Original Article

Visual Quality Improvement In Deep Sea Images

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Abstract

In image processing, image enhancement plays a significant role in improving image quality. This is done by emphasizing relevant information and suppressing irrelevant information. Due to the various impacts of the underwater medium, the image caught in the water could be more precise. These effects are controlled by the suspended particles that cause light to be absorbed and scattered as a picture is formed. The underwater environment brought low contrast and faded color problems, which could be more conducive to imaging data. As a result, the imaging data must be improved before moving on to further processing during any image-based exploration and inspection activities. This work proposes a fusion using wavelet technique to improve gloomy underwater visuals by fixing poor colour variance and colour manipulation issues. Various wavelet families, including Daubechies, Symlet, biorthogonal, Han Real, Beylkin, and Coiflet, are used in this study to fuse the images. Results show that Biorthogonal and Daubechies wavelet families perform significantly better than others. In recent years, Wavelet Transform (WT) has emerged as a powerful tool for time-frequency analysis, denoising, and signal coding.

I. INTRODUCTION

Underwater imaging has many applications because rivers, seas, lakes, and oceans contain essential resources. As a result, scientists and researchers are very interested in collecting data about undersea species. It has been shown that light scattering and absorption in water are the main contributing factors in deep sea visuals. The amount of light that hits the photographed object is diminished by scattering as it is refracted in various directions. Increasing the image's visibility and application suitability is known as image enhancement. Enhancing underwater photos has become a crucial field of research in the modern world. Due to the aquatic medium's physical characteristics, such as light scattering and reflection, as the water depth rises the visibility of underwater objects decreases, resulting in a decline in image quality. The turbidity brought on by color dispersion and the color emitted by the attenuation of varying light at various wavelengths makes it challenging to capture clear underwater images. In underwater photographs, color dispersion and color emission result in blurred subjects and low contrast.

II. LITERATURE SURVEY

- Images captured underwater frequently suffer from quality deterioration, such as lack of saturation, blurred features, off-colour hues, uneven lighting, etc. Repairing and improving underwater images is essential for several practical applications and represents a significant challenge in image processing and computer vision. It compared the effects of typical undersea image improvement and recovery techniques on photographs taken in bluish-green, tan in colour, off the coast, and submerged sea photographs.
- Water scattering and absorption frequently cause blurry images and distorted colors in underwater photography. The fusion strategy concurrently gets rid of haze and corrects color casts. This paper presented a fusion-based underwater

image improvement technique to perform color correction and dehazing for various underwater sceneries simultaneously.

• The analysis of undersea photographs is essential. These photographs affects the quality of deep sea and it lead to severe issues compared to pictures from a cleaner environment. Utilizing a dark channel beforehand, atmospheric light is obtained.

• The importance of underwater image improvement in marine engineering and underwater robotics has drawn much attention. Underwater picture capture is frequently plagued by noise, color cast, low illumination, and contrast degradation. The visibility of objects in underwater scenes at varying distances is a significant challenge for image processing.

PROPOSED UNDERWATER IMAGE ENHANCEMENT AND OBJECT CLASSIFICATION

The primary issues with underwater images include Colour cast issues (bluish tint) , crinkle patterns , haze , attenuation of light reaching the depths of the ocean from the uppermost layer of the water and an abundance of marine life.

The workflow of the proposed underwater image categorization system is illustrated in Fig. 1. The intended project is to provide the input images into the MATLAB platform for enhancement purposes. The enhanced images from MATLAB are provided in the YOLOv5 classification model to classify fish and marine growth. The proposed YOLOv5 architecture for underwater image classification is shown in Fig. 2. The YOLO architecture is composed of 24 Convolution layers, which are followed by two fully connected layers. YOLO predicts numerous bounding boxes per grid cell. Non-maxima suppression is used to pick the bounding boxes with he highest Intersection Over Union (IOU) with the ground truth.

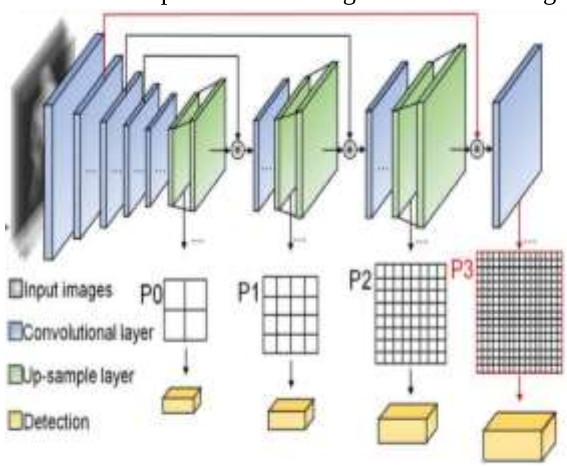


Fig 2

III. PROPOSED WORK

From the dataset, the input image is chosen and prior-processing of the portraits includes white balancing, gamma correction, and sharpening for the white-balanced image. Next, we apply various algorithms to get the normalized weights, and after that, we perform Multiscale fusion to get the resultant enhanced version of the input image.

Fig 1 Block diagram of the proposed system

WHITE BALANCING

White balance (WB) is a method of removing artificial colour tints from images so that items that remain white in person appear white in images.

GAMMA CORRECTION

Gamma correction is used to perform nonlinear procedures on the pixels of the input image and thereby updating the image's saturation. Gamma correction is often used to smooth out dark background details. If the Gamma (γ) = 1, then the dual-gamma function slope yields a straight line. When the value for $\gamma > 1$, the highlighted portion of the image is suppressed, and the dim role is extended; When the value of $\gamma < 1$, the highlighted a section of the image is extended, and the dim part is suppressed.

SHARPENING

Any enhancing method that draws attention to an image's edges and minute details is called image sharpening. By combining a signal proportionate to the original image with a high-pass filtered version of it, image sharpening is accomplished.

EXPERIMENTAL SETUP

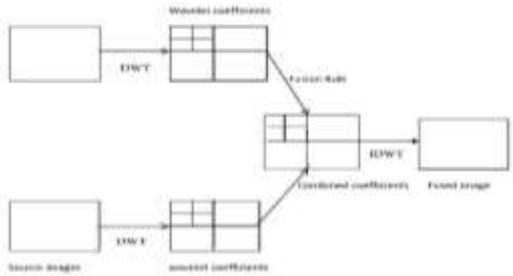
DATASET

The Underwater Image Enhancement Benchmark (UIEB) and ExDarkNet – COCO datasets are used in this work, which are publicly available. The Underwater Image Enhancement Benchmark (UIEB) dataset contains blurred and hazed images of marine growth, and the ExDarkNet – COCO dataset contains bluish-tinge images of underwater. COCO, Tensorflow, and Darknet provide the UIEB and ExDarkNet datasets. The dataset contains 2895 images and a median–image ratio of 640 x 640. The dataset includes a total of 6 classes for the detection of underwater objects listed below 1. Anomaly 2.Echinus 3. Holothurian 4. Marine Growth 5.Scallop 6.Star Fish. The Underwater image dataset contains color-scattered, light-attenuated, greenish-blue images. Figure 3 shows sample photos from the datasets including marine growth and underwater images. The two datasets have all the different kinds of fish and marine growth of the underwater scene. The amount of marine growth and fish varies greatly across all three datasets. To avoid data imbalance between fishes and marine growth, data augmentation techniques were used on the UIEB and ExDarkNet - COCO datasets.

IV. METHODOLOGY

IMAGE FUSION

Image fusion aims to generate an image that combines the best features of the fused photos. High spatial and spectral resolution, an area in focus, functional and anatomic information, different spectral information, or colour and texture information are all desirable characteristics.



Flowchart of methodology

WAVELET TRANSFORM

Wavelet transforms give a framework for signal decomposition, with each level corresponding to a lower frequency band or coarser resolution. Transforms are classified into two types: continuous and discrete.

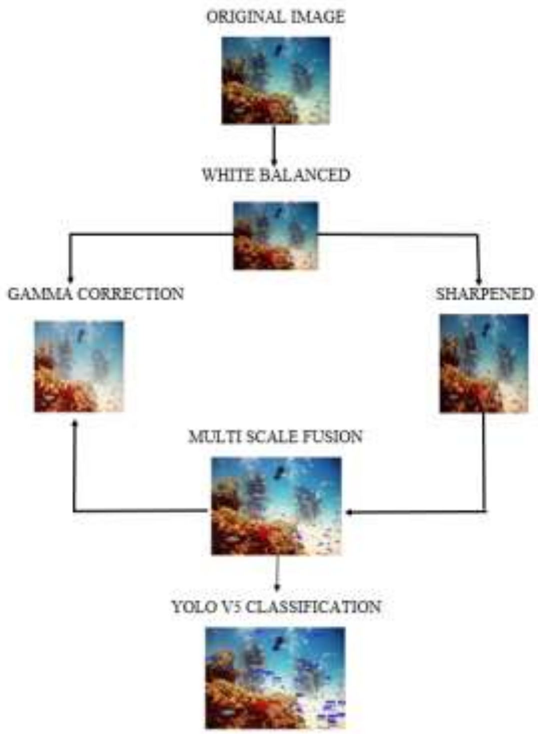
WAVELET FAMILY

WT may use several kinds of wavelet families to analyse the signal. Based on their traits and desired functions, these families are further subdivided into many family members.
The mother wavelet is the base of WT signal analysis technology. It includes Haar, Daubechies, Biorthogonal, Morlet, Symlets, Maxican-hat, Coiflets, and Mayer. These wavelets are further classified on the basis of the number of coefficients, such as db2 and db4 (the 2 and 4 coefficients of the Daubechies wavelet, respectively).

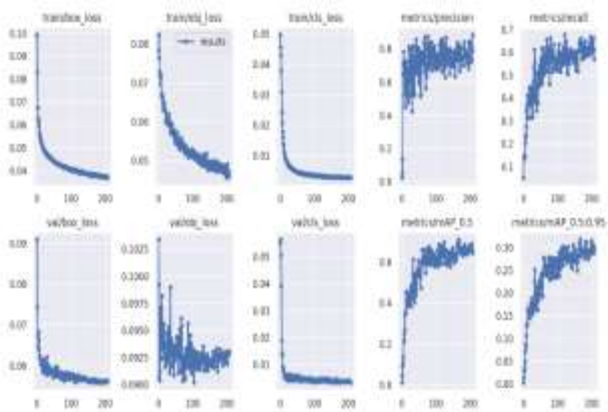
YOLO CLASSIFICATION

YOLO provides a number of advantages over classifier-based systems. When testing, it takes into account the complete image, allowing the image's global context to influence its predictions. It also produces predictions with a single network assessment, as opposed to R-CNN systems, which take thousands of evaluations for a single image. As a result, it is extremely fast—more than 1000 times faster than R-CNN and 100 times faster than Fast R-CNN.

RESULTS AND DISCUSSIONS



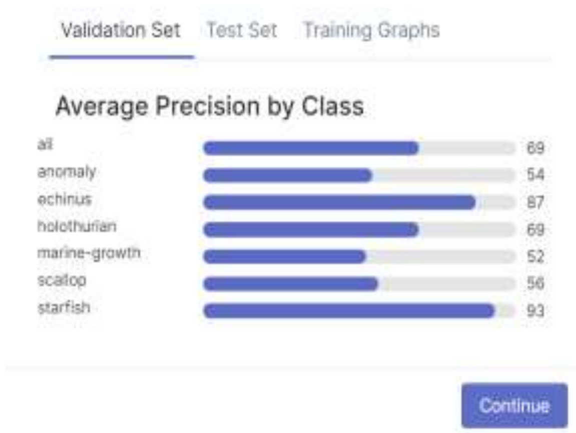
Execution of Proposed System



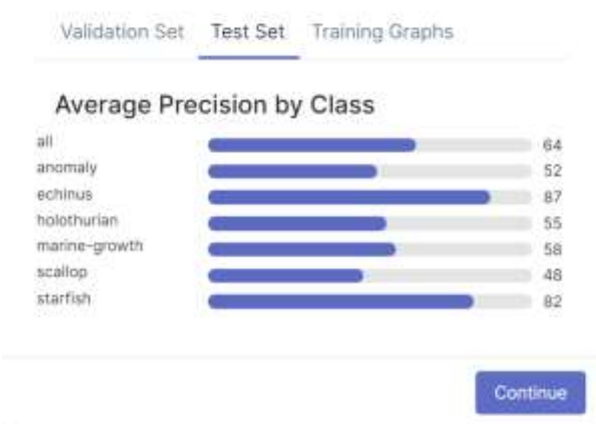
Training Graphs of Classification Model

Fig 3 **Input Image**

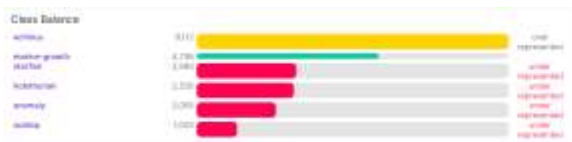
Enhancement Process



Validation Set of Classification Model



Test Set of Classification Model



Class Balance

TRAINING AND VALIDATION

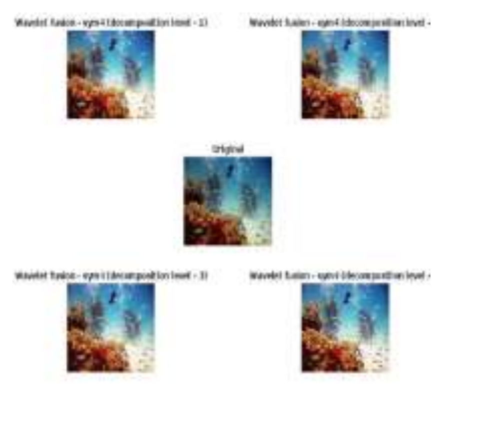
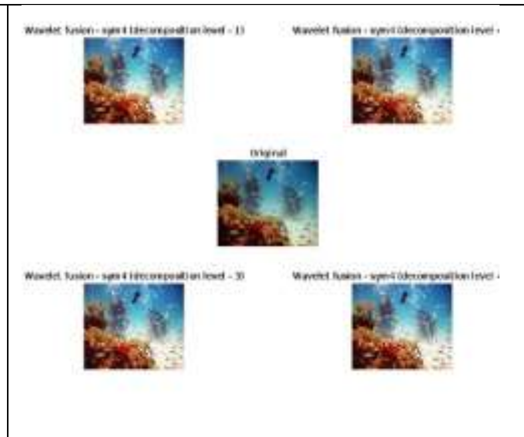
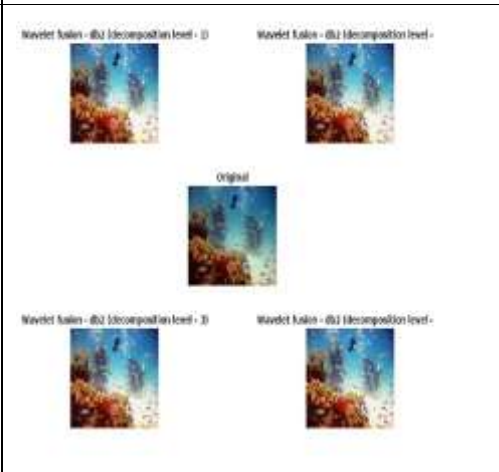
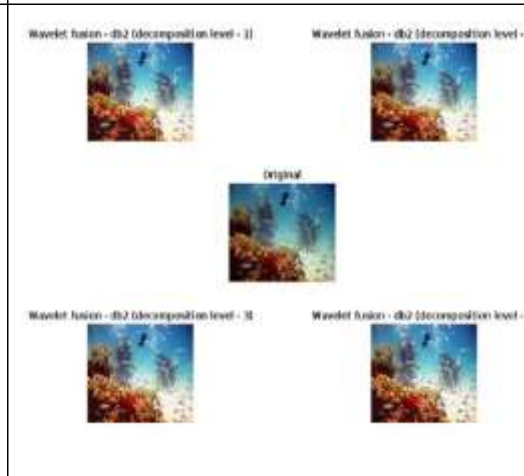
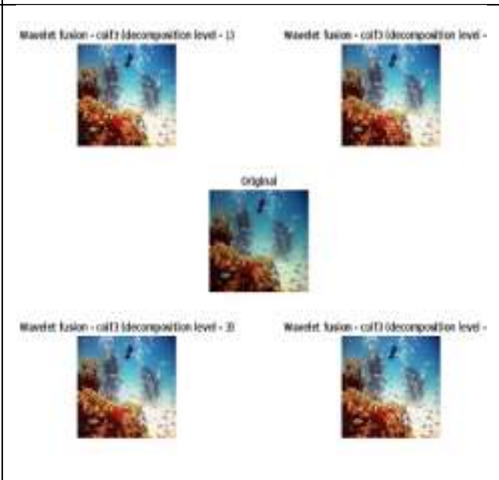
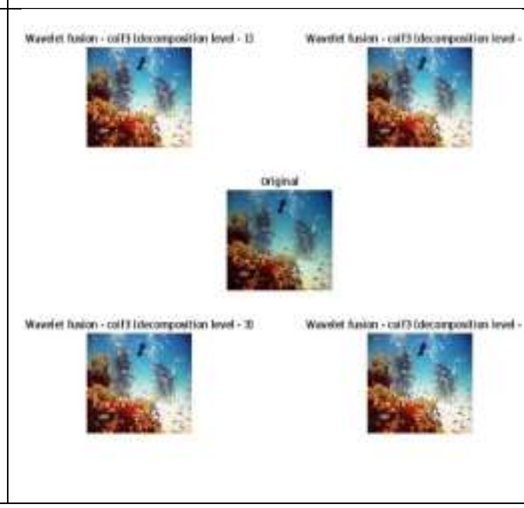
It is observed that as the validation accuracy increases, test accuracy decreases. Similarly, as the test loss decreases, the validation loss decreases too. We can obtain better results by training on more images or training the model for more epochs. We have achieved a Mean Average Precision of 71.0%, a Positive prediction of 81.0%, and found relevant cases within the dataset is 62.7%.

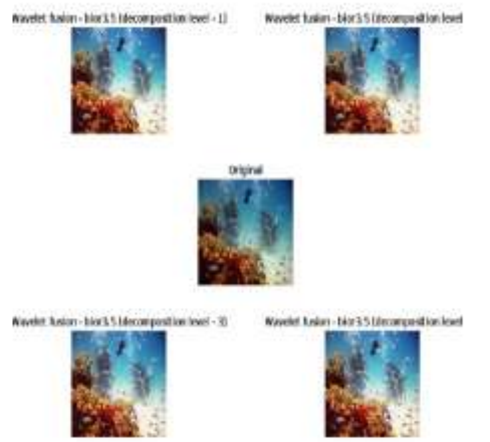
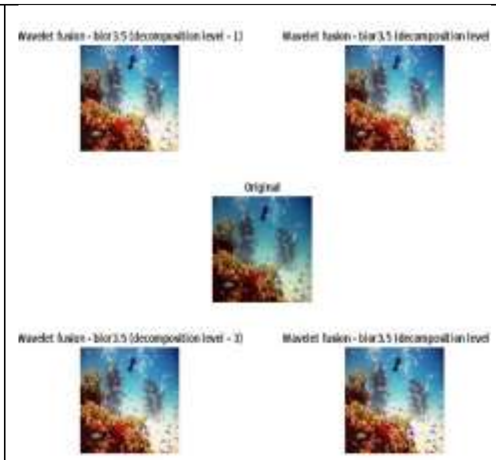
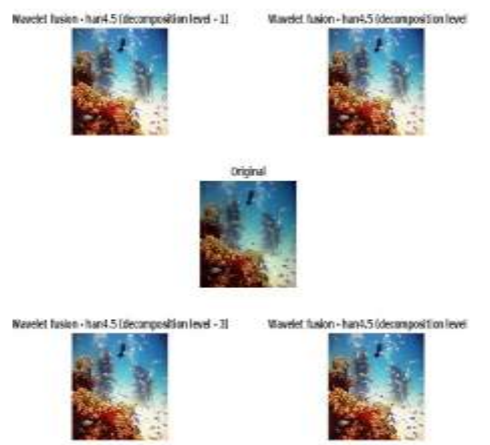
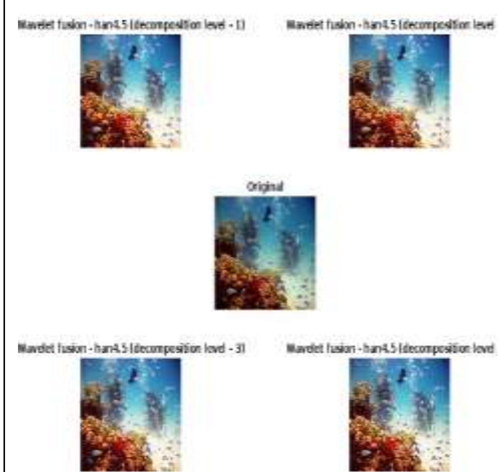
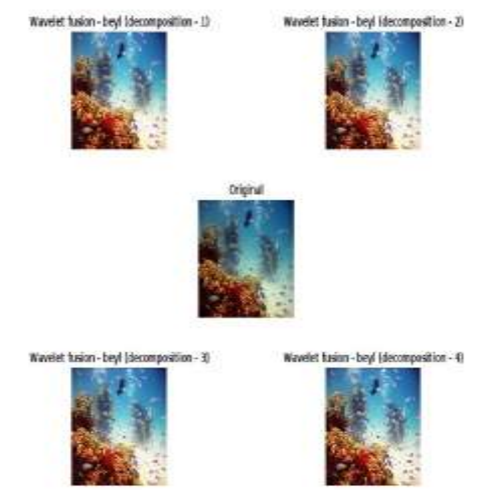
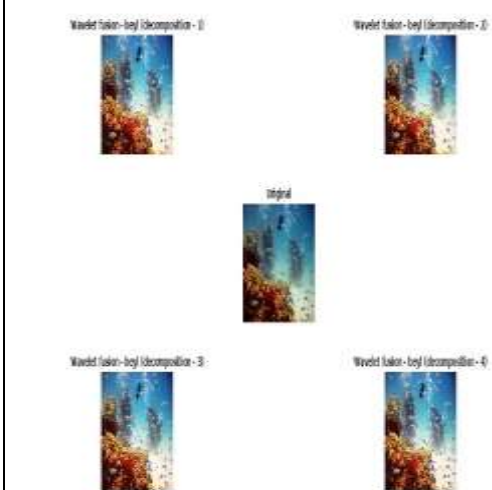
Dataset Details

EVALUATION METRICS

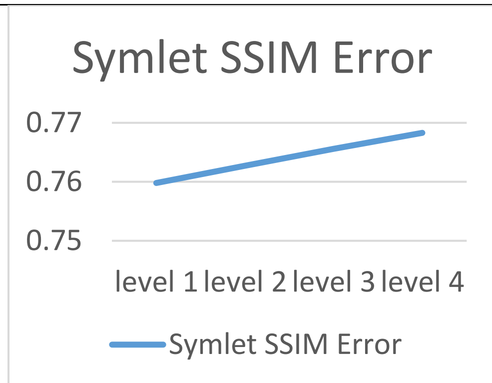
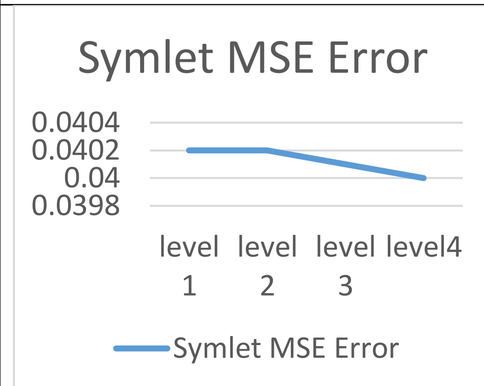
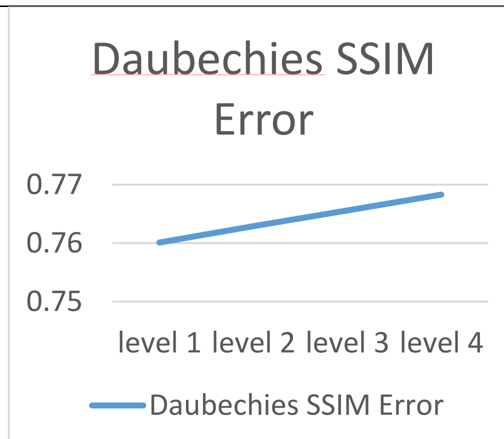
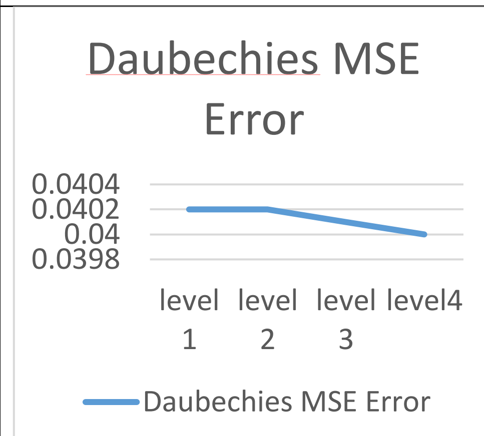
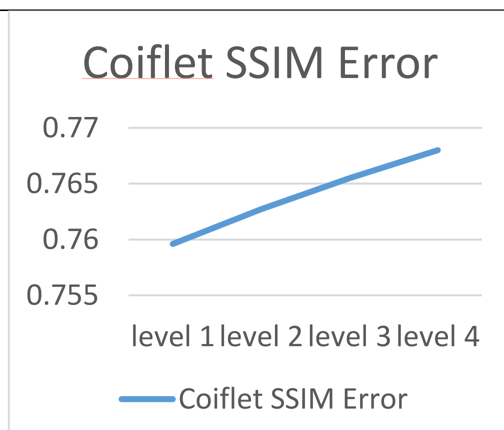
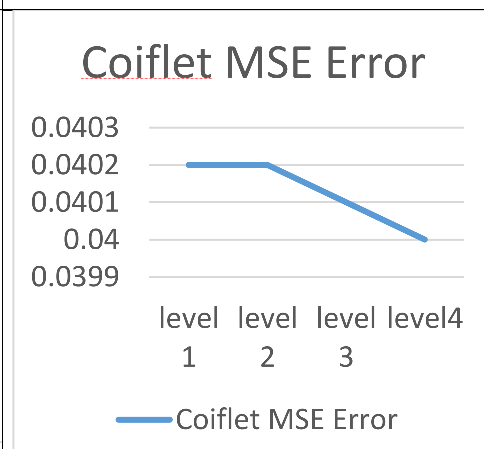
COMPARISON OF WAVELETS

ERROR / TYPE	SSIM	MSE

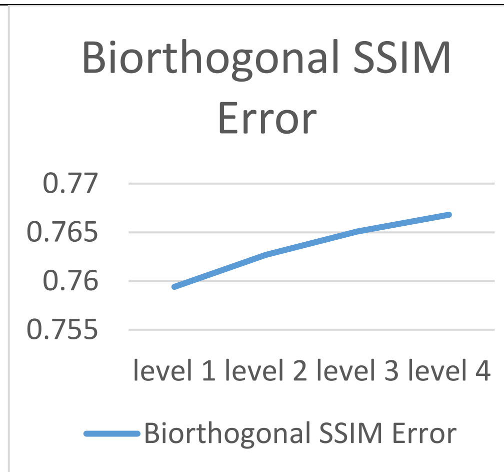
SYMLET		
DAUBECHIES		
COIFLET		

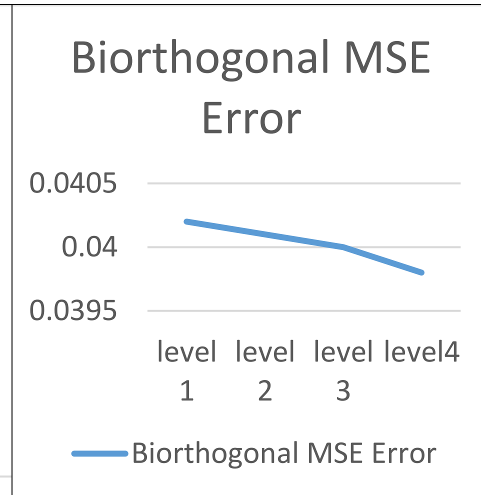
BIORTHOGONAL		
HAN REAL		
BEYLKIN		

COMPARISON OF ERROR

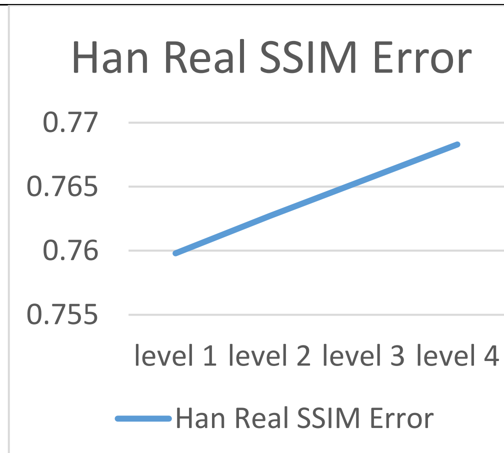
ERROR / TYPE	SSIM	MSE
SYMLET		
DAUBECHIES		
COIFLET		

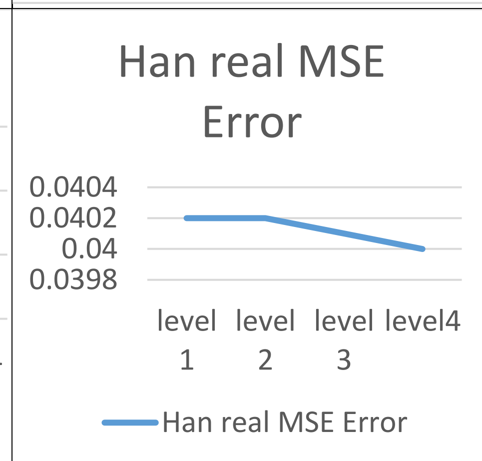
BIORTHOGONAL



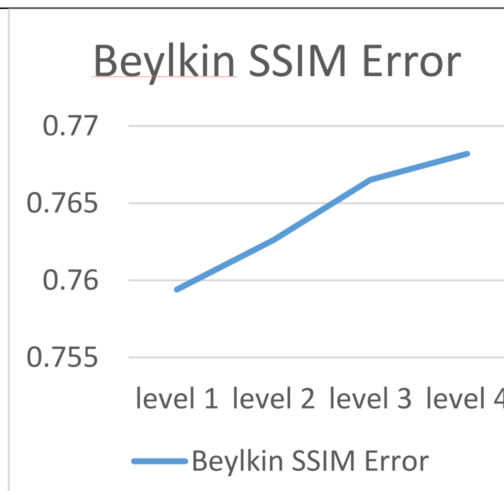


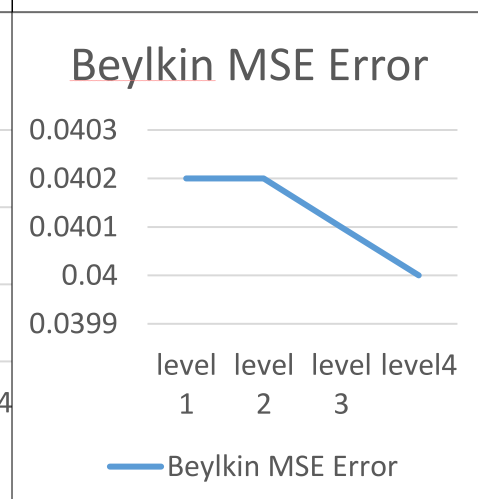
HAN REAL





BEYLKIN





Enhanced Image

Classified Image

EXPERIMENTAL RESULTS AND DISCUSSIONS

The proposed method compares underwater image fusion using the following wavelets: Symlet, Daubechies, Coiflet, Biorthogonal, Han real, and Beylin. The performance of the fusion techniques is compared using the Structural Similarity index and Mean square Error. The comparison shows that the enhanced image produced by the Biorthogonal wavelet fusion technique is better than the images produced by other techniques. The classification is done using the YOLOv5 model; You Look Only Once architecture works better for underwater images. Thus we conclude our work by enhancing the images using wavelet fusion techniques, thereby identifying the best technique for enhancing underwater images. Once enhanced images are given to the YOLOv5 classification model, the resultant output image shows the enhanced and classified underwater images.

RESULT

Diverse strategies were used to improve the underwater images, and wavelets were compared. Eventually, the classification of underwater images was accomplished.

CONCLUSION

This study aims to find crystal-clear underwater images, which is problematic given that scattering and absorption occur in underwater images. To this end, the enhancement technique has been developed specifically for underwater images and will analyze the results of the output image.

All underwater photographs can be processed using these techniques, removing impediments and creating a more straightforward, powerful image.

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