International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-7, Issue-7, July 2021
ISSN: 2395-3470
www.ijseas.com

Performance Analysis of Strength Pareto Evolutionary Algorithm II Based Gradient Channel Prior

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Abstract

In this paper, a novel Gradient channel prior (GCP) is designed and implemented. The designed technique modifies the GCP using Strength pareto evolutionary algorithm II (SPEA-II) by to optimize hyper-parameters of dehazing. Adaptive histogram equalization will also be used to remove the uneven illuminate problem of the digital haze removal. Thus, the proposed technique has an ability to remove the limitations of existing techniques. Different kind of quality metrics are used to evaluate the effectiveness of the proposed technique over the existing one. Extensive experiments are performed to evaluate the effectiveness of the proposed dehazing technique. It is found that the proposed technique outperforms competitive techniques in terms of percentage of saturated pixels, new visible edge, new edge gradients, etc. Therefore, the proposed technique can be used in real-time imaging systems.

Keywords: *Haze, Restoration, Transmission, Atmospheric.*

1. Introduction

Haze removal is definitely an important concept in the image processing domain. Pictures of outside scenes are normally disturbed by the atmospheric dampness, airborne dirt and dust, smoke a cigarette, waters droplet etc. These problems usually are cause to generate the actual environment that usually called Haze [1, 2]. The actual atmospheric happening disturbs the particular clarity with sky. Most atmospheric individual particles have a range below of 1000m and haze intensity is 4 to10 [3, 4, 5].When an atmospheric particles suspended around the sky haze produced. Haze is very essential for depth clue to understand scene [6].The formation on the imprecise image is usually motivated because light by you source can be dotted by simply water droplets in the sky [7, 8]. Scattering is occurred by 2 essential phenomena namely attenuation and air-light Haze is big obstacle in visibility applications, so much needed to remove effectively, because debris, light up in addition to dried up dust disturb the clarity of sky [9, 10]. This leads degradation of outsides pictures as well as weakening of equally colour and compare images [11]. The indegent weather conditions ailments additionally reduce the clearness of pictures. These types of atmospheric ailments are utilized to clouds the actual caught scene [12]. The air is actually included a number of misted contaminants [13, 14]. So, haze occurs in the pictures because of absorption and scattering. These kinds of tossed events generally labeled in 2 categories for instance attenuation and atmosphere light. Dehazing is crucial in computer eye-sight software and computational photography [15, 16]. It is considered as very efficient method because pictures without haze make possibility of improvement in the interpretation of computer vision work. A novel Gradient station earlier (GCP)) is proposed. GCP rates the television broadcasting guide based on the style gradient. The idea minimizes the feel in addition

to color distortion issues. Additionally, it is capable to get over a variety of concerns like sky-region, halo artefact, in-homogeneous haze, gradient letting go artefacts, in addition to color distortion.L0 filtration system is accustomed to refining the television broadcasting guide extracted from GCP. This filter keeps sizeable ends in addition to refines the television broadcasting guide efficiently. An advised L0 filtration system is computationally more quickly as compared to the previous filtering techniques. Consequently, it is more suitable intended for real-life haze eradication systems. An altered clean up product is also regarded to unravel color distortion in addition to halo artefacts issues. The idea redefines the television broadcasting guide to 20 cut down colour distortion problem. For this purpose, with the ability to protect the functional detail. To evaluate the functionality connected with GCP, extensive findings are generally carried out. GCP tremendously help the radiometric in addition to spatial info connected with fuzzy graphics specifically for graphics influenced through huge haze gradient and sophisticated background.

2. Literature Review

Bian et al. (2020) [1] proposed that the dehazing method frequently just indicates results whenever control the style for your specified errors concentration. Therefore, a good versatile obscure impression dehazing method based on SVM is proposed. The creativity things are highlighted below: First, pairing the functions of the downgraded pictures regarding errors weather conditions, this dimly lit funnel histogram and also texture highlights of this input pictures usually are removed so that you can make up the attribute vectors. **Qunfang et al. (2020) [2]** Haze removal shown that the night time images is much more difficult in comparison to day image dehazing a result of the unequal lighting, very low distinction and also intense colouring distortion. In this report, following the solutions based on Black route earlier, most people propose to your girlfriend an effective however efficient approach utilizing Retinex principle and also Taylor line extension regarding night-time image dehazing, known as 'RDT '.**Shu et al. (2020) [3]** suggested that the dehazing is actually connected with vital value to the outdoor undercover, as well as major issues predominantly range from spatial-temporal coherence and also computational efficiency. That paper gifts a proficient real-time movie dehazing technique via incremental sign discovering and also spatial-temporally coherent regularization, even though clearly suppressing the potential visual artefacts '. **Cong et al. (2020) [4]**proposed that the Landscape field of vision inside outside illustrations or photos is often deteriorated simply by undesirable climate conditions for instance snow, errors, as well as rain. Primarily, wreckage as a result of errors is normally viewed available as light colouring as well as reduced contrast with images. To beat impression wreckage, dehazing algorithms good atmospheric scattering style make use of sign map opinion, which in turn is related to the errors thickness all over the level with scenes. **Young et al. (2020) [5]** discussed that the Landscape field of vision inside outside illustrations or photos is often deteriorated simply by undesirable climate conditions for instance snow, errors, as well as rain. Primarily, wreckage as a result of errors is normally viewed available as light colouring as well as reduced contrast with images. **Ziyi et al. (2020) [6]** proposed that the existing purposeably competitive ways of restoring haze-free photos are pretty much based upon actual physical styles along with mastering methods. Maintaining aspect facts with the picture although carefully eliminating errors is definitely a challenging endeavor in single-image dehazing. In this cardstock, through embedding the iterative dehazing design in the generative course of action with the Cycle-Consistent Adversarial System (CycleGAN), we all offer one called ICycle GAN that will maintains the

actual defogging thoroughness with the learning-based dehazing strategy although holding the nice constancy with the actual physical model-based dehazing method. **Yao Wang et al.(2019)[7]** produced a method based haze ailments formed by simply contaminants as well as h2o drops in the atmosphere impression the way segmentation accuracy connected with State-of-the-art Drivers Guidance Methods (ADAS) by simply degrading this form a contrast as well as coloring faithfulness connected with images. **Engin et al. (2018)[8]** presented that the end-to-end multi-level, identified as Cycle-Dehaze, for solitary picture dehazing difficulty, which will doesn't need twos associated with imprecise as well as matching floor truth of the matter photos for training. That is certainly, all of us train the multi-level by nourishing clean and imprecise photos inside an unpaired manner. Also, the suggested tactic isn't going to make use of approximation on the atmospheric scattering type parameters. **Galdran et al. (2018) [9]** proposed that the sort of novel image-dehazing procedure based on the minimization associated with two electricity functional and also a union structure to combine the output of the two optimizations. Your suggested fusion-based variational image-dehazing (FVID) procedure is a spatially differing picture development process that initial lowers some sort of formerly suggested variational system that increases compare as well as saturation to the imprecise input. **Zhang et al. (2018) [10]** developed that the image haze elimination can be a process around laptop vision. On the other hand, haze elimination is demanding difficulty automobile enormously ill-posed, that is that at every pixel we've got to estimation the sign as well as the worldwide atmospheric mild from just one colouring measurement. With this newspaper, all of us propose a brand new serious learning-based opportunity for taking away haze through solitary suggestions image. **Yao Wang et al.(2019)[11]** produced a method-based haze ailment formed by simply contaminants as well as h2o drops in the atmosphere impression the way segmentation accuracy connected with State-of-the-art Drivers Guidance Methods (ADAS) by simply degrading this form a contrast as well as coloring faithfulness connected with images. Present road segmentation techniques are usually not suitable pertaining to packed haze ailments; darkness, under-estimation, as well as over-enhancement challenges come about right after dehazing. **Engin et al. (2018)[12]** presented an end-to-end multi-level, identified as Cycle-Dehaze, for solitary picture dehazing difficulty, which will doesn't need twos associated with imprecise as well as matching floor truth of the matter photos for training. That is certainly, all of us train the multi-level by nourishing clean and imprecise photos inside an unpaired manner. **Galdran et al. (2018) [13]** proposed some sort of novel image-dehazing procedure based on the minimization associated with two electricity functional and also a union structure to combine the output of the two optimizations. Your suggested fusion-based variational image-dehazing (FVID) procedure is a spatially differing picture development process that initial lowers some sort of formerly suggested variational system that increases compare as well as saturation to the imprecise input. **Zhang et al. (2018) [14]** developed an image haze elimination can be a process around laptop vision. On the other hand, haze elimination is demanding difficulty automobile enormously ill-posed, that is that at every pixel we've got to estimation the sign as well as the worldwide atmospheric mild from just one colouring measurement. **Khoury et al. (2018) [15]** presented an dehazing is the operation of improving a color image of an organic world containing a strong unfavourable veil associated with errors for visualization as well as as being a pre-processing move for laptop imaginative and prescient vision systems. In the work, all of us investigate routines associated with 12 state-of-the-art image quality analytics around assessing dehazed photos, as well as examine problems around creating an efficient dehazing analysis metric. **Zhang et al. (2017) [16]** has defined brand new end-to-end solitary image dehazing

procedure, identified as Largely Connected Chart Dehazing Network (DCPDN), which could together understand the sign place, atmospheric mild as well as dehazing all of together. Your end-to-end finding out is obtained by directly embedding the atmospheric scattering type in to the multi-level, in that way making sure that the suggested procedure just comes after the physics-driven scattering type for dehazing. **Wang et al. (2017) [17]** applied the images grabbed around imprecise as well as foggy climate tend to be severely changed through the scattering associated with atmospheric contaminants, which will directly influences the efficiency of out of doors laptop imaginative and prescient vision systems. With this newspaper, a fast algorithm criteria for solitary image dehazing is suggested based on straight line transformation by if some sort of straight line connection exists inside lowest sales channel between imprecise image and also the haze-free image. **Ren et al. (2016) [18]**discussed that in the efficiency associated with current image dehazing strategies is restricted by hand-designed features, such as black sales channel, colouring disparity as well as utmost compare, having complicated union schemes. With this newspaper, all of us propose some sort of multi-scale serious sensory multi-level for single-image dehazing by finding out the applying among imprecise photos along with matching sign maps. Your suggested algorithm criteria have a coarse-scale World Wide Web which will states an all natural sign place based on the overall image, and also a fine-scale world wide web which will refines benefits locally.

3. Proposed Algorithm

Definitions: p_A (main population atiteration A), $\bar{p}_A$ (archive population at iteration A), M(archivesize), and G (maximum number of generations).

(1) Initialization: set $G = 0$ and generate the initial population p_0 and empty archive $\bar{p}_A = \varphi$. (2) Calculate the fitnessvalues for individuals ofp_A and $\bar{p}_A$ (both population and archive sets) using gradient channel prior.

For each individual a in the archive $\bar{p}_A$ and population $\bar{p}_A$, the strength value $R_{(a)}$ is calculated using the following equation:

$$R_{(a)} = |\{k | k \in p_A + \bar{p}_A \ \wedge \mathrm{a} > k\}|$$

where the symbol þ stands for multiset union, the symbol $+$ corresponds to the Pareto dominance relation, and the symbol $>$ means AND.

For SPEA-II, fitness $f(a)$ is defined as follows:

$$f(a) = S(a) + d(a)$$

The raw fitness $S(a)$ of an individual i is calculated by the following equation:

$$S(a) = \sum_{k \in p_A + \bar{p}_A, k > a} S(ak)$$

However, if the optimization goal is a minimized search of $f(a)$, the raw fitness should be minimized here, i.e., $S(a) = 0$, which corresponds to a nondominated individual [15]. The individual's density for distinguishing those with the same raw fitness values is calculated by the K-nearest neighbor method, using the following equation:

$$S(a) = \frac{1}{\sigma_{a+2}^{l}}$$

where σ_a^l represents the objective space distance between the ith and kth nearest neighbors, and we also have$l = \sqrt{M + M}$Eq. (6).

(1) Selection: duplicate all the nondominated solutions in +both p_A and $\bar{p}_A$ to $\bar{p}_{A+1}$. If the size of$\bar{p}_{A+1}$exceeds $\bar{N}$, reduce $\bar{p}_{A+1}$using the truncation operator, i.e.,

$$a \leq Dk, \quad k \in \bar{p}_{A+1} \rightarrow \begin{array}{c} k \in \bar{p}_{A+1}: \leftrightarrow \forall 0 < l < \bar{p}_{A+1}: \sigma_a^l = \sigma_a^l \wedge \\ \exists 0 < l < \bar{p}_{A+1}: [(\forall 0 < L < l: \sigma_a^l = \sigma_k^l) \wedge \sigma_a^l < \sigma_k^l] \end{array}$$

Otherwise, fill $\bar{p}_{A+1}$with the dominated individuals in $p_A$and $\bar{p}_A$. In Eq., a and k are individuals, and also$a \leq Dk$ means that individual a dominated individual.

(2) If the stopping criterion $A \geq G$ is not satisfied, go to Step 2; or else, the archive members are presented as a Pareto optimal set [10]. (3) Create the new population: individuals are selected from $\bar{p}_{A+1}$ by means of binary tournament selection (creating mating pool) [10]. (3) Mutation and crossover operators are applied to the mating pool, and at last the population p_{A+1} are created. Set $A = A + 1$ and go back to Step 2.

4. Results and Analysis

This proposed algorithm is screened about many images. This formula is used making use of many overall performance parameters like Contrast gain, saturated pixels, new visible edges, Peak signal to noise ratio, new edge gradients. To implement proposed algorithm, style as well as implementation have been completed in MATLAB utilizing image digesting toolbox. To get your house mix approval, most people have designed strategy in which even comes close next to many well-known image enhancement techniques available in literature. Result exhibits the recommended method supplies much better results as compared to existing techniques.

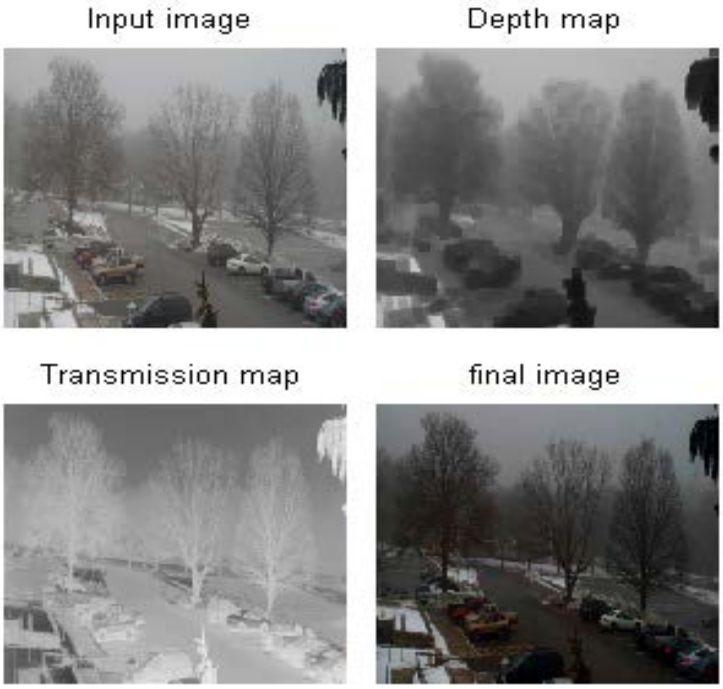

Figure 1 Visual analysis (a) Input image (b) Depth image, (c) Transmission from map (d) Results obtained from the final image.

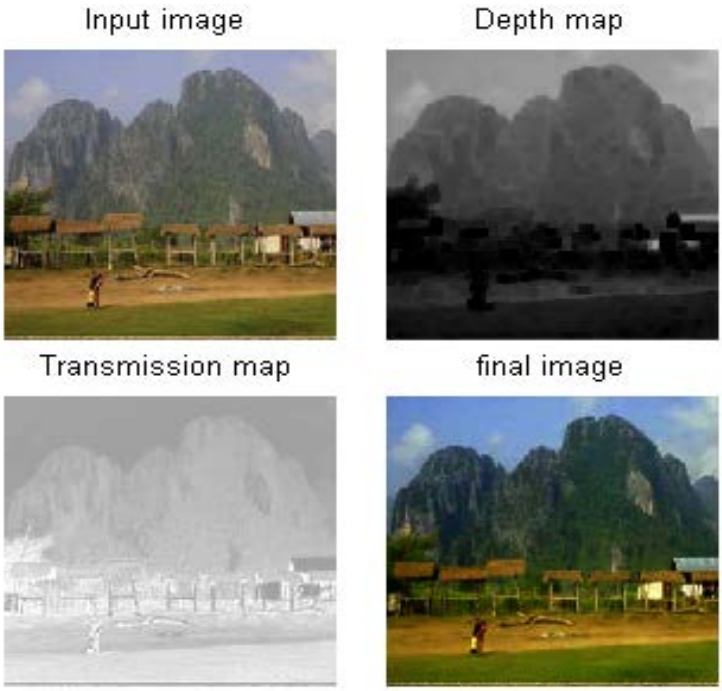

Figure 2 Visual analysis (a) Input image (b) Depth image, (c) Transmission from map (d) Results obtained from the final image.

Figures 1 and 2 show the visual analysis of the proposed model. It shows that the dept information and transmission map obtained from the proposed model is significantly rich and thus the obtained restored images have better spatial and spectral information.

A proposed of algorithm criteria is usually examined in numerous images. A algorithm criteria is applied applying various efficiency indices peak signal to noise ratio (PSNR), Saturated pixels (SP), and Contrast gain (CG).

Table 1 is displaying the particular quantized research into the different Peak signal to noise ratio. It's obviously proved that may this Peak signal to noise ratio will be highest possible with regards to the particular recommended algorithm for this purpose algorithm offers much improved success than the disposable methods.

Table1: Peak signal to noise ratio

Image	DCP	GCP	Proposed
1	24.85	25.03	28.20
2	24.45	26.80	29.68
3	24.40	25.74	27.75
4	23.82	23.72	28.56
5	24.15	25.19	28.50
6	23.06	25.92	29.56
7	25.39	26.84	29.69
8	24.42	25.53	27.96
9	24.54	23.29	28.64
10	25.33	24.25	27.87
11	25.11	26.48	29.82
12	24.39	23.61	28.75
13	25.77	24.69	28.67
14	25.55	26.39	28.69
15	25.25	25.15	28.79

Table 2 is displaying the particular quantized research into the different saturated pixels. It's obviously proved that may this saturated pixel will be highest possible with regards to the

particular recommended algorithm for this purpose algorithm offers much better success than the disposable methods.

Table2: Saturated pixels

Image	DCP	GCP	Proposed
1	0.0450	0.0498	0.0232
2	0.0548	0.0528	0.0290
3	0.0530	0.0521	0.0310
4	0.0480	0.0502	0.0250
5	0.0580	0.0450	0.0280
6	0.0510	0.0453	0.0315
7	0.0513	0.0456	0.0302
8	0.0528	0.0421	0.0250
9	0.0589	0.0489	0.0257
10	0.0479	0.0517	0.0218
11	0.0549	0.0478	0.0290
12	0.0411	0.0463	0.0259
13	0.0515	0.0548	0.0287
14	0.0512	0.0486	0.0317
15	0.0532	0.0480	0.0297

Table 3 is displaying the particular quantized research into the different Contrast gain. It's obviously proved that may this Contrast gain will be highest possible with regards to the particular recommended algorithm for this purpose algorithm offers much better success than the disposable methods.

Table 3: Contrast gain

Image	DCP	GCP	Proposed
1	2.046845	1.811919	2.277865
2	2.001669	2.328287	2.627987
3	1.386567	1.860709	2.081908
4	1.385442	1.978183	2.243818
5	1.784569	2.024897	2.275369
6	1.778126	2.218281	2.550189
7	1.283189	1.783185	2.236981
8	1.965893	2.658972	2.278598
9	2.154263	1.985326	2.289756
10	1.317845	2.364526	2.589875
11	1.985478	2.302547	2.518182
12	1.829231	2.102727	2.345862
13	1.185423	2.274589	2.502145
14	1.969875	1.865875	2.198632
15	1.885479	1.845235	2.227273

5. Conclusion

Image dehazing has been found as a challenging issue as it degrades the quality of obtained images. Therefore, it becomes more interesting to restore hazy images since only single hazy image available. The comprehensive review of the existing techniques has shown following gaps in the literature. The hyper-parameter tuning of Gradient channel prior has been ignored in the literature. An efficient tuning has an ability to improve the results further. Most of existing techniques still suffer from texture distortion issue. Therefore, a suitable gradient aware channel prior is required to handle this issue. The existing techniques suffer from saturated pixels problem.

Therefore, a novel Gradient channel prior (GCP) has been designed and implemented. The designed technique modifies the gradient channel prior using by SPEA-II to optimize hyper-parameters of dehazing. Adaptive histogram equalization has also been used to remove the uneven illuminate problem of the digital haze removal. Thus, the proposed technique has an ability to remove the limitations of existing techniques. Different kind of quality metrics are used to evaluate the effectiveness of the proposed technique over the existing one.
In near future, we will concentrate one of the following issues:-

1. Other optimization techniques instead of particle swarm optimization will be used to improve the dehazing results further.
2. One may apply the proposed technique to restore remote sensing images.
3. New filters will also be designed and implemented to improve the results further.

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