Improving Mix-CLAHE with ACO for Clearer Oceanic Images

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Abstract— *Oceanic pictures have poor visibility attributable to various factors; weather disturbance, particles in water, lightweight frames and water movement which results in degraded and low contrast pictures of underwater. Visibility restoration refers to varied ways in which aim to decline and remove the degradation that have occurred whereas the digital image has been obtained. The probabilistic Ant Colony Optimization (ACO) approach is presented to solve the problem of designing an optimal route for hard combinatorial problems. It's found that almost all of the prevailing researchers have neglected several problems i.e. no technique is correct for various reasonably circumstances. the prevailing strategies have neglected the utilization of hymenopter colony optimization to cut back the noise and uneven illuminate downside. The main objective of this paper is to judge the performance of ANT colony optimization primarily based haze removal over the obtainable MIX-CLAHE (Contrast Limited adaptive histogram Equalization) technique. The experiment has clearly showed the effectiveness of the projected technique over the obtainable strategies.*

Keywords— Oceanic pictures, CLAHE, MIX-CLAHE, Haze, ACO.

I. INTRODUCTION

Light within the ocean is like lightweight in no alternative place on Earth. It is a world that's visibly completely different from our acquainted terrestrial world, and one that marine animals, plants, and microbes area unit tailored to in extraordinary ways that. Lightweight behaves terribly otherwise once it moves from air into water. It moves through the expansive depths of Associate Ocean that void of solid surfaces. These associated alternative factors mix to make setting that has no equivalent onto land. water absorbs lightweight rather more powerfully than air will, however actinic radiation is formed from a rainbow of various wavelengths, every perceived by United States of America as a distinct color. Blue lightweight penetrates farther into water (giving the ocean its distinctive color). At an equivalent time water absorbs red, orange, and yellow wavelengths, removing these colors. The waves act like lenses to focus lightweight, making a scintillating field of vision whose brightness will increase and reduces by an element of 100 as every wave passes by, creating it not possible for eyes to regulate. Below 850 meters, though, the diver would now not be ready to see something, even trying up. Human eyes aren't sensitive enough to notice the minute amounts of daylight that haven't been absorbed by the water. At 1,000 meters, even the foremost visually sensitive sea animals will longer see the sun. The region below this is often called the dark (no-light) zone, however this is often solely true for daylight, as luminescence is common.

This paper proposes new technique that integrates MIX-CLAHE and ACO technique. The main goal is to cut back the noise and uneven illuminate downside.

II. VISIBILITY RESTORATION TECHNIQUES

Various image restoration techniques are as follows:

1. Dark Channel Prior
2. CLAHE (Contrast Limited Adaptive histogram equalization)
3. Wiener filtering
4. Bilateral filtering
5. Mix-CLAHE

2.1 Dark channel prior: Dark channel prior [3] has been developed to estimate part lightweight within the dehazed image thus on manufacture the output image. This system is largely used for non-sky patches, as a minimum of one color channel has astonishingly low intensity at some pixels. The intensity is reduced attributable to 3 components:-

- ➢ Colorful things or surfaces (green grass, tree, blooms and then on)
- ➢ Shadows (shadows of automotive, buildings etc)
- ➢ Dark things or surfaces (dark bole, stone)

2.2 CLAHE

Contrast Limited adaptive histogram equalization short form is CLAHE [39]. This method doesn't wish any foreseen weather information for the process of hazed image. Firstly, the image captured by the camera in foggy condition is reborn from RGB (red, inexperienced and blue) color house is modified into HSI (hue, saturation and intensity) color house. The images are converted because the human sense colors similarly as HSI represent colors. Secondly intensity component is processed by CLAHE without effecting hue and saturation. This process use histogram equalization to a contextual region. The first histogram is clipped and the clipped pixels are redistributed to each gray-level. In this each pixel intensity is shortened to maxima of user selectable. Finally, the image processed in HSI color space is converted back once again to RGB color space.

2.3 Wiener filtering

Wiener filtering relies on dark channel previous: Wiener filtering [4] is employed to counter the issues like color distortion whereas utilizing dark channel prior the estimation of media perform is rough that build halo result in final image. Thus, median filtering is employed to estimate the media perform, thus edges may be preserved. within the wake of creating the median perform a lot of correct it's combined with wiener filtering therefore the image restoration downside is reborn into improvement downside. Blurring is owing to straight movement during a pic is that the consequence of poor sampling. each pel during a digital illustration of the pic got to represent the intensity of one stationary purpose before of the camera.

2.4 Bilateral filtering

Bilateral Filtering [2] smoothes images while preserving edges, by means of a non-linear mixture of nearby image values. In this, filter replaces each pixel by weighted averages of its neighbour's pixel. The weight given to each neighbour pixel decreases with both the distance in the image plane and the distance on the intensity axis. This filter produces faster results. While using the bilateral filter we can use pre-processing and post processing steps for better results. Histogram equalization is used as pre-processing and histogram stretching as an article processing. These steps help to improve the contrast of image before and after usage of bilateral filter.

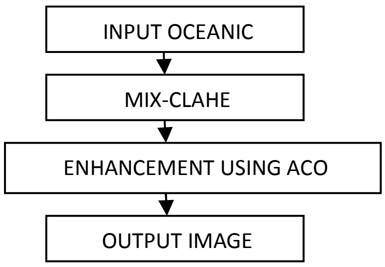
2.5 Mix-CLAHE

The Paper [16] has presented method to boost underwater images utilizing a mixture Contrast Limited Adaptive Histogram Equalization. The enhancement method effectively improves the visibility of underwater images and produces the best MSE and the best PSNR values. Thus, it indicates that the mix-CLAHE based method is promising for classifying coral reefs particularly when visual cues are visible. For each 10m increase in depth the brightness of sunlight will drop by half. The majority of red light is fully gone by 50% from the outer lining but blue continues to great depth. That's why most underwater images are dominated by blue-green coloration. CLAHE-Mix first normalizes caused by CLAHE-RGB.

III. ACO IMPLEMENTATION

Ant Colony improvement (ACO) could be a meta-heuristic for determination exhausting combinatorial improvement issues. The ennobling offer of ACO may well be the secretion path birth and following behavior of real ants that use pheromones as a communication medium. In analogy to the biological example, ACO relies on indirect communication within a colony of easy agents, referred to as (artificial) ants, mediate by (artificial) secretion trails. The secretion trails in ACO function distributed, numerical information that the ants use to probabilistically construct ways to the problem being solved which the ants adapt throughout the algorithm's execution to mirror their search expertise.

IV. PROPOSED METHODOLOGY TO IMPROVE MIX-CLAHE



Flow chart 1: Proposed methodology

The present analysis work planned to completed n varied stages that have to be compelled to be preceded following and first of all methodology can discuss datasets used for thesis work, as delineate below:

3.1.1 Dataset:

The oceanic image dataset could be a assortment of 25-30mm images of deep reef and hazed pictures of Deep Ocean. For the operating of thesis planned methodology used totally different kind of underwater hazed pictures. a number of these square measure given below.

Fig.1: Adapted from Dataset [3], [7]

In total, the pictures square measure divided into 25-30 clips, taken at totally different locations within the ocean. Some examples square measure shown within the Figure eight. Given pictures square measure taken from totally different knowledge sets.

V. FLOW CHART

Flow chart of planned methodology describes varied phases step by step that clarify the suitable operating of current methodology.

Below square measure the steps for the planned algorithmic program

Phase 1: choose the input image. Any digital image is diagrammatical as Associate in Nursing array of size M*N pixels.

Phase 2: 1st of all, apply MIX-CLAHE technique on the input image. This method was fictitious to cut back unwanted artefacts in addition as brightness in a picture. MIX-CLAHE technique mixes the results of CLAHE-RGB and CLAHE-HSV. the most aim of this method was to reinforce the distinction of a picture and provides natural look to underwater pictures.

$$\{r_{c1}, g_{c1,} b_{c1}\} = \left[\frac{R_c}{(R_c+G_c+B_c)}, \frac{G_c}{(R_c+G_c+B_c)}, \frac{B_c}{(R_c+G_c+B_c)}\right] \quad (1)$$

Then the result of CLAHE-HSV is converted to RGB color model by finding chroma

$$C = V * S \quad (2)$$

$$H' = \frac{H}{60^0} \quad (3)$$

Then, by using C and H', X is determined as follows:

$$X = C(1 - |(H' \bmod 2) - 1| \quad (4)$$

The conversion from HSV to RGB which is denoted by

$$\{r_{c1}, g_{c1,} b_{c2}\} = \begin{cases} (0,0,0), \mathit{if\ H\ is\ undefined} \\ (C, X, 0),\ if\ 0 \le H' < 1 \\ (X, C, 0), \text{if } 1 \le H' < 2 \\ (0, C, X), \text{if } 2 \le H' < 3 \\ (0, X, C), \text{if } 3 \le H' < 4 \\ (X, 0, C), \text{if } 4 \le H' < 5 \\ (C, 0, X), \text{if } 5 \le H' < 6 \end{cases} \quad (5)$$

Finally, both conversions' from eq.1 and eq.5 are integrated using Euclidean norm:

$$RGB_n = \sqrt{r_{c1}^2 + r_{c2}^2} + \sqrt{g_{c1}^2 + g_{c2}^2} + \sqrt{b_{c1}^2 + b_{c2}^2} \quad (6)$$

Phase 3: In this phase whole working of ACO algorithm will be performed. In analogy to the biological example, ACO is based on indirect communication inside a colony of simple agents, called (artificial) ants, mediated by (artificial) pheromone trails. The pheromone trails in ACO serve as distributed, numerical information, that the ants use to probabilistically construct methods to the issue being solved and that the ants adapt during the algorithm's execution to reflect their search experience. The given table reveals the information about numerous parameters used in working of proposed methodology.

Since, there are no pre-defined connections between nodes, the implementation starts with generating the connections between the nodes. The generation of the next edge of the current point for ant follows equation 5 in which it choose next edge probabilistically according to the attractiveness and visibility.

Since, there are no pre-defined connections between nodes, the implementation starts with generating the connections between the nodes. The generation of the next edge of the current point for ant follows equation 7 in which it choose next edge probabilistically according to the attractiveness and visibility.

$$\text{Distance}(i,j) = \text{sqrt}\ ((x(i) - x(j)^2 + (y(i) - y(j)^2)) \quad (7)$$

x, location co-ordinates such that is Euclidean distance between location,

Each ant maintains a tabu list of infeasible transitions for that iteration and Update attractiveness of an edge according to the number of ants that pass through. The pheromone update process is done in two phases; first, each ant updates its own local path, and later a global process updates the arcs of the best rout,. Then we have to update local pheromone value

$$\tau_{ij}(t) = (1-p)\tau_{ij}(t))p.\tau_0 \quad (8)$$

τ_{ij}Describes the amount of pheromone on edge [i, j] at time t. ρ Describes pheromone decay $0 < \rho < 1$; and τ_0 is the initial value of pheromone on all edges.

$\tau_{ij}(t) \leftarrow (1\text{-}p)\, \tau_{ij}(t) + p.\, \Delta\, \tau_{ij}(t)$ (9)

Where $\tau_{ij}(t)$ is the amount of pheromones on the edge (i,j) at time t; ρ is a parameter governing pheromone decay such that 0< <1; and where is the length of the current best tour. The pseudo code of our implementation is presented in three parts. Algorithm 1 shows the random pixel generation and Algorithm 2 shows generation of pheromone matrix and Algorithm 3.

Phase 4: Then the final image is obtained. Following figure shows the output of proposed technique, which is clearer than previous technique.

VI. RESULT AND DISCUSSION

6.1Performance Evaluation

The algorithm is applied using various performance indices peak signal to noise ratio (PSNR), Mean squared error (MSE), Root Mean Square Error (RMSE) and Normalized Cross Correlation (NCC).

In order to implement the algorithm, design and implementation has been done in MATLAB using image processing toolbox. The developed approach is compared against a well-known image dehazing technique. We are comparing proposed approach using some performance metrics. Result shows that our approach gives better results than the existing technique.

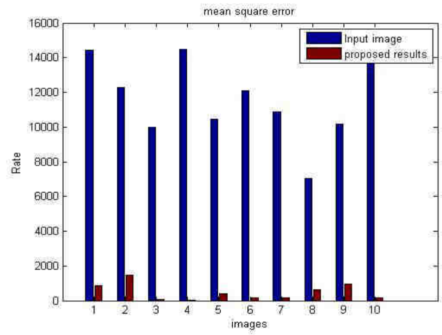
6.1.1Mean Square Error

Table 1: Mean Square error

Images	MIX-CLAHE	Proposed results
1.	14416.1732	871.901595
2	12290.3195	1493.579016
3	9991.7233	76.649915
4	14464.645	0.507545
5	10441.2884	398.670682
6	12114.9567	172.566432
7	10887.2157	140.830117
8	7034.0424	637.698711
9	10198.5361	965.254002
10	15228.2168	150.231886

Table 1 is showing the quantized analysis of the mean square error. As mean square error needs to be reduced therefore the algorithm is showing the better results

Than the available methods as mean square error is less in every case. The mean Square error is reduced in each case.



Graph 1: MSE Evaluation

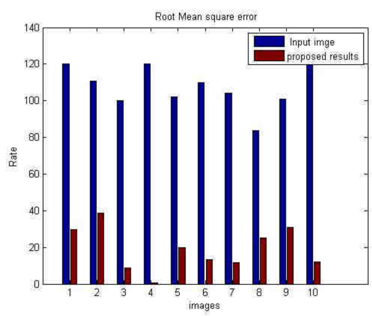
6.1.2 Root Mean Square Error

Table 3 is showing the comparative analysis of the root mean square error. Table has clearly shown that is less in our case therefore the algorithm has shown significant results over the available algorithm.

Table 2: RMSE Evaluation

Images	MIX-CLAHE	Proposed results
1	120.0674	29.5280
2	110.8617	38.6469
3	99.9586	8.7550
4	120.2691	0.7124
5	102.1826	19.9667
6	110.0680	13.1365
7	104.3418	11.8672
8	83.8692	25.2527
9	100.9878	31.0685
10	123.4027	12.2569

Graph 2 has shown the quantized analysis of the Root mean squared Error of different images. It is very clear from the plot that there is decrease in RMSE value of images with the use of method over existing method. This decrease represents improvement in the objective quality of the image



Graph 2: RMSE Evaluation

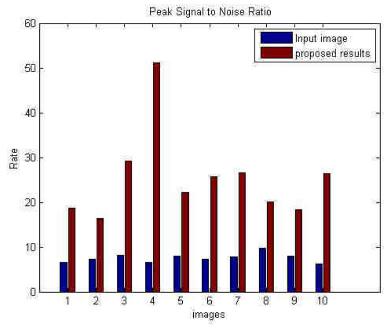
6.1.3 Peak Signal to Noise Ratio

Table 4 is showing the comparative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized; so the main goal is to increase the PSNR as much as possible. Table 4 has clearly shown that the PSNR is maximum in the case of the algorithm; therefore algorithm is providing better results than the available methods. The method is tested on the number of images and in each case shows the better results than the existing method.

Table 3: PSNR Evaluation

Images	MIX-CLAHE	Proposed results
1	6.5423	18.7261
2	7.2352	16.3885
3	8.1344	29.2857
4	6.5277	51.0761
5	7.9433	22.1247
6	7.29s76	25.7612
7	7.7616	26.6438
8	9.6588	20.0846
9	8.0454	18.2844
10	6.3043	26.3632

Graph 3. has shown the quantized analysis of the peak signal to noise ratio of different. It is very clear from the plot that there is increase in PSNR value of images with the use of method over existing methods. This increase represents improvement in the objective quality of the image.



Graph 3: PSNR

VII. CONCLUSION

This paper projected a replacement technique that primarily used for underwater haze removal. The review analysis shows that underwater pictures square measure littered with low distinction and low visibility. This paper has offered a replacement technique ACO primarily based MIX-CLAHE that is integrated technique of MIX-CLAHE and hymenopterous insect colony optimisation. The projected technique has been designed and enforced in MATLAB victimization image process tool. The projected methodology has mentioned numerous performance metrics to check the effectiveness of current technique, these square measure PSNR, MSE and RMSE. The experimental results indicates that projected technique offers higher results as compare to out there ways. Therefore ACO primarily based MIX-CLAHE technique proves best for underwater haze removal osn massive set of hazed pictures. Also the hymenopterous insect colony suffers from slow converges speed thus in future we'll try and scale back it victimization different organic process optimisation primarily based techniques.

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