Underwater Color Image Enhancement Using Genetic Optimization and CLAHE Method

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Abstract- *The nature of underwater images is poor due to particular engendering assets of light in water, illumination and poor visibility. In this way, underwater color enhancement is important to increment visual quality. This paper presented an underwater color IE using genetic algorithm optimization (GA) and contrast limited adaptive histogram equalization (CLAHE).With the use of GA Optimization, it is performed through common trade of geneticobjects between parents. Offsprings are framed from parent qualities. Wellness of offsprings is assessed. The fittest people are permitted to breed as it were. In computer world, GA is supplanted by series of bits and normal choice supplanted by a fitness function. The performance evaluation based on the peak signal noise ratio (PSNR), Weighted PSNR (WPSNR) and mean structural similarity matrix (MSSIM). The comparison of our proposed is on PSNR, WPSNR and MSSIM which shows better than previous methods (DCP, BBHE and Contrast Adjustment (CA)). The experimental contains eight test images like underwater image, seawater image.*

Keywords- GA; BBHE; CLAHE; PSNR; Contrast Adjustment; WPSNR; MSSIM

I. INTRODUCTION

Enhancement of an image is a non-specific procedure known to increaseimages visual quality or perception of knowledge in images for human viewers. In the past few years, there are a lot of researches on the improvement of image quality, but only limited works in the area of underwater imaging. Different from common images, obtaining clear and high contrast images in underwater environment is always a challenging task yet an essential issue in marine engineering. Those challenges are difficult to be dealt with, mostly due to the physical properties of the water medium which is 800 times denser than air [1].

A Color correction method based on an improved gray world implementation assumption is proposed through Kwok et al. which dodge color saturation as experienced in customary procedure through use gamma adjustment. Image visual quality is further improved through putting in an intensity preservation criterion as an additional mean to compute the outcome [2].

II. USING TECHNIQUE

A. Genetic Optimization

Wherever GA employs the principles of natural selection to find solutions to optimization and search problems. It allows a population of many individuals to evolve towards a better solution such that they maximize the "fitness". GA thus helps in finding the optimal value from the solution space. The issue is to choose consequently an optimal set of 12 parameter estimations of a summed up enhancement work, that make the most of some fitness function. The calculation utilizes both spatial and grayness equivocalness measures as the fitness esteem. Various point hereditary traverse operations have been utilized for better joining. Continuous meeting of the enhancement function, upgraded output and wellness worth to their optimal states is experimentally shown for images having both compact and elongated objects (bimodal as well as multimodal). The problem of selecting an image enhancement operator and the relevance of GAs.

A. Generate Initial Population: In most of the algorithms the first generation is arbitrarily generated, by choosing the genes of the chromosomes among the permitted alphabet for the gene. Because of the simpler computational process it is accepted that whole populations have the similar number (N) of individuals.

B. Evaluate Fitness Function: Calculation of the function values that we want to minimize or maximizes.

C. Check for Termination of the Algorithm: As in the greatest optimization algorithms, it is likely to stop the genetic optimization.

D. Value of The Function: The function value of the biggest individual is within a describe range around a set value. It isn't advocated to make use of this criterion alone, because of stochastic detail in search the procedure, the optimization would no longer finish within practicable time.

E. Maximal Number of Iterations: That is greatest generally used stopping criteria. It assurances that the algorithms will give particular outcomes within certain time, whenever it has reached the extremum or not.

F. Stall Generation: If within specially set number of generations (iterations) there's no enhancement of the health operate value of the pleasant person the algorithm stops.

G. Selection: Between total individuals in the current population are selected those, who will carry on and by means of mutation and crossover will create offspring populace. At this stage elitism would be utilizing the first-rate n participants are straight transferred to the subsequent iteration. The elitism assurances, that the value of optimization function cannot get worst (once the extreme is reached it would be kept).

1) Crossover: The individuals chosen by selecting recombine with all other and novel individuals will be generated. The intention is to get offspring contributors, which inherit the greatest viable mixture of the characteristics (genes) of their parents.

2) Mutation: By means of a random modification of particular of the genes, it is assured that even if none of the individuals hold the necessary gene value for the extreme, it is still probable to reach the extreme.

3) New Generation: The elite individuals chosen from selection are collective [3].

B. CLAHE

AHE and CLAHE were proposed to overcome the over noise problem amplification. While AHE performing if the region is managed has a comparatively less intensity range then noise in region becomes additional enhanced. It can also cause some kind of artifacts to appear on those regions. To limit artifacts and noise appearance, an AHE alteration known as CLAHE can be used. CLAHE is an adaptive contrast histogram equalization technique, where the contrast of an image is enhanced by applying CLAHE on small data regions known as tiles rather than complete image. The resulting neighboring tiles are then stitched back seamlessly applying bilinear interpolation [4].

C. BBHE

In this method, decomposed input image and two sub images are formed on mean value bases. One subimage contains the samples set that are less than or equal to mean whereas other subimage is samples set greater than mean. Then technique equalizes both sub images independently according to their respective histograms with a constraint that samples in first subimage are mapped in range from minimum gray level to input mean and samples in second subimage are mapped in range from mean to maximum gray level.

That means one subimage is equalized over the range up to mean and other subimage is equalized over the range from mean based on the respective histograms. The resultant equalized sub images are bounded by each other around input mean, which has an effect of preserving the mean brightness [5].

III. LITERATURE SURVEY

R.Sathya (2015) et al presents that Dark channel prior is method used for removing the haze present in the underwater image. Generally its key observation based technique - most local patches in the haze-free underwater images include pixels which have low intensities in at least one color channel. Applying this prior with haze imaging color model estimations the haze thickness and recover an improved image quality haze free image [6]
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FahimehFarhadifard (2015) et al present that strategy is a single image approach that does not require additional knowledge of environment such as depth, distance camera/object or water quality. The experimental results show that the proposed method can efficiently enhance almost every underwater image; and offers a quality that is typically sufficient for high level computer vision algorithms [7].

Huimin Lu (2013) et al present that a new underwater model to compensate attenuation discrepancy along the propagation path, and to propose a fast guided trigonometric bilateral filtering enhancing algorithm and a novel fast automatic color enhancement algorithm. The enhanced images are categorized through reduced noised level, higher dark regions exposedness, better global contrast while finest details and edges are enhance significantly [8].

Muhammad SuzuriHitam (2013) et al presents that novel technique known as mixture CLAHE color models that specifically developed for underwater image enhancement. The technique operates CLAHE on HSV and RGB color models and both outcomes are combined together applying Euclidean norm [9].

Chunmei Qing (2015) et al present that an adaptive dahazing framework for underwater image enhancement, which includes two main parts: adaptive underwater brightness estimation and locally adaptive histogram equalization. The enhanced images are characterized by more accurate exposure of underwater images, especially in the dark regions. And improved contrast for the better details and edges are enhanced significantly in the images [10].

Shijie Zhang (2014) et al present that a novel underwater imaging model is proposed and it can improved define the underwater images degradation including color distortion and contrast attenuation. In addition, a new observation that the intensity of the water part within image is mostly contributed through scattering light is also proposed [11].

Pushkresh Kumar Dwivedi (2015) et al present that distance of objects from the scene point based on the pixel intensity and a subsequent optimization technique is used for getting prominent result [12].

IV. PROPOSED WORK

This paper implemented with the enhancing the superiority of images by using angenetic optimization and CLAHE method. In this research, worked on color image. The advantage of GA is used to enhance image contrast. With the support of mapping depth of image values according to the predefined desk. Every intensity price I is mapped to a brand new value B. The value of curve bis represented by

$$B = \frac{I - Lmin}{Lmax - Lmin}$$

Where Lmax and Lmin represent maximum and minimum intensity values.

In this experiment, take number of generations is 2, quantity of chromosomes is 2, mutation rate is 0.5.Offsprings are created during crossover and mutation. The crossover is an process when new chromosomes – offsprings are produced by means of fusing elements of other chromosomes – parents. The mutation is random replacement of chromosome bits. Hence offsprings form a new new release which replaces the historic one. The simulation result is performed on PSNR, WPSNR and MSSIM.

Proposed Algorithm

1. Read underwater color image is specified as I and an image resize with 512*512 dimension
2. Then the dimensions of the image are set

$[r, c, ch] = size(I)$

Where r,c is the row and column of underwater image and ch is number of measurement

3. Convert RGB into Ycbcr format for further processing.
4. For each sub-image do the following:
   - Compute the histogram of the sub-image .
   - Compute the high peak estimation of the sub-image.
   - Nominal clipping level calculate, P from 0 to high peak utilizing the binary search
   - For each gray level bin in the histogram do the following:
     i. If the histogram bin is greater than the nominal clip level P, clip the histogram to the nominal clip level P
     ii. Collect the quantity of pixels in the sub-image that created the histogram receptacle to surpass the ostensible clasp level(P).
   - Distribute the clipped pixels uniformly in all histogram bins to obtain the renormalized clipped histogram.
   - Equalize the above histogram to get clipped HE mapping for sub-image
5. For each pixel in the input image, do the following
   - If the pixel belongs to an internal region (IR), then
     i. Compute four weights, one for each of the four closest sub-images, in view of the closeness of the pixel to the focuses of the four closest sub-images (closer the focal point of the sub-imapicture, bigger the weight).
     ii. Calculate the yield mapping for the pixel as the weighted aggregate of the cut HE mappings for the four closest sub-images utilizing the weights figured previously.
   - If the pixel has a place with a border region (BR), then
     i. Compute two weights, one for each of the two closest sub-images, founded on the proximity of the pixel to the two nearest sub-images middles.
     ii. Calculate the output mapping for the pixel as the weighted aggregate of the clipped HE mappings for the two closest sub-images utilizing the weights processed previously.
   - If pixel fits in with CR, output pixel mapping is the clipped HE mapping for sub-image that contains the pixel.
6. Apply the yield mapping got to each of the pixels in the input image to acquire the image enhanced by CLAHE.
7. Initialize the population of possible solutions.
8. Calculation of an evaluation i.e. fitness function that plays the role of the environment, rating solution in positions of their ‘fitness’.

9. Definition of genetic operators (selection, crossover, mutation) that alter the composition of children for the period of replica.
10. Establishing values for the parameters (population measurement, possibilities of applying genetic operators) that the genetic algorithm makes use of .The genetic algorithm take in following strictures.
11. Again Convert Ycbcr to RGB format for obtaining color image.

Pseudo code of GA:

1) Begin with a randomly generated population of N chromosomes, the place N is the size of populace, l – size of chromosome x.
2. Calculate the fitness price of operate φ(x) of each and every chromosome x in the populace.
3. Repeat exceptoff springs are created:
   3.1. Probabilistically indicate a pair of genetic material from present people by value of fitness function.
   3.2. Produce an offspring y_i by crossover and transformationoperatives, where i = 1, 2, …,N.
4. Exchangerecentpopulace with anew created one.
5. Go to stage 2.

12. Calculate MSE amongthe input image and enhanced image.

$$MSE = \frac{1}{M*N}||y - s^{\wedge}||^2 = \frac{1}{MN}\sum_{i=1}^{MN}(y-s)^2$$

where M, N is size of input image, y is original input image and s is enhanced image

13. Calculate PSNR between input image and enhanced image.

$$PSNR = 10\times log10\frac{maxValue(size(y))}{sqrt(mean(mean(MSE)))}$$

Where y is input image, MSE is mean contrast

14. Structural Similarity Matrix (SSIM)- It is used for calculating similarity content between original image and enhanced image.

$$SSIM = \frac{(2\mu_x\mu_y - c_1)(2\sigma_{xy} - c_2)}{(\mu_x^2 - \mu_y^2 - c_1)(\sigma_x^2 - \sigma_y^2 - c_2)}$$

Where $\mu_x$is the average of x, $\mu_y$is the average of y, σ_{xy} is the covariance of x and y, c_1= $(K_1L)^2$, c_2= $(K_2L)^2$,K_1= 0.01 and K_2= 0.03by default and L is the dynamic range of pixel values.

$$MSSIM(E,F) = \frac{\sum_{k=1}^{R} SSIM(x,y)}{R}$$

Where R is the total number of local windows in the image, E and F denote the original image and the enhanced image, respectively; x and y are the image contents at the k-th local window in the original and enhanced images

15. Weighted PSNR- It calculates the value of WPSNR among I and enhanced image.

$$WPSNR(x) = \frac{20 \times log10((255))}{\sqrt{MSE(x)} \times NVF} \quad (11)$$

The method to calculate this factor as a simplified function is:

$$NVF = NORM\left(\frac{1}{1 + \delta_{block}^2}\right)$$

Where δ stand for the luminance difference for the 8 × 8 blocks of the picture and NORM represents the normalization function value. Typical values for the WPSNR in lossy should be greater than 40 which indicate high quality.

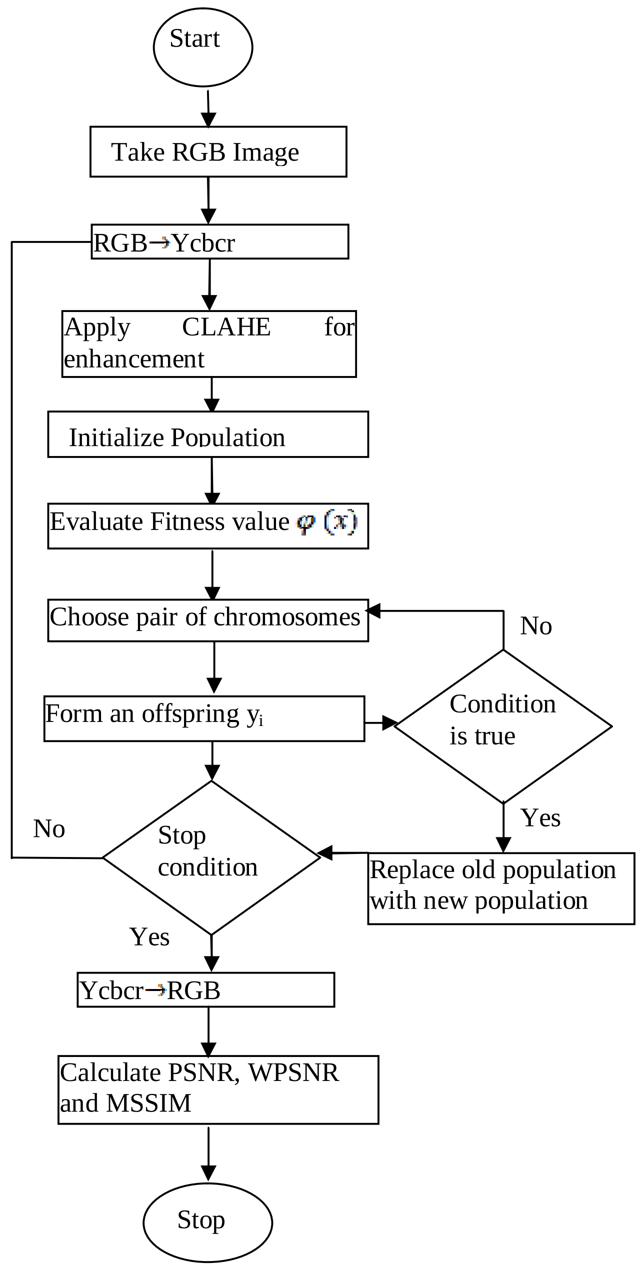


Fig 1: Flow chart of Proposed Work

V. RESULT ANALYSIS

The simulation work is performed on MATLABR12 using Image Processing Toolbox. This system contains underwater image and seawater image. For the experiment, we take eight test images with 512*512 image resolution. The performance is evaluated on different parameters.

Fig 2: Experimental Dataset of Underwater image

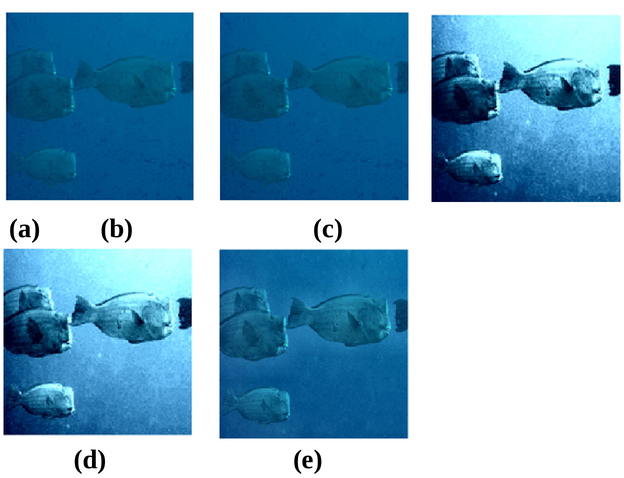


Fig3. Results of different filters on 2.jpg iage: (a) Input Image, (b) DCP , (c) BBHE, (d) Contrast Adjustment, (e) Proposed method

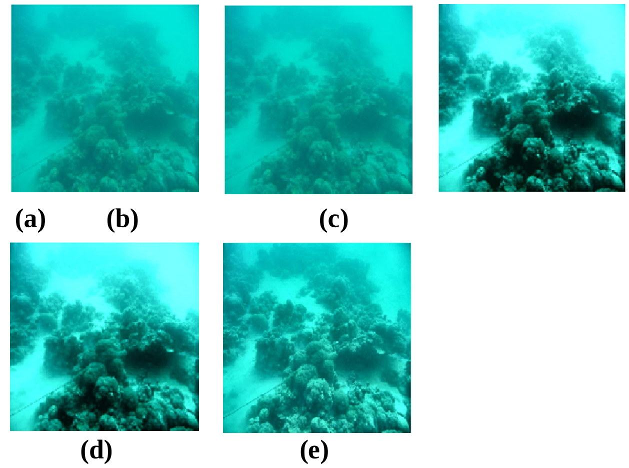


Fig3. Results of different filters on 1.jpg iage: (a) Input Image, (b) DCP , (c) BBHE, (d) Contrast Adjustment, (e) Proposed method

Table1. PSNR Comparison of Proposed System with DCP System, BBHE and Contrast Adjustment method

Image	DCP PSNR	BBHE PSNR	Contrast Adjustment PSNR	Proposed PSNR
fig1a	13.50	9.70	10.68	78.05
2.jpg	40.85	8.98	9.13	91.21
fokXu-S	12.25	13.34	13.72	93.24
fish	20.76	12.87	18.54	67.88
caires2	15.90	11.74	18.60	71.32
fort	21.67	13.57	19.70	68.78
dolphin	19.46	14.27	16.57	75.16
1.jpg	52.05	13.85	14.62	56.08

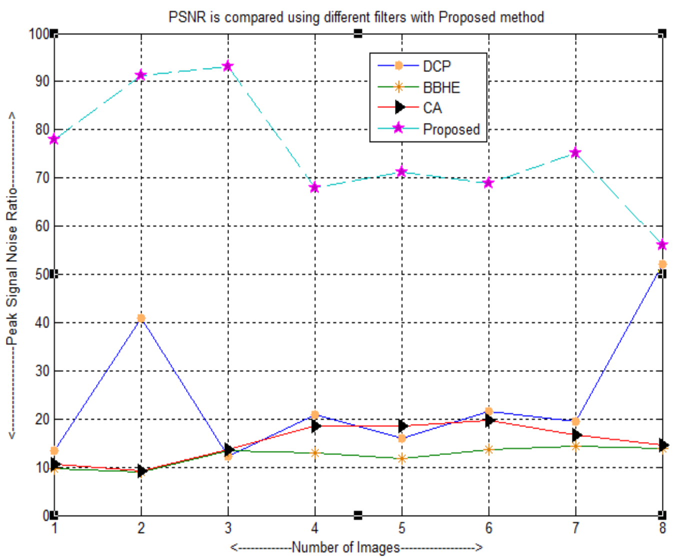
Table2. WPSNR Comparison of Proposed System with DCP System, BBHE and Contrast Adjustment method

Image	DCPWP SNR	BBHE WPSNR	Contrast Adjustment WPSNR	Proposed WPSNR
fig1a	60.36	65.91	68.38	76.54
2.jpg	77.44	68.35	71.28	83.83
fokXu-S	60.42	65.53	68.06	78.24
fish	64.04	66.87	63.63	66.09
caires2	60.38	67.22	64.24	67.85
fort	61.57	67.86	64.56	66.85
dolphin	65.10	69.14	69.76	70.73
1.jpg	88.32	65.84	66.25	67.59

Table3. MSSIM Comparison of Proposed System with DCP System, BBHE and Contrast Adjustment method

Image	DCPMSSIM	BBHE MSSIM	Contrast Adjustment MSSIM	Proposed MSSIM
fig1a	0.2536	0.5602	0.6710	0.8787
2.jpg	0.9937	0.2171	0.1246	0.1979
fokXu-S	0.0886	0.7710	0.8575	0.9008
fish	0.5271	0.4201	0.4836	0.5230
caires2	0.4206	0.5039	0.6702	0.5793
fort	0.3632	0.4831	0.5690	0.5457
dolphin	0.4740	0.4173	0.5742	0.5116
1.jpg	0.9942	0.3956	0.3987	0.4854

Table1 has demonstrated the quantized examination of the PSNR of various pictures utilizing DCP framework, BBHE method, and CA method and by Proposed Approach. It's clear from the Table that there is an increase in PSNR estimation of pictures with the utilization of the proposed strategy over existing system. This diminishing speaks to change in the target nature of the picture.



Graph1. Shows PSNR Comparison Existing Method v/s Proposed Method

In Graph1, it shows that comparison of PSNR values using existing method and proposed method. Base results shows by sky Blue line, BBHE result presented by blue line, CA result shows by red line and proposed result shows using green line. This graph shows that proposed result is much improved than current method.

VI. CONCLUSION

In this work, the proposed technique presents that underwater image enhancement using optimized GA and CLAHE. It allows to performa robust search for discovery the global optimum. The result of the optimization be contingent on the chromosome encoding scheme and involvement of genetic operators as well as on the fitness function.The experimental effect suggests that the simpler performance as compared to previous ways on the basis of PSNR, WPSNR and MSSIM. The proposed hybrid method provides a better PSNR in underwater image enhancement where the difficult of low illumination and very poor contrast are prime problems. It can improve the images taken under blurry, stormy conditions.This system improves the image superiority and preserves the edges of an image. In the future work, we will try to decrease the computational time of GA and merge with other optimization algorithm.

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