A Comparative Analysis of Various Visibility Enhancement Techniques through Single Image Defogging

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Abstract - *This paper reports various fog removal algorithms how fog is removed and improved in visibility are reviewed. While capturing an image in foggy weather condition degrades the image due to the presence of airlight. The airlight in each region of the degraded image is detected and restored. Which states that the fog formation is the function of the depth and the depth information is estimated with various assumptions or prior information. The defogging technique entangled problems related to visual surveillance, intelligent vehicle, tracking and remote sensing. The overall objective of this paper is to analyse the various techniques for efficiently eliminating the fog from the digital image.*

Key Words: Comparative study, airlight, Fog removal, Image enhancement, Performance evaluation.

1. INTRODUCTION

The main objective of image processing is to understand, recognize and interpret the data from the image pattern. And in some cases, due to the presence of moistureless particles such as dust, smoke, snow, haze and fog corrupt the image. The tiny water droplets suspended in the air cause fog and it is generally classified according to the physical process producing saturation or near-saturation of the air. The water droplet causes absorption and scattering lead to attenuation (reduces the contrast) and airlight (whiteness effect). When a light from the scene comes towards the camera or the observer gets attenuated due to scattering through water droplets and degrades the image quality. These aerosols lack the sensitivity of cameras and the human eye to resolve so an effective fog removal technique is enhanced to restore the degraded image.

Looking from the atmospheric point of view, weather conditions get varied regarding size and type of the particle present in the air. Bad weather condition is broadly categorised as steady and dynamic by the type of the visual effect. In steady lousy weather, the water droplet is tiny and it is steady floating in the air which includes fog, mist, and haze. Where in the case of dynamic weather, the water droplet is found to have 1000 times larger volume than steady weather which includes snow and rain. Radiation fog, Advection fog Upslope fog, Ice fog, Freezing fog, Fog mixing fog, Frontal fog are main types of fog.

The fog removal technique is broadly classified into image enhancement and image restoration. The primary objective of image enhancement is processing the given image and producing a more suitable image whereas in case of image restoration the corrupted or defogged image is processed to evaluate the original image.

The contrast and colour characters of the image degrade drastically under foggy weather condition. Generally, clear day images have more contrast than the foggy image so fog removal algorithm is designed to enhance the scene contrast. Which tends to be challenging as the recovery of luminance and chrominance and maintaining the colour fidelity is complex. Pixel value should be taken into consideration as it gets saturated in case of over enhancement. So there are some constraints taken into consideration for image enhancement which are the preservation of appropriate colour fidelity and to avoid saturation of an image.

Image restoration method is much better than the image enhanced as it maintains the detailed information and also produces a natural result. The restoration technique is classified into multiple images and a single image defogging method. In multiple images defogging, two or more images of the same scene are used which operated under weather condition, polarization and depth map based techniques. Whereas in the case of single image defogging, the single input image is taken and this method depends upon statistical assumption and essence of the scene. This paper reports various fog removal algorithms how fog is removed and improved in visibility are reviewed. The overall objective of this paper is to analyse the various techniques for efficiently eliminating the fog from a digital image.

2. LITERATURE REVIEW

[1] OPTIMAL TRANSMISSION ESTIMATION VIA FOG DENSITY PERCEPTION FOR EFFICIENT SINGLE IMAGE DEFOGGING

Here in this paper, a simple and practical prior constraint single image defogging technique is adopted. The fog density of a recovered image is directly estimated rather than approaching prior assumption. Primarily from the foggy image, three fog relevant statistical features are derived and then this fog relevant features develop a simple fog density evaluator (SFDE). This low computational evaluator could precisely predict the fog density of a single image without a reference of fog-free images. Secondarily a transmission and fog density based formulation is developed via SFDE for the given foggy image patch. Two optimal and effective transmission map are derived for evaluating the transmission value using the Optimal Transmission model via SFDE (OTSFDE) and a Simpler Optimal Transmission model via SFDE (SOTSFDE).

[2] CONTRAST IN HAZE REMOVAL: CONFIGURABLE CONTRAST ENHANCEMENT MODEL BASED ON DARK CHANNEL PRIOR

Conventionally, De-hazing is performed by adjusting the contrast and saturation to improve the quality of the reconstructed image. The difficulty in haze removal algorithm is reformulated subjecting to luminance reconstruction scheme based on statistical analysis of luminance value. The augmentation of contrast is based on the variance in the gradient space and the interpretation of contrast shows that dark channel magnifies the diversity details by maximizing the changes in input image gradient or the saturation of the scene radiance is enhanced by minimizing the difference to the estimated initial dark channel. The resultant contrast value supercilious for the given brightness value. Here the atmosphere light estimation module operates on colour constancy method which outperforms even when noise is considered. And the luminance-oriented optimized framework runs at a processing time of 0.55 seconds for the 1-megapixel image.

[3] SINGLE IMAGE VISIBILITY RESTORATION USING DARK CHANNEL PRIOR AND FUZZY LOGIC

In this paper, the fog removal algorithm is designed in such a way that it is time efficient and competent in both homogeneous and heterogeneous. Here we have DCP (dark channel prior) algorithm in which the prior assumes that a fog-free, clear image has intensity value close to zero in any one of the colour channel. The DCP algorithm is fused with fuzzy contrast enhancement technique which converts the image into the fuzzy domain and spatial operation for fast and improved contrast while the Global Histogram Equalization (GHE) or Adaptive Histogram Equalization (AHE) over-saturate the patch. It also reinforces the minute details of the degraded fog image.

[4] VISIBILITY ENHANCEMENT TECHNIQUE FOR HAZY SCENES

Here in this paper, an effective visibility enhancement technique for single image de-hazing is designed using Dark Channel Prior technique. Estimate the dark pixels having low intensity at any one of the RGB channels and this dark channel provides exact estimation for obtaining the transmission map. For the edge preservation of transmission map, the bilateral filter is used. To obtain the gamma correction technique and for estimating the exact colour of the hazy input image, a Laplacian distribution value is used.

And for evaluating the sufficient transmission map, gamma correction technique is used. To evaluate the quality of the enhanced image, performance metric such as PSNR, e metric and σ metric are used for measurement.

[5] EFFECT OF VARIOUS MODEL PARAMETERS ON FOG REMOVAL USING DARK CHANNEL PRIOR

Here in this paper, the dark channel prior technique is used which evaluate the transmission map from the constant transmission parameter, which ranges between 0.9 and 1. The obtained output for different filter produces a varying constant parameter and on changing image patch size the diverse results are studied which shows that the increase in constant transmission parameter leads to increase in the contrast of the scene. It concludes when the patch size is increased, the image quality increases and noise decreases.

[6] DEHAZING FOR IMAGE AND VIDEO USING GUIDED FILTER

A high-performance vision algorithm is required for effective haze removing. So here in this paper, a fast real-time image and video dehazing method are proposed. And also the airlight and the down-sampled transmission estimation and extraction are performed ease using this proposed algorithm. The improved guided filter is used to estimate the transmission map which can further refined and up-sampled. The obtained results show the algorithm outperforms regarding speed and ability to improve visibility.

[7] FOG DETECTION FOR DE-FOGGING OF ROAD DRIVING IMAGES

In this paper generally, the fog removal technique deteriorate the visual due to excessive contrast improvement. Here the fog detection algorithm is designed such that it selectively apply de-fogging method only at a foggy region. Besides, an excessive contrast enhancement adjustment and luminance compensation are done to avoid too dark output. This proposed algorithm produces 97% of fog detection accuracy and the subjective image quality is improved.

[8] IMAGE HAZE REMOVAL USING IMAGE VISIBILITY RESTORATION (IVR) & EDGE PRESERVING DECOMPOSITION (EPD)

In this paper, the removal of haze is done by using the dark channel prior algorithm and the estimation of atmospheric light technique. To obtain the transient image, the pixel value in dark region and atmospheric variation is estimated. If the size of the image increases, it estimates that PSNR quality is low and the computational time is high. If the size of the image decreases, it estimates that PSNR quality is high and the computational time is low. As a result, the high-quality haze-free image is obtained.

[9] ACCELERATED FOG REMOVAL FROM REAL IMAGES FOR CAR DETECTION

In this paper, an accelerated image enhancement technique is used to detect the number of cars for traffic management. Fog removal is based on simplified dark channel prior with a combined filter. The combined filter consists of the proposed adaptive filter with edge preserving technique to modify transmission map promptly. Finally, the car detection algorithm is used to decide the presence or absence of a car in each image. The computational time of the proposed algorithm is low.

[10] VISIBILITY ENHANCEMENT WITH SINGLE IMAGE FOG REMOVAL SCHEME USING A POST-PROCESSING TECHNIQUE

In this paper, visibility enhancement is done by effective post-processing technique using single grey or a colour image through fog removal. The dark channel prior algorithm is used for improving visibility. This algorithm preserves sharp details of the defogged image and also maintains the colour quality of the defogged image. WLS filter is used in post-processing technique. Comparatively, single image processing in the proposed system is better than an existing system.

[11]VISIBILITY ENHANCEMENT OF REAL-TIME FOGGY VIDEOS

In this paper, a new and simple visibility enhancement method is proposed which is implemented in the Graphics processing unit (GPU) in real time. Kalman filter is used to reduce the processing time for video frames and it is also observed that the average processing time for SD video stream is 5ms in which it is superior to the other observed implementations. They can extend our method for better restoration using anisotropic diffusion implemented in GPU.

[12] IMAGE-BASED AUTOMATED HAZE REMOVAL USING DARK CHANNEL PRIOR

Previously a dehazing mechanism was developed based on dark channel prior which cannot automatically set the patch size and the sky regions transmission value. The current paper tries to fill this gap to automate these values. In this paper, they proposed a practical algorithm for haze removal focusing on the removal of significant demerits remained in previous works. It mainly uses the concept of the dark channel prior and proposed some set of assumptions to get a better result. Also, adaptive result calculation is the central theme of our work. Simulation is done by taking around 50 natural hazy images. From both subjective and objective measures, our method gives better results compared to some existing methods.

[13] INCREASE DEHAZING PROCESS USING FAST GUIDED FILTER ON THE DARK CHANNEL PRIOR

In this paper, haze removal is done by using a guided filter and fast guided filter on the dark channel prior. Execution of fast guided filter in the dark channel prior is faster than guided filter implementation in the dark channel prior. The resultant image is separated by the effect of fog in a better quantity.

[14] A NOVEL IMAGE DEFOGGING ALGORITHM BASED ON MULTI-RESOLUTION FUSION TRANSFORM

In this paper, they propose a novel algorithm based on a fusion model integrated with a multi-resolution approximation technique. They present a multi-resolution defogging algorithm for extracting foreground objects of interest from weather degraded images and enhancing the extracted regions visibility at the same time. This method yields accurate results and faster than existing de-hazing strategies. PSNR is maximized and computational complexity is reduced.

[15]SINGLE FOG IMAGE RESTORATION VIA MULTI-SCALE IMAGE FUSION

In traditional prior methods, have an issue on halo artifacts and brightness distortion so to overcome this they proposed an algorithm based on the multi-scale fusion of single image restoration. The entire region is divided into two regions, the global atmospheric light can be effectively obtained in the sky regions. The new Kirsch operator with adaptive boundary constraint designed to optimize the transmission. From the experimental results, it is observed that the method outperforms regarding both efficiency and the dehazing visual effect.

[16]HAZE REMOVAL USING THE DIFFERENCE-STRUCTURE PRESERVATION PRIOR

Here in this paper, the dehazing algorithm designed on the basis of difference structure-preservation prior, which could estimate the optimal transmission map and restores the actual scene. In order to obtain a more accurate transmission map, an assumption is made that an image patch is approximated by a spare linear combination of an element from a neighbour basis set. Here the similar structure is used throughout as possible and the difference between similar patches are maintained. So as the result the highest SSIMs (structural similarity image) is achieved as the structural consistency is retained throughout the dynamic difference-structure-preservation process.

[17] IMAGE DEHAZING USING NON-SYMMETRY AND ANTI-PACKING MODEL BASED ON DARK CHANNEL PRIOR

Here in this paper, a novel method is added along with the dark channel prior algorithm based on the Non-symmetry and Anti-packing Model (NAM). Also, an auto level is used to enhance the haze-free image's visual effect. The NAM is used to calculate the atmospheric light and the guided filter is used to estimate the accurate transmission. Also, this method shows several advantages of the NAM when compared to a quadtree. Primarily, the blocks of NAM are rectangular in structure and the size gets varied to avoid segmenting the image into smaller blocks. So as the result the NAM operates faster than the quadtree. Secondarily, the each NAM block is standardized providing accurate atmospheric light.

[18] A SYSTEM ARCHITECTURE FOR REAL TIME TRAFFIC MONITORING IN FOGGY VIDEO

Here, this paper presents an architecture for real-time traffic monitoring systems and it is required to satisfy two significant constraints. Primarily, the defogged image should be quality enough for further processing such as tracking and object detection. Secondarily, the proposed algorithm should be computationally cheap for real-time processing. The proposed paper consist of an N thread for real-time monitoring and the parallel architecture provides reduces the processing time. The experimental result shows the output obtained is suitable for live fog removal.

[19] IMAGE DEHAZING BASED ON REGION GROWING

The conventional single image haze removal algorithm has an issue in error in atmospheric light value, the lower

transmission in the sky area and the problem of halo and splashes artifact. Here an improved weight-based quad-tree hierarchical search algorithm to better select atmospheric light A and the seed point of region growing. There are three conditions taken into consideration to calculate the transmission, where the higher is contrast, the lower information loss, the more balance histogram of the haze-free image. For refine transmission, the edge preserving filter is applied and down-sampling is done to achieve the proper result.

[20] A FAST METHOD OF FOG AND HAZE REMOVAL
The primary objective of this paper is to enhance the visibility, saturation, contrast and reduce noise in the foggy image. Here they have introduced a method that uses the single frame for enhancing foggy images using multilevel transmission map. In comparison, this technique is fast and free from noise or artifacts generated while processing enhancement techniques. It is observed that the technique is suitable for VGA resolution and it shows better performance regarding both processing time and quality.

[21] SINGLE IMAGE FOG REMOVAL ALGORITHM BASED ON AN IMPROVED DARK CHANNEL PRIOR METHOD
Here they have proposed a fast single image fog removal algorithm based on an improved dark channel prior. And it is observed that the proposed algorithm can increase 28.5% of computing speed and 41.8% of image contrast ratio to the conventional one. This algorithm can even remove fog efficiently without the influence in the night too. And this algorithm is suitable for the surveillance system and real-time computing in an embedded system.

[22] MODIFIED DARK CHANNEL PRIOR MODEL AND GAUSSIAN LAPLACIAN FILTERING WITH TRANSMISSION MAP FOR FOG REMOVAL
The proposed system is a modified dark channel prior and Gaussian Laplacian filtering (GLP) with transmission map in

which the GLP is used to remove the noise from the fog image after that matte for recovering the fog-free image. From the results, it is observed that this algorithm can outperform as edge preservation smoothing approach has provided quite promising results regarding peak signal to noise ratio (PSNR) and entropy and execution time.

[23] A NEW FAST METHOD FOR FOGGY IMAGE ENHANCEMENT
Here a novel method is proposed to enhance the contrast in foggy images and this develops an image atmospheric model which is based on the Koschmieder's theory of atmospheric vision. To achieve an outline of a strength of the fog in different areas morphological operators operation is performed. This proposed algorithm outperforms regarding quantitative and qualitative analysis and also the computation time is low.

[24] VECTORIZATION AND OPTIMIZATION OF FOG REMOVAL ALGORITHM
This paper proposed to approach vectorization, optimization and low memory capacity. An optimized anisotropic diffusion, histogram stretching and smoothing based fog removal algorithm is proposed. 70% of the time complexity is eliminated using anisotropic diffusion and the accuracy is achieved using optimization technique but it is neglected for significant improvement. Here the performance defogging of the algorithm is increased up to 90 fps (approx.) for VGA image on DSP platform.

[25] VISIBILITY ENHANCEMENT THROUGH SINGLE IMAGE FOG REMOVAL
Here a novel and effective algorithm are proposed for single image fog removal that is capable of handling images of gray and colour channel. Weighted Least Square (WLS) and High Dynamic Range (HDR) algorithm is fused with dark channel prior. From the simulation results, it is observed that the output frog-free image contains more clear edges with details and better contrast. The primitive advantage of this algorithm produces a high-quality image and also maintains the colour quality.

[26] A HAZE DENSITY AWARE ADAPTIVE PERCEPTUAL SINGLE IMAGE HAZE REMOVAL ALGORITHM
In conventional methods usually, require complicated manual parameters setting to the variance of input. Dark channel prior is considered to be the most efficient de-haze method but there is some limitation including low luminance, sky region distortion and low saturation are inevitable. Here, this paper introduces a haze density detector which adaptively adjusts the parameter settings and besides, it improves the original dim recovered image by adaptively adjusting exposure and colour saturation YCbCr colour space. Furthermore, a fast guided filter is employed to refine the transmission map and the experimental results show that the proposed method outperforms both objectively and subjectively.

[27]DEVELOPMENT OF IMAGE DEHAZING SYSTEM
Here in this paper, a mean channel guided algorithm for defogging is presented whose function is more accurate and robust as compared with the convention methodologies. And it is hardware-implemented version will work on low cost, low power and a portable processing core raspberry pi along with a display screen. The obtained results of mean channel guided prior are compared with DCP, MCP, SIFRGMF. The obtained visibility enhancement algorithm performs qualitatively and quantitatively better and efficient in removing haze from synthetic as well as real-life images.

[28] IMAGE DEHAZING USING DARK CHANNEL PRIOR AND THE CORRECTED TRANSMISSION MAP
Single image de-hazing based on dark channel prior may encounter colour distortion in a bright region so to overcome this situation 3 methods are proposed in this paper. Primarily the transmission threshold was determined, then by using the threshold to correct the transmission map in different ways and make adaptive to fog, three algorithms

can effectively deal with the sky, white object and so on. The complexity of calculation to refine the transmission map is minimized using the fast guided filter. The experimental result shows these methods are feasible to eliminate colour distortion of out-door image and visibility is also enhanced.

[29] SINGLE IMAGE DEHAZING BASED ON ONE DIMENSIONAL LINEAR FILTERING AND ADAPTIVE HISTOGRAM EQUALIZATION METHOD

This paper presents a single image de-hazing method which is based on a one-dimensional linear filter. The primary objective of this paper is to resolve any type of foggy problem by using this algorithm, based on mean enhancement methodology and adaptive histogram equalization method. YCbCr model excels in colour compression in which Y luminance can be used separately for storage in high resolution and the chromaticity components treated separately to enhance the results. Eventually, it achieves the linear complexity and results demonstrates the effectiveness of the proposed algorithm.

[30] PARALLEL IMAGE DEHAZING ALGORITHM BASED ON GPU USING FUZZY SYSTEM AND HYBRID EVOLUTION ALGORITHM

Here in this paper, a parallel hybrid evolution algorithm based on GPU is proposed to enhance the computational performance. In conventional evolution algorithm, the calculation of fitness function occupies most of the computation time. So to overcome these circumstances we implement this part on GPU by using CUDA framework to reduce the computational load. The experiment results show that the algorithm proposed can remove the haze efficiently and successfully.

3. GAPS IN LITERATURE SURVEY

Digital defogging algorithm plays an essential role in numerous vision applications and it is found that the current analysis mistreated numerous subjects. Limitations in the literature survey are list below,

1. It is found that most of the discussed algorithm have ignored the actual use of soft computing techniques to improve the adaptively of the digital defogging removal algorithm.
2. Majority of the paper has ignored the issue of irregular light.
3. 85% of the existing methods have taken static restoration value.

4. FUTURE WORK

So in near future, the problem of uneven illumination of the digital fog removal has to be sorted out. To enhance the visibility of image caused by atmosphere suspended particles like dust, haze and fog which causes failure in image processing such as video surveillance systems, obstacle detection systems, outdoor object recognition systems and intelligent transportation systems. And visibility restoration techniques should be developed to run under various weather conditions.

5. CONCLUSION

This paper investigates various fog removal techniques described here, the majority of the scientific study has ignored several issues i.e., no technique is better for different kind of circumstances. The effectiveness of the methods, different qualitative assessment are evaluated and the experimental results demonstrate the used methods show good results for fog degraded visuals. This analysis contributes to developing a new and better fog removal algorithm.

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REFERENCES

[1] Zhigang Ling, Jianwei Gong, Guoliang Fan, "Optimal transmission estimation via fog density perception for efficient single image defogging" in IEEE Transactions on Multimedia, Aug 2015, pp. 1-13.

[2] Ping-Juei Liu, Shi-Jinn Horng*, Jzau-Sheng Lin, and Tianrui Li, "Contrast in haze removal: configurable contrast enhancement model based on dark channel prior" in IEEE Transactions on Image Processing, 2018, pp. 1-16.

[3] Subhadeep Koley, Ahana Sadhu, Hiranmoy Roy, soumyadip Dhar, "Single image visibility restoration using dark channel prior and fuzzy logic" in IEEE International Conference on Electronics, Materials Engineering & Nano-Technology (IEMEN Tech), 2018, pp. 1-7.

[4] R.Ahila Priyadharshni, S.Aruna, "Visibility enhancement technique for hazy scenes" in IEEE International Conference on Electrical Energy Systems (ICEES), 2018, pp. 1-6.

[5] Neha, Rajesh Kumar Aggarwal, "Effect of various model parameters on fog removal using dark channel prior" in IEEE International Conference On Recent Trends in Electronics Information & Communication Technology (RTEICT), May 2017, pp. 1-4.

[6] Zheqi Lin, Xuansheng Wang, "Dehazing for image and video using guided filter" in Open Journal of Applied Sciences, World Congress on Engineering and Technology, 2012, pp. 1-5.

[7] Kwang Yeon Choi, Kyeong Min Jeong, Byung Cheol Song, "Fog detection for de-fogging of road driving images" in IEEE International Conference on Intelligent Transportation Systems (ITSC), 2017, pp. 1-6.

[8] Zinab Khan, Dr.Anjali Asish Potnis, "Image haze removal using image visibility restoration (IVR) & edge preserving decomposition (EPD)" in IEEE International Conference on Computer Communication and Informatics (ICCCI -2017), Jan 2017, pp. 1-5.

[9] Rawan Younis, Nabil Bastaki, "Accelerated fog removal from real images for car detection" in IEEE-GCC Conference and Exhibition (GCCCE), 2017, pp. 1-6.

[10] Md. Imtiyaz Anwar, Arun Khosla, and Gajendra Singh "Visibility enhancement with single image fog removal scheme using a post-processing technique" in IEEE International Conference on Signal Processing and Integrated Networks (SPIN), 2017, pp. 1-6.

[11] Manvendra Singh Chauhan, Jayashree Pradhan, Pradipta Roy, Dipak Das, "Visibility enhancement of real-time foggy videos" in IEEE International Conference on Image Information Processing (ICIIP), 2017, pp. 1-5.

[12] Mohammad Shorif Uddin∗, Bishal Gautam∗, Aditi Sarker∗, Morium Akter∗ and Mohammad Reduanul Haque†, "Image-based automated haze removal using dark channel prior" in IEEE Region 10 Humanitarian Technology Conference (R10-HTC), Dec 2017, pp. 1-4.

[13] Rizal Mutaqin, Fresy Nugroho, Nugraha Gumilar, "Increase dehazing process using fast guided filter on the dark channel prior" in IEEE International Conference on Electrical, Electronics and Information Engineering (ICEEIE), 2017, pp. 1-6.

[14] Zhuohan Cheng, Xin Xiang, Yaochen Shen, "A novel image defogging algorithm based on multi-resolution fusion transform" in IEEE International Conference on Opto-Electronic Information Processing, 2017, pp. 1-4.

[15] Yin Gao, Yijing Su, Qiming Li, Jun Li*, "Single fog image restoration via multi-scale image fusion" in IEEE International Conference on Computer and Communications, 2017, pp. 1-6.

[16] Linyuan He, Jizhong Zhao, "Haze removal using the difference-structure preservation prior" in IEEE Transactions on Image Processing, 2016, pp. 1-13.

[17] Yunping Zheng, Yukang shu, changting cai, "Image dehazing using non-symmetry and anti-packing model based on dark channel prior" in International Conference on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD 2017), 2017, pp. 1-6.

[18] Sangkyoon Kim, Soonyoung Park, Kyoungho Choi, "A system architecture for real time traffic monitoring in foggy video" in IEEE Korea-Japan Joint Workshop on Frontiers of Computer Vision (FCV), 2015, pp. 1-4.

[19] Wei Liu, Ping Ye, Hanxu Sun, "Image dehazing based on region growing" in IEEE International Conference on Systems and Informatics (ICSAI), 2017, pp. 1-6.

[20] Veeranjaneyulu Toka, Nandan Hosagrahara Sankaramurthy, Ravi Prasad Mohan Kini, Prasanna Kumar Avanigadda, sibsambhu kar, "A fast method of fog and haze removal" in IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 2016, pp. 1-5.

[21] Chi-Chia Sun, Heng-Chi Lai, Ming-Hwa Sheu, Yi-Hsing Huang, "Single image fog removal algorithm based on an improved dark channel prior method" in IEEE International Symposium on Intelligent Signal Processing and Communication Systems (ISPACS), Oct 2016, pp. 1-4.

[22] Jaiveer Singh Sikarwar, Abhinav Vidwans, "Modified dark channel prior model and gaussian laplacian filtering with transmission map for fog removal" in IEEE International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT), 2016, pp. 1-6.

[23] Mohammad Javad Abbaspour, Mehran Yazdi, Mohammadali Masnadi-shirazi, "A new fast method for foggy image enhancement" in Iranian Conference on Electrical Engineering (ICEE), 2016, pp. 1-5.

[24] Krishna Swaroop Gautam, Abhishek Kumar Tripathi, M.V. Srinivasa Rao, "vectorization and optimization of fog removal algorithm" in IEEE International Conference on Advanced Computing, 2016, pp. 1-6.

[25] Md. Imtiyaz Anwar*, Arun Khosla, "Visibility enhancement through single image fog removal" in International Journal, Engineering Science and Technology, 2017, pp. 1-9.

[26] Chuanzi He, Chendi Zhang, Qingrong Cheng, Xixiaoyi Jin, Jianjun Yin "A haze density aware adaptive perceptual single image haze removal algorithm" in Proceedings of the IEEE International Conference on Information and Automation Ningbo, Aug 2016, pp. 1-6.

[27] Amruta Deshmukh, Satbir Singh, "Development of image dehazing system" in IEEE International Conference on Wireless Networks and Embedded Systems(WECON), 2016, pp. 1-5.

[28] Lei Shi, Li Yang, Xiao Cui, Zhigang Gai, Shibo Chu, jing Shi, "Image dehazing using dark channel prior and the corrected transmission map" in IEEE International Conference on Control, Automation and Robotics, 2016, pp. 1-4.

[29] Ashok Shrivastava, Dr Sanjay Jain, "Single image dehazing based on one dimensional Linear Filtering and Adoptive Histogram Equalization method" in IEEE International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT), 2016, pp. 1-5.

[30] Che-Lun Hung, Hsiao-Hsi Wang, Ren-You Yan, "Parallel image dehazing algorithm based on GPU using fuzzy system and hybrid evolution algorithm" in IEEE/ACIS International Conference on Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing (SNPD), 2016, pp. 1-3.

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