1. **Introduction**
   1. **Overview**

The problem of underwater image enhancement and colour correction is difficult and has become more important recently. The colour contrast of images captured underwater cannot be distinguished or noticed by the human eye. Using expensive equipment, we may capture underwater images that are bluish and greenish in colour because more depth prevents light from reaching its full strength. Since there is less light intensity at a certain depth, the camera is unable to capture images using all three RCB values, which results in bluish or greenish images. Underwater images suffer from significant colour distortion and the dominance of a heavy blue colour.In order to improve these images, we created a system using IOT (Raspberry Pi) in which images clicked under water are improved and saved in a new folder. When compared to previous underwater enhancement techniques, our technique produces more natural underwater images.

In our system, images are taken underwater and saved in the input image folder on the local device. When the Python script is executed, all of the captured images are processed simultaneously. We have used four methods to improve the images: 1. Neutralizing image cast 2. Histogram equalization 3. Swarm intelligence 4. Unsharp masking These techniques improve underwater images and result in a natural underwater image. The improved images are saved on the local device in the result folder.

As it concentrates on enhancing the contrast and colour of underwater images through contrast stretching, the results imply that it enhances the quality of damaged underwater images. It employs the sharpening technique to bring out minute details in an image or to increase detail that has been lost due to low contrast and high scattering of light. Therefore, images generated by our technology are natural underwater images.

* 1. **Motivation**

The ocean contains various abundant resources. However, it has not been effectively explored and exploited by humans, especially in the underwater world. Underwater image processing plays an indispensable role in underwater operations by humans or underwater robots. Underwater image enhancement is an active research problem that deals with correcting image distortions to recover true pixel intensities.

* 1. **Problem Definition and Objectives**

Underwater image enhancement and colour correction are challenging tasks that have gained priority in recent years. The colour contrast of underwater images cannot be distinguished or detected with clarity by the human eye. We get bluish and greenish underwater images while using expensive equipment since the intensity of light cannot be attained at higher depths. In contrast to all previous methodologies, our proposed model makes use of a hardware-based Raspberry Pi model, and the camera model will be trained so that underwater image reconstruction is not required because it will clear the images as soon as the image is captured. Thus, our problem description reads: A method for using a Raspberry Pi to improve the colour of underwater images.

* 1. **Project Scope & Limitations**

The proposed model captures an image as the input and a sequence of operations such as naturalizing image cast, histogram equalization, swarm intelligence method, unsharp masking, etc. are performed on the input image. Finally, multi-scale images  
The fusion of the inputs is done to obtain the resultant enhanced image as an output.  
This will result in clicking images underwater which is believed to be a tedious task given the extreme absorption and scattering effects of the medium. Therefore, image improvement techniques are applied to get rid of image noise and improve overall colour correction of an image.

Cost of hardware components. The model requires a Raspberry Pi and camera module, which are expensive.

As the model is placed under the water to capture images, hardware components need to be protected from water and pressure.

* 1. **Methodologies of Problem Solving**

Four Strategy we have followed in our model:

**1. Superior underwater colour cast neutralization:**

This is the initial action. The first stage presents a novel strategy to remove the underwater colour cast. It introduces a new approach to neutralize underwater color cast. Before color cast neutralization color channels are decomposed. the Natural Underwater Colour Enhancement approach lessens the underwater colour cast. By considering the variations between superior and inferior colour channels, these gain factors are determined.

**2. Fusion of dual-intensity pictures based on the mean and median values**

Next the idea is to construct lower-stretched and upper-stretched histograms in the second stage using the dual-intensity images fused based on the average of mean and median values. The relationship between these histograms greatly enhances the visual contrast. Following the computation of the picture histogram's minimum, maximum, mean, and median values, the average point between the mean and median values is computed.

1. **Swarm-intelligence based mean equalization:**

Then, a mean equalization based on swarm intelligence is suggested to enhance the output image's naturalness. The mean values of inferior colour channels are modified to be close to the mean value of superior colour channels through the fusion of swarm intelligence algorithms. Based on mean values, colour channels are classified as superior or inferior. Each pixel's fitness is assessed, and adjustments to its velocity and location are made until mean equality is achieved.

1. **Unsharp masking:**

Lastly, the unsharp masking technique is applied to sharpen the overall image. Unsharp masking is the process of making a slightly fuzzy exposure of the original negative onto a brand-new roll of film. The unsharp mask filter method involves subtracting an unsharp mask from the sample image. An unsharp mask only produces a hazy image by spatially filtering the specimen image with a Gaussian low-pass filter.

**02 Literature Survey**

**2.1 Color Correction Based on CFA and Enhancement Based on Retinex with Dense Pixels for Underwater Images**

Author : Changli Li1, Shiqiang Tang1

Published Year : 2020

Platform : IEEE Access

This paper proposed two methods:

1. Underwater image color correction method based on color filter array (CFA) .

2. Underwater image enhancement method based on retinex theory.

This paper dealt with underwater image colour correction and underwater image enhancement methods. A colour distortion correction is made for the red channel from the other two channels (blue and green), as for any RGB image captured by a camera with a colour filter array, its RGB values are dependent. The linear function for adaptive histograms is used to improve the visual quality of the whole image. The result shows that the proposed method gives clearer, more uniform visual effects.

**2.2 Fast Underwater Image Enhancement for Improved Visual Perception**

Author : Md Jahidul Islam1 , Youya Xia2

Published Year : 2020

Md. Jahidul Islam1.[2] In his paper, he proposed another methodology for improving underwater image quality based on the generative adversarial network (GAN) model. Using information about an image's global colour, local texture, and style, this approach creates a perceptual loss function. In addition to ensuring substantially faster inference times, it conducts extensive qualitative and quantitative assessments and user studies to demonstrate that the suggested model performs as well as and frequently better than state-of-the-art models. That shows how well it works to enhance the performance of underwater object detection and human body pose estimation.

**2.3 Simultaneous Enhancement and Super-Resolution of Underwater Imagery for Improved Visual Perception**

Author : Peigen Luo† and Junaed Sattar‡

Published Year : 2020

Junaed Sattar‡.[3] In this paper, the simultaneous enhancement and super-resolution (SESR) problem is described and a productive learning-based underwater imaging solution is presented. It presents its comprehensive training process, accompanying loss functions, and thorough network architecture. It carries out a number of qualitative and quantitative experiments that indicate Deep SESR: (i) offers SOTA performance on underwater image enhancement and super-resolution; (ii) exhibits significantly better generalization performance on natural images than existing solutions; (iii) provides competitive results on terrestrial images; and (iv) achieves quick inference on single-board platforms. Deep SESR is appropriate for usage in close to real time by visually guided underwater robots due to its impressive performance, computational efficiency, and accessibility of application-specific design options.

**2.4 An approach for underwater image enhancement based on color correction and dehazing.**

Author : Yue Zhang

Published Year : 2020

Platform : International Journal of Advanced Robotic Systems.

This paper has an improved approach for eliminating the local reddish effect and reducing image noise.As when light propagates in water, water medium ,water particles and scatter light will absorb.Because of this underwater images present defects such as color deviation, low contrast, and blurry details. This paper includes two algorithms for color correction of underwater images. 1)White Balance Algorithm (WB) The main problem of underwater images are greenish-blue appearance due to scattering of waves when depth is increasing. As higher wavelength waves get absorbed first. So red will be absorbed first. Red channel is degraded first when it passes through water and green channel is almost safe because of its shorter wavelength compare to red channel. So, this white balance method mainly focuses on restore the colors which are degraded due to absorption of white light propagate through water. 2)Dark Channel Prior Algorithm (DCP) Dark channel prior algorithm is mainly proposed for image dehazing. But directly applying the DCP algorithm to underwater images does not provide a good enhancement effect. The dark channel value obtained based on the minimization and operation is likely to be the red channel component in the dark channel calculation process, which leads to a dark image after restoration.