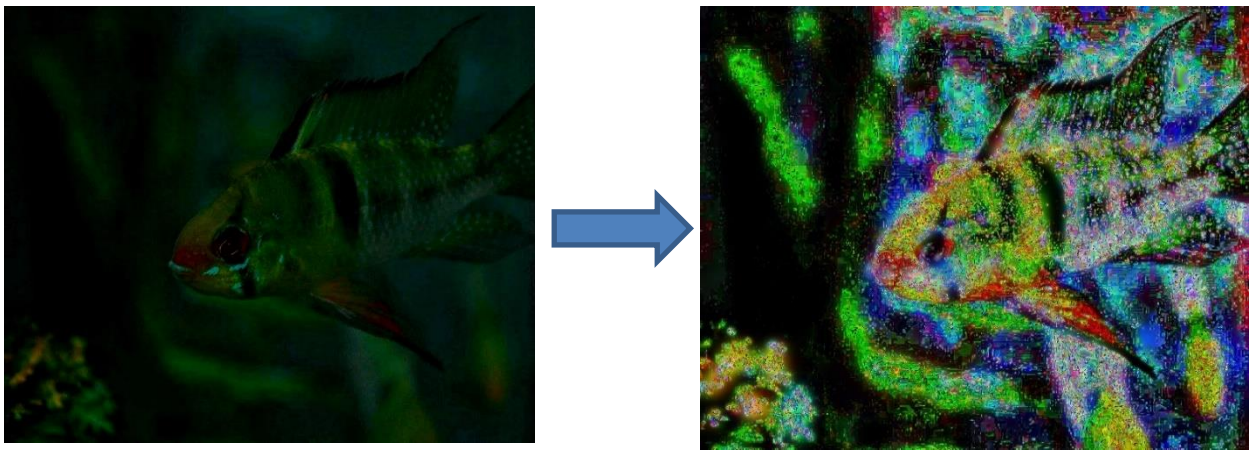
3. **Contrast Enhancement:** It is a process that makes the image features stand out more clearly by making optimal use of the colors available on the display or output device. Contrast manipulations involve changing the range of values in an image in order to increase contrast.



Input Image

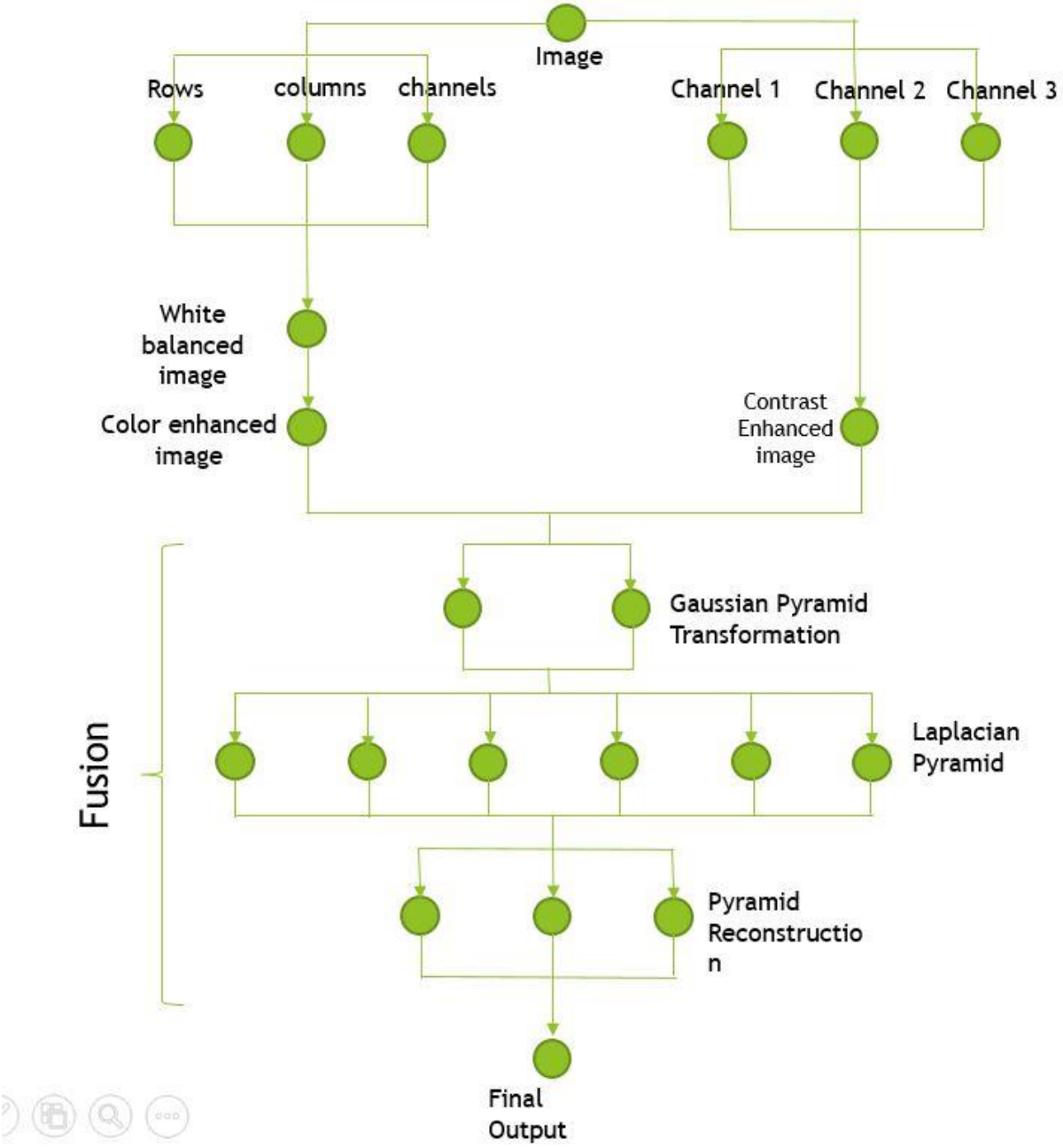
Output (Contrast Enhance)

4. **Fusing it together**: The output image of white balance and colour balance is then fed to fusion algorithm. In this process the image is decomposed by Gaussian Pyramid and Laplacian Pyramid algorithm by using weight and image itself. And the calculated separate pixels of RGB colour are reconstructed using the algorithm Pyramid Reconstruct. After this all the parameters are merged together to form the final image.



Input for Fusion Process

Final Output



Parallel Network

Parallelizing the algorithm:

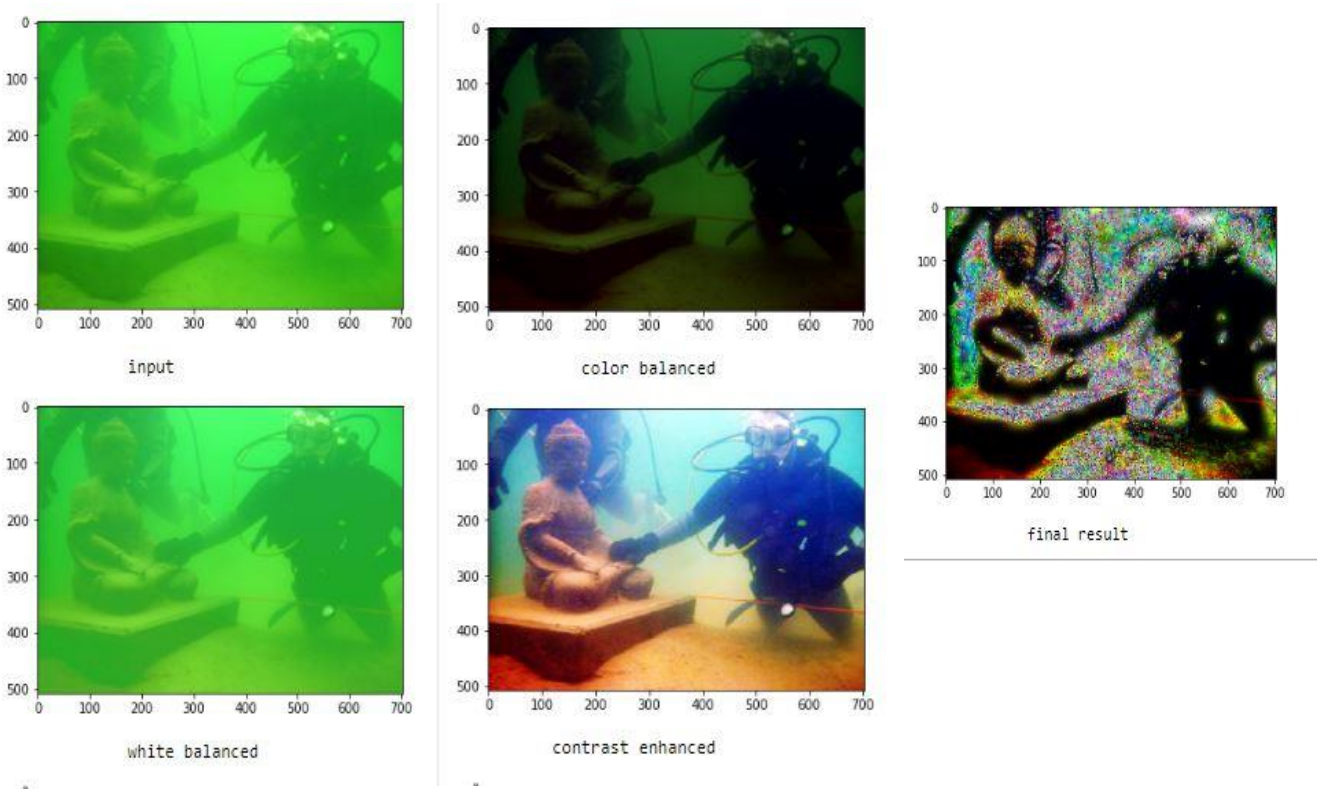
From the serial algorithm of fusion it can be seen that there were several set of processes that can be parallelized.

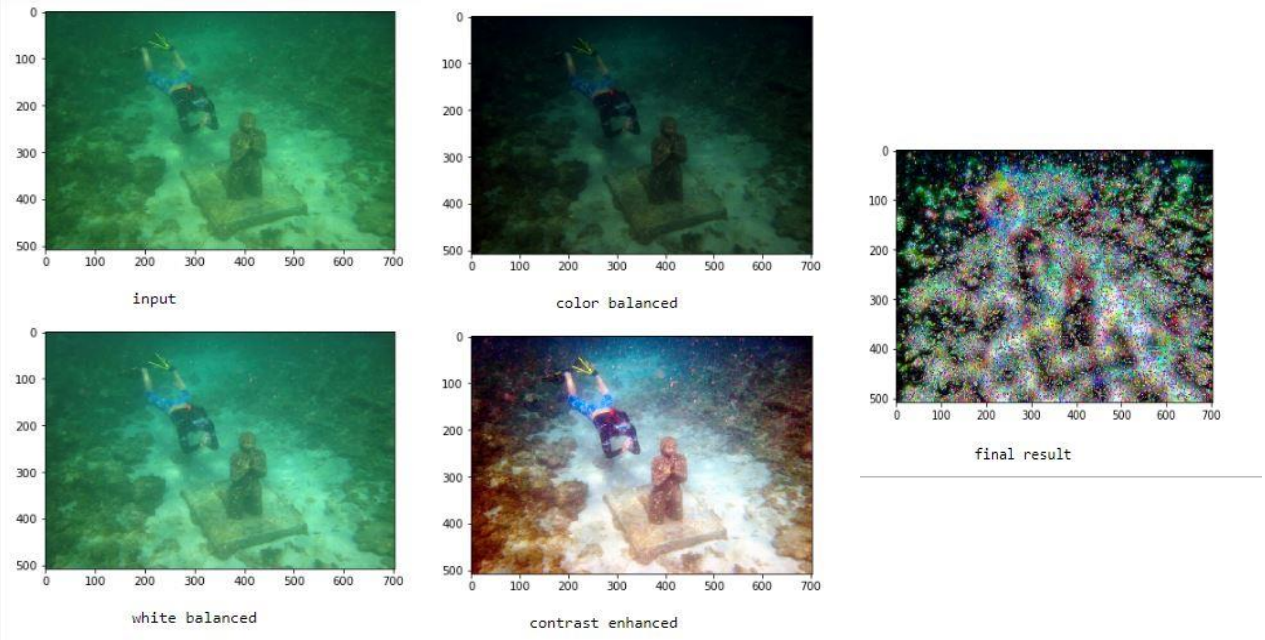
1. While white balancing the image, three dimension i.e. rows, columns and channels of image are white balanced concurrently / parallelly.
2. In contrast enhancement, the three channels (RGB) of the image are fed concurrently in parallel.

3. The two algorithms (white + colour) balance and contrast enhancement are applied parallelly.
4. Applying Gaussian Pyramid transformation (2 simultaneously)
5. Applying Laplace Pyramid transformation (6 simultaneously)
6. Pyramid reconstruction (3 simultaneously)

Multithreading is used for this purpose. In computer architecture, **multithreading** is the ability of a central processing unit (CPU) to provide multiple threads of execution concurrently, supported by the operating system.

Results: The results obtained after implementing the image enhancement parallel algorithm for different images were as follows.





Conclusion: Applying multithreading parallelism at various locations improved the time taken (Ts>Tp) most of the time, which may be useful when using the algorithm for videos which requires computation time less than that of 30 fps (frames per second) and also for high quality sequence of images.

Serial time taken for the algorithm for some part of the code was found be smaller larger than its parallel counterpart as expected. While in some cases, the time for parallel algorithm was slightly more than its serial counterpart. This may be because overhead (*W*) for that particular part is much larger and dominates. If problem size is increased, this overhead may become significantly lower and we can obtain speedup to be increased and parallel time (Tp) becomes lower than serial time (Ts).

Another aspect of the results is that the output obtained were having low clarity. That may be due to, non-availability of some of the weights for the fusion process (like exposedness weights and saliency weights).