Underwater Image Enhancement Using the Multilayer Perceptron and Color Feature-Based SRCNN

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ABSTRACT

- **Problems in Traditional Approach** : The traditional underwater visual display systems have problems, such as low visibility, poor real-time performance, and low resolution, and cannot meet the needs of real-time high dentition displays in extreme environments.
- **Solution** : An underwater image enhancement method and a corresponding image super-resolution algorithm.
- Image enhancement Technique.
- Super-resolution Convolutional neural networks
- the Retinex algorithm
- gamma correction.
- Dark prior

SRCNN MODEL

- The SRCNN network structure is constructed by a three-layer convolutional neural network, which is composed of image block feature extraction and representation, and also nonlinear mapping and reconstruction of high-resolution images.
- First layer, feature extraction and representation is applied to the image blocks from the original image, and the image blocks extracted by convolution can be expressed as

$$F1(Y) = max(0, W1*Y + B1) \quad \text{----(1)}$$

- where Y represents the original high-resolution image ,$W1$ and $B1$ represent the convolution kernel and deviation.
- Second layer of nonlinear mapping is as follows:

$$F2(Y) = max(0, W2*F1(Y) + B2) \quad \text{--------(2)}$$

- Third layer, a convolution is conducted on the output high resolution image blocks of the second layer to generate images that are close to the original high-resolution images, which can be expressed as:

$$F3(Y) = max(0, W3*F2(Y) + B3) \quad \text{--------(3)}$$

PROPOSED METHOD

MULTILAYER PERCEPTRON-BASED ENHANCEMENT

- First, **<u>Retinex algorithm</u>** is used to initially defog the image. Second, due to the low contrast of underwater images, the image brightness was adjusted by **<u>gamma correction</u>** to make the image more natural.
- The preprocessed image can be obtained from the following equation:

$$r'(x, y) = r''(x, y)$$

- where $r'(x, y)$ is the image enhanced with the Retinex algorithm and $r''(x, y)$ is the Gamma corrected map.
- Finally, **<u>a dark channel prior</u>** is used, and the contrast stretch technique is applied to improve the dynamic range of the image.

Output of MULTILAYER PERCEPTRON-BASED ENHANCEMENT

Original Image

After Retinex

After Gamma Correction

After Dark Prior

COLOR FEATURE-BASED SUPERRESOLUTION

- The method in this paper is based on an SRCNN composed of three convolution layers to improve the input image. The method in this paper is divided into three steps.
- The first step is to divide the low-resolution image into three separate images with three RGB channels.
- In the second step, the three images are trained by a convolutional neural network to obtain three output images. In the
- Third step, the obtained three images are fused to obtain the high-resolution image reconstruction.

- The first step is channel processing. The original image is divided into R, G and B channels to extract different information from each channel. The segmentation processing formula can be expressed as:

$$Fi = image(Fi) \quad (i = R, G, B)$$

- The second step is the convolutional neural network training. The images of the three different channels are trained by a convolutional neural network. The training formula can be expressed as:

$$Fi = \max(0, Wj * Fi(j-1) + Bj) \quad (j = 1, 2, 3)$$

- The third step is image fusion, where the output image of the second step is fused. The fusion formula can be expressed as:

$$F = Image(Fr, Fg, Fb)$$

- Dataset used : **UIEB Dataset Size (630 MB)** 890 raw underwater images with corresponding high-quality reference images
- **SRCNN Training**
- **Training SRCNN 100 Epochs**
- **Adam Optimizer (0.001 learning rate)**
- **Testing on** 60 challenging underwater images.

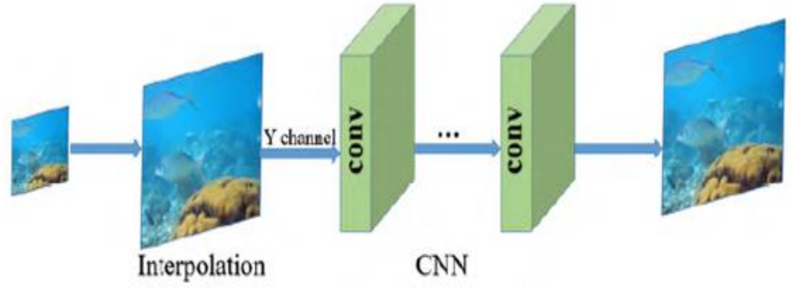


FIGURE 1. Flowchart of the SRCNN.

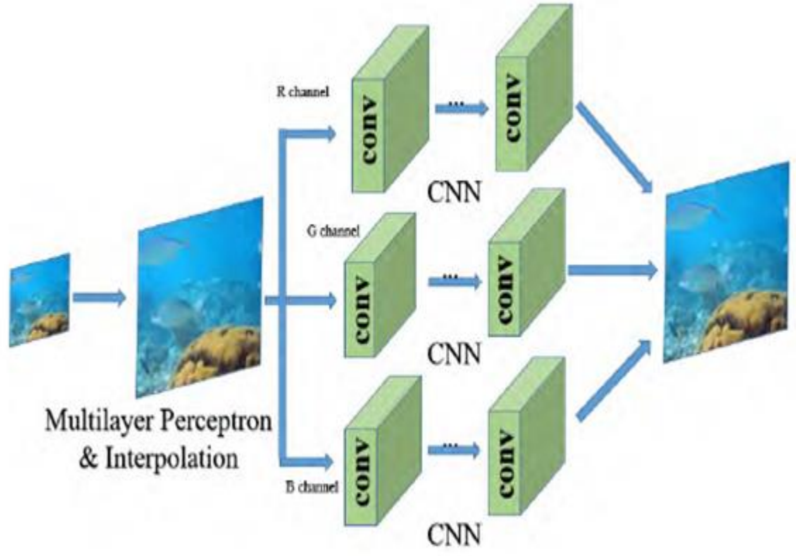


FIGURE 2. Flowchart of the proposed method.

EXPERIMENTAL RESULTS AND DISCUSSION

- ***VISUAL ANALYSIS***

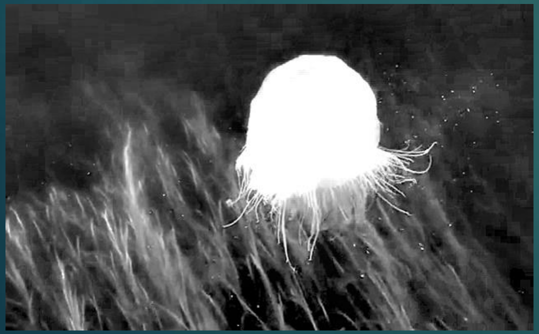
Original image

Retinex image

Gamma Image

Dark Prior

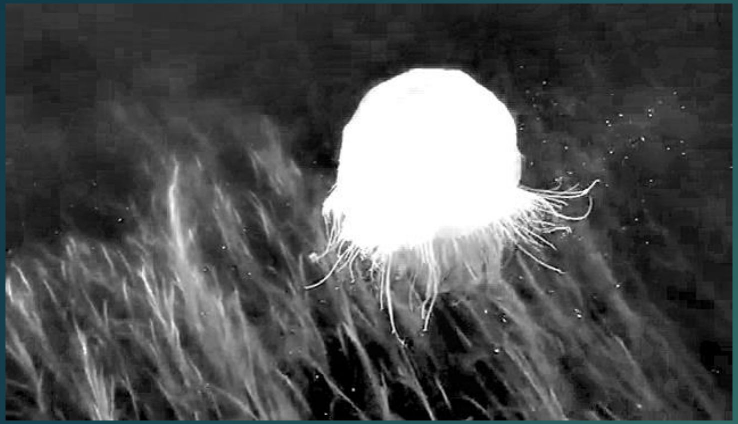
SRCNN Images



Red channel

Blue channel

Green channel



Red Channel

Blue Channel

Green Channel

Fused Image/Output Image

IMAGE QUALITY EVALUATION

PSNR : peak signal-to-noise ratio, ii between two images.
This ratio is used as a quality measurement between the original and a compressed image.

Image Channels	PSNR value
Red channel	29.4263
Green channel	28.6954
Blue channel	31.6093

Images no.	PSNR value	SSIM Value	PSNR/SSIM
image1	15.135387224955284	0.5460245819947694	27.719241448181304

Conclusion

- This paper presented an improved image enhancement method and an image super resolution method. The proposed enhancement method employed a combination of the Retinex algorithm and a neural network to enhance the details of the image and restore the image color.
- Referring to the network structure of an SRCNN, a convolutional neural network model that is trained on the R, G and B channels of an image is adopted, and the output images are fused to obtain clear textures and edge effects under the premise of ensuring the PSNR indexes.
- a good reconstruction effect on most images, its advantages are not obvious for images with nonobvious edges and irregular textures.
- The next step is to try to classify and reconstruct the edges and textures to generate images with clear edges and rich textures and further study image fusion.
- I will further try the **SRGAN Model** to reconstruct the edges and textures to generate images with clear edges and rich textures

Thank You

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