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A Block Based Scheme using Tuned Tri-threshold Fuzzy Intensification Operators for Underwater Images

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Abstract— Basically, the contrast and sharpness of the images captured in underwater will be significantly deteriorated and diminished caused by the less perceptibility of the image which is due to the water medium's physical properties. In this work, improved version of a block based scheme using tuned tri-threshold fuzzy intensification operator for underwater images is proposed. First of all, background image in underwater images are detected by DCT scaling. Later then image enhancement is done by using tuned tri-threshold fuzzy intensification operator and weber's law. Propoposed algorithm is tested on various underwater images, collected from internet and compared with original block based scheme. Experimental results show that proposed scheme is better than original block based scheme

Keywords— Underwater image, Fuzzy Intensification Operator, PSNR, Entropy, MSE

I. INTRODUCTION

In today's scenario, Processing of under water images are one the challenging field in image processing due to the physical properties of the water medium. In some cases, these images are deteriorated due to scattering, refelection and absorption.

In work[1], morphological operator is used to detect background and contrast enhancement is carried out by using two operators based on weber's law. Various techniques[2-5] are developed based on morphological operators for various types of images. Few techniques based on DCT coefficients for enhancing color images are also proposed in work[6-8].

In work [9], tuned tri-threshold fuzzy intensification operator is used enhance visibility of images captured in dusty weather.

In work [10], a block based scheme based on morphological operator and weber's law has been proposed.Various algorithms have been proposed to enhance the underwater images by considering the basic properties of light propagation in physics [11].

The overall work is summarized as follows: Section 2 and 3 gives the existing algorithm that is used for compare the proposed algorithm with existing one. Section 4 gives the proposed methodology which is used in this work. Section 5 gives the experimental results which shows the accuracy of proposed algorithm and finally section 6 gives conclusion of this work.

II. TUNED TRI-THRESHOLD FUZZY INTENSIFICATION OPERATOR

This section gives the detailed explanation of tuned tri-threshold intensification operator [14]. This technique starts with the first tuning parameter, i.e. zeta, which is used to control the processed image color fidelity. After that the processed image is disintegrated into R,G and B channels. Now to calculate the value of intensification operator, two factors, named as the value of tau and membership function, are required. Tau is basically represents the threshold value of the operator and the member function is used to set the pixel's values of a given channel between the range of 0 to 1.

To calculate the value of mebership function for each channel, following formulas are used-

$$f_{red} = \frac{[r-\min(r)]}{[\max(r)-\min(r)]}$$

$$f_{grn} = \frac{[g-\min(g)]}{[\max(g)-\min(g)]}$$

$$f_{blk} = \frac{[b-\min(b)]}{[\max(b)-\min(b)]}$$

And the value of intensification operator is calculed by using follwoing formulas-

$$K_{red} = 2 * (f_{red}(x,y))^2 \quad \text{if } f_{red}(x,y) \leq \text{Ʈred}$$

$$\text{Otherwise } 1\text{-}2\text{*}(1\text{-}f_{red}(x,y))^2$$

$K_{grn} = 2 * (f_{grn}(x,y))^2$ if $f_{grn}(x,y) \leq Ꚍ_{grn}$

Otherwise $1-2*(1-f_{grn}(x,y))^2$

$K_{blk} = 2 * (f_{blk}(x,y))^2$ if $f_{blk}(x,y) \leq Ꚍ_{blk}$

Otherwise $1-2*(1-f_{blk}(x,y))^2$

III.BLOCK BASED SCHEME

In this scheme, First of all color image is converted into YCbCr format due to better processing. Then color image is divided into n x n blocks where each block consists of both AC and DC cofficients of an image. here first component in n x n block denotes the DC value of an image and another component represents AC value of an image.
And by using these coefficients, brightness and contrast of an image are imrpoved. By using this method, background of an image can be obtained.
For each block, background criteria is detected by using following formula-

$$Ꚍ(x) = \gamma (f)(x)$$

Weber's Law states that the it is the ratio of the difference in max to min Luminance value to the min Luminance value and it is denoted by C –

$$C = \frac{L_{max} - L_{min}}{L_{min}}$$

IV.PROPOSED METHODOLOGY

In this work, block based scheme along with tuned tri-threshold fuzzy intensification operator is used. Proposed algorithm steps are as follows-

Step 1: Input RGB color image.

Step 2: Convert RGB image into YCbCr image for better processing.

Step 3: Define block size [Here block size=8 is taken].

Step 4: Convert whole image into number of blocks.

Step 5: Adjust local background illumination using DCT.

Step 6: Enhance each block of a color input image using tuned tri-threshold fuzzy intensification operator.

Step 7: Merge all blocks of an image.

Step 8: Now convert YCbCr image into RGB color image.

Step 9: Enhanced Output Image

V. EXPERIMENTAL RESULTS

In this section, experimental results are performed on various underwater images collected from internet. All experiments are performed on Core i3 processor with 2 GB RAM.

The following performance criterias are used to check the performance of proposed scheme.

1. Peak Signal to Noise Ratio(PSNR) and MSE

The reconstruction quality of the enhanced image can be measured in PSNR and MSE in dB.

$$PSNR = 10 \log_{10} \frac{255^2}{MSE}$$

$$MSE = \frac{\sum_{i=1}^{W} \sum_{j=1}^{H} (X_{ij} - X_{\tilde{ij}})}{W \times H}$$

where x_{ij} and $X_{\tilde{ij}}$ denotes the original and reconstructed pixel, respectively, and the images are of size W × H. A lower value for MSE means lesser error, and as seen from the inverse relation between the MSE and PSNR, this translates to a high value of PSNR. Logically, a higher value of PSNR is good because it means that the ratio of Signal to Noise is higher.

2. Entropy

It is well known that the entropy H (m) of a message source m can be measured by

$$H(m) = \sum_{i=0}^{M-1} p(m_i) \log \frac{1}{p(m_i)}$$

where M is the total number of symbols mi 2 m; p(mi) represents the probability of occurrence of symbol mi and log denotes the base 2 logarithm so that the entropy is expressed in bits

3. Histogram Analysis

In an image processing context, the histogram of an image normally refers to a histogram of the pixel intensity values. This histogram is a graph showing the number of pixels in an image at each different intensity value found in that image

4. Horizonal and Vertical coorelation

Correlation is a statistical technique that can show whether and how strongly pairs of variables are related. Here horizonal and vertical coorelation values shows the strong coorelation between pairs of variables.

Figure 1 shows the sample underwater images taken from internet.

Table 1 shows the effectiveness of proposed scheme with existing one on input image (1).

Parameters	**Existing scheme**	**Proposed Scheme**
PSNR	8.050	20.896
MSE	0	0.615481
Entropy	0.796682	0.0350222
Horizontal coorelation value	0.940658	0.868089
Vertical coorelation value	0.954803	0.859227

Table 2 shows the effectiveness of proposed scheme with existing one on input image (2).

Parameters	**Existing scheme**	**Proposed Scheme**
PSNR	8.022	21.078
MSE	0	0.911742
Entropy	0.932759	0.0308779
Horizontal coorelation value	0.925409	0.8671
Vertical coorelation value	0.947622	0.842777

Table 3 shows the effectiveness of proposed scheme with existing one on input image (3).

Parameters	**Existing scheme**	**Proposed Scheme**
PSNR	8.022	21.046
MSE	0	0.792846
Entropy	0.915179	0.0315726
Horizontal coorelation value	0.93644	0.827326
Vertical coorelation value	0.95173	0.859831

Table 4 shows the effectiveness of proposed scheme with existing one on input image (4).

Parameters	**Existing scheme**	**Proposed Scheme**
PSNR	8.034	20.857
MSE	0	0.964816
Entropy	0.998268	0.035985
Horizontal coorelation value	0.993334	0.990902
Vertical coorelation value	0.994442	0.990076

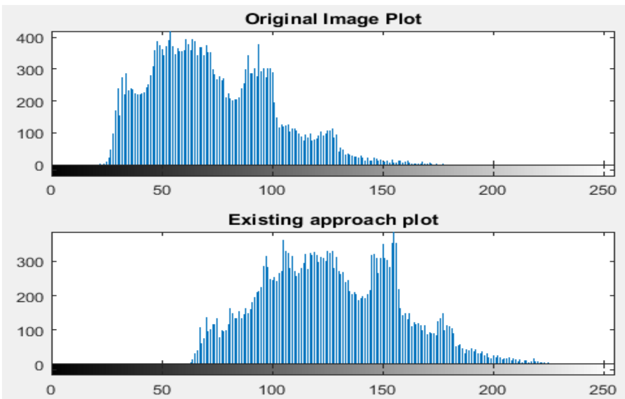
Table 5 shows the effectiveness of proposed scheme with existing one on input image (5).

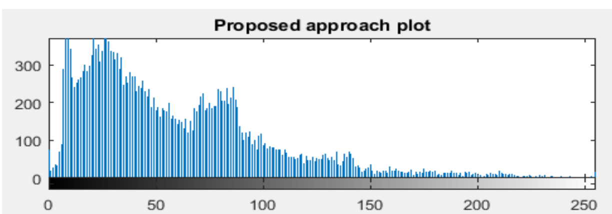
Parameters	**Existing scheme**	**Proposed Scheme**
PSNR	8.022	21.533
MSE	0	0.805952
Entropy	0.998472	0.0225487
Horizontal coorelation value	0.943216	0.860287
Vertical coorelation value	0.934251	0.838114

Figure 2 shows the original, enhanced image using existing approach and enhanced image using proposed approach of sample image(1).

Original Image Existing approach Proposed approach

Figure 3 shows the histograms of orginal image, existing approach and proposed approach of sample image (1).





VI.CONCLUSION

Due to water medium physical properties, underwater images are deteriorated due to absorption, refelection and scattering. In this work, hybridization of block based scheme and tuned tri-threshold fuzzy intensification opretor based scheme for image enhancement is proposed. This proposed scheme is tested on five underwater images taken from internet. Future work is to check the proposed scheme with various other existing algorithm for their effective ness.

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