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Image Restoration Using Sparse Dictionary Matrix Learning K-Svd Algorithm

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***Abstract*-Images captured in smoky weather conditions causes the poor visibility, which will create a more impacts on the outdoor computer vision systems, such as video surveillance, intelligent transportation assistance system, remote sensing space cameras and so on. In certain situations, actual visibility restoration approaches cannot able to restore images due to poor evaluation of haze thickness and the determination of color cast problems. In our work, we propose a visibility restoration approach to effectively solve inadequate haze thickness estimation and alleviate color cast problems. By doing so, a high-quality image with clear visibility and color can be generated to improve the visibility of single input image (with fog or haze), as well as the image's details. Our approach process from two important statistical observations about haze-free images and the haze itself. First, Wavelet decomposition is applied and LUM Filter is applied on the decomposed image. Finally, we can get the dehazed output.**

***Keywords*-Discrete Wavelet Transform,Lower-Upper-Middle, Dehazing, Visibility Restoration, Image sharpness assessment, Cumulative Probability of Blur Detection.**

I.INTRODUCTION

The visibility of external images captured in smoky weather is often degraded due to the presence of haze, fog, sandstorms, and so on. Poor visibility is caused by atmospheric factors in turn causes failure in computer vision applications, such as outdoor object recognition systems, obstacle detection systems, video surveillance systems, and intelligent transportation systems. In order to form a solution for this problem, visibility restoration (VR) techniques are developed and play a crucial role in many computer vision applications that operate in various weather . However, removing haze from an image with a complex structure and color distortion may be a difficult task for VR techniques. This paper proposes a completely unique VR method that uses a combination of three major modules: 1) a depth estimation (DE) module; 2) a color analysis (CA) module; and 3) a VR module. The proposed

DE module takes benifits of the median filter method and adopts our adaptive gamma correction technique. By doing so, halo effects are often avoided in images with complex structures, and effective transmission map estimation are achieved. The proposed CA module is predicated on the grey world assumption and analyzes the color characteristics of the input hazy image. The Visibility Restoration module intakes the modified transmission map and thus the color-correlated information to repair the color distortion in variable scenes captured during inclement weather . The experimental results demonstrate that our proposed method provides superior haze removal as compared with the previous state-of-the-art method through qualitative and quantitative evaluations of different scenes captured during various weather conditions. Complication in processing exterior images is that the presence of haze, fog or smoke which fades the colours and reduces the contrast of the observed objects. We introduce a completely unique algorithm and variants for visibility restoration from one image.

The main advantage of the proposed algorithm compared with other is its speed: its complexity may be a linear function of the amount of image pixels only. Rate permits restoration to be applied in the initial time within real-time performing applications like sign, lane-marking and obstacle detection from an in-vehicle camera. Another advantage is that the possibility to handle both color images or gray level images since the anomaly between the presence of fog and therefore the objects with low color saturation is solved by assuming only small objects can have colors with low saturation. The algorithm is controlled only by a few parameters and consists in: atmospheric veilinference, image restoration and smoothing, tone mapping.

A modified study and quantitative evaluation is proposed with a couple of other state of the art algorithms which demonstrates that similar or better quality results are obtained. Finally, an application is presented to lane-marking removal in gray level images, illustrating the interest of the approach.

II. RELATED WORK

To extract the fog form the images , Curved Wavelet Transform for Image Coding[1] and know about the image restoration , Cryo-CARE Content-Aware Image Restoration for Cryo-Transmission Electron Microscopy Data Tim-Oliver[2].For compressing the images and denoising , Adaptive Wavelet Thresholding for Image Denoising and Compression [3].To process the blurred images we used , Blind Image Restoration based on Total Variation Regularization of Blurred Images[4]. Wavelet Transform Filtering and Nonlinear Anisotropic Diffusion Assessed for Signal Reconstruction Performance on Multidimensional Biomedical Data[5] and Non Blind Image Restoration Scheme Combining Parametric Wiener Filtering and BM3D Denoising Technique[6].For filtering ,Blind Image Restoration Based on Wiener Filtering and Defocus Point Spread Function Estimation[7]. Multiscale Image Blind Denoising[8]. A No-Reference Image Blur Metric Based on the Cumulative Probability of Blur Detection[9]. No-Reference Objective Image Sharpness Metric Based on the Notion of Just Noticeable Blur[10].
Method I

1. Digital Image Processing

The identification of objects in an image is the main thing in image processing. It contain various techniques like noise removal, feature extraction , regions and possibly areas with certain textures. Manipulating data within the sort of a image through several possible techniques. These images are often in two-dimensional array of brightness values, and is most familiarly represented in some patterns. An image are often processed optically or digitally with a computer. To digitally process the image, it is necessary to reduce the image to a series of numbers which will be manipulated by the personal computer. A typical digitized image may have 512 × 512 or roughly 250,000 pixels, although much larger images are getting common.

Once the image has been digitized, there are three basic operations will be performed within the computer. For some extent point operation, a pixel value within the output image depends on one single pixel value in the input image. For local operations, several neighbouring pixels within the input image determine the worth of an output image pixel. In a global operation, all the input image pixels produces an output image pixel value. These operations, taken singly or in together, are the means by which the image is enhanced, restored, or compressed. An image is enhanced when it's modified in order that the knowledge it contains is more clearly evident, but enhancement can be include making the image more visually appealing. An example is noise smoothing. To smooth a noisy image, median filtering is applied with a 3 × 3 pixel window. The value of each pixel in the noisy image is recorded, along with the values of its nearest eight neighbours. These nine numbers are then ordered consistent with size, and therefore the median is chosen because the value for the pixel within the new image. As the 3 × 3 window are moved one pixel at a time across the noisy image, the filtered image is produced.

1.1. Classification of Images:

1.1.1. Binary Image:A binary image be a digital image that has only two possible values for every single pixel. Typically two colors used for a binary image are black and white though any two colors are used. These colors are used for the objects within the image is the foreground color while the other image is the background color. Binary images is also called bi-level or two-level. This means that each pixel is stored as a single bit (0 or 1).This name black and white, monochrome or monochromatic are often used for this project , but may also designate any images that have only single sample per pixel, like grayscale images .

1.1.2. Gray Scale Image:A grayscale Image is digital image in which the value of every pixel is a single sample, It carries only intensity information. These images is also known as black-and-white, are composed exclusively of shades of gray (0-255), varying from black (0) at the weakest intensity to white (255) at the strongest. Grayscale images are distinct from one bit black and white images, these are the context of computer imaging and images with only the two colors, black, and white (also called bi-level or binary images). Grayscale images have many different shades of gray in between. Grayscale images are known as monochromatic and in such cases they are monochromatic proper when only a given frequency is captured. It is synthesized from a full color image, then the section about converting to grayscale.

1.1.3. Color Image:A digital color image may be a digital image that includes color information for every single pixel. Each pixel has a feature value which determines it's appearing color.

This value is qualified by three numbers giving the decomposition of the color within the three primary colors Red, Green and Blue. Any color visible to human eye are represented in this way. The decomposition of a color in the three primary colors is quantified by a range between 0 and 255. For example, white will be coded as (R,G,B) = (255, 255, 255); black will be known as (R,G,B) = (0,0,0); and say, bright pink will be : (255,0,255). Images are in two-dimensional array of color values, pixels, each of them coded on 3 bytes, representing the three primary colors. This allows the image to contain a value of 256x256x256 = 16.8 million

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different colors. This technique is also known as RGB encoding, and is specifically adapted to human vision. It is observable that our behaviour and social interaction are greatly influenced by emotions of people whom we intend to interact with. Hence a successful emotion recognition system could have great impact in improving human computer interaction systems in such a way as to make them be more user-friendly and acting more human-like. Moreover, there are a number of applications where emotion recognition can play an important role including biometric authentication, high-technology surveillance and security systems, image retrieval, and passive demographical data collections. It is unarguable that face is one the most important feature that characterises human beings. By only looking ones' faces, we are not only able to tell who they are but also perceive a lot of information such as their emotions, ages and genders. This is why emotion recognition by face has received much interest in computer vision research community over past 20 years .

III. METHOD

There are four main modules in image restoration Image Acquisition and restoration, Depth estimation, Color analysis, Visibility Restoration.

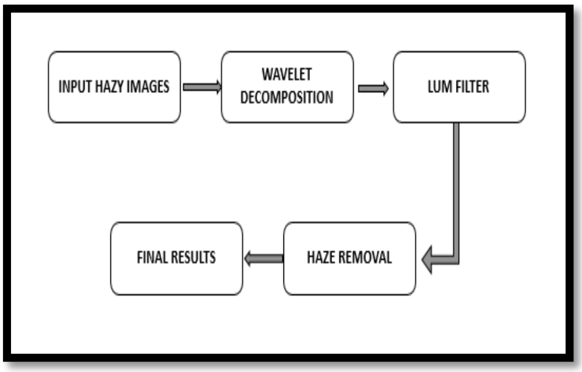

Fig 1 Method.

1.Image Acquisition and Restoration:
Image Acquisition is to acquire a digital image. To do so requires an image sensor and the capability to digitize the signal produced by the sensor. The sensor could be monochrome that produces an entire image of the problem domain every 1/30 sec. The image sensor could even be line scan camera that produces one image line at a time. Scanner produces a two-dimensional image. If the output of the camera or other imaging sensor is not in digital form, an analog to digital converter digitizes it. The nature of the sensor and the image it produces are determined by the application.Image enhancement is among the best and most appealing areas of digital image processing. Basically, the concept behind enhancement techniques is to bring out detail that's obscured, or just to spotlight certain features of interesting a picture . Image restoration is a locality that also deals with improving the looks of a picture . However, unlike enhancement, which is subjective, image restoration is objective, within the sense that restoration techniques tend to be supported mathematical or probabilistic models of image degradation. Enhancement, on the other hand, relies on human subjective preferences regarding what constitutes a "good" enhancement result. For example, contrast stretching is taken into account an enhancement technique because it's based totally on the pleasing aspects it'd present to the viewer, where as removal of image blur by applying a deblurring function is taken into account a restoration technique.

2.Depth estimation:
The task of 3-d depth estimation from a isolated still image. It behaves supervised learning method to this problem, in which we start by gathering a training set of monocular images (of unstructured indoor and outdoor environments which include forests, sidewalks, trees, buildings, etc.) and their related ground-truth depthmaps. Then, we apply supervised learning to predict the value of the depthmap as a function of the image. Depth estimation may be a challenging problem, since local features alone are insufficient to estimate depth at some extent , and one must consider the worldwide context of the image.

Our model utilize a hierarchical, that comes with multiscale local- and intercontinental-image features, and models the depths and therefore the relation between depths at different points in the image. We show that, even on unstructured scenes, our algorithm is usually ready to recover fairly accurate depthmaps. We further propose a system that has both monocular cues and stereo (triangulation) cues, to urge significantly more accurate depth estimates than is possible using either monocular or stereo cues alone.This implemented lower-upper-middle (LUM) filter is a nonlinear filter that is simple to define and yet effective for noise attenuation in non-stationary signal processing. A general class of LUM filters includes LUM smoothers and LUM sharpeners as special cases.The standard median filter with filter-window length is compared to the lower-upper-middle (LUM) filter.

When comparing with the mean filter, the median filter has a better fault-protection ability but weaker noise-attenuation result. However, it still makes edges of some faults ambiguous.The LUM filter uses smoothing and sharpening parameters to limit the smoothing characteristics of the quality median filter. Therefore, it strikes an inexpensive balance between structure enhancement and fault protection. While coherent events can be preserved by either of the two filters, the median filter has a better result of fault protection than the mean filter and the LUM filter can further reduce the fault damage of the standard median filter. It has two parameters, one for smoothing and the other for sharpening.Smoothing is desired, the LUM filter outputs the middle sample if it is between the two order statistics; otherwise, it outputs the closest of the two order statistics. Then Sharpening is desired, the roles are reversed. . The LUM sharpener outputs the center sample if it's outside the 2 order statistics; otherwise it outputs the closest of the 2 order statistics. Furthermore, both characteristics can be achieved at the same time.

2.1 Visual Cues for Depth Perception

Monocular cues is "contextual information," within the sense that they're global properties of an image and can't be inferred from small image patches. For example, occlusion cannot be determined if we look at just a small portion of an occluded object. Although local information like the feel and color of a patch can give some information about its depth, this is often usually insufficient to accurately determine its absolute depth. For another example, if we take a patch of a clear blue sky, it is difficult to tell if this patch is infinitely far away (sky), or if it is part of a blue object. Due to ambiguities like these, one must check out the general organization of the image to work out depths.

3.Color analysis

The use of color image processing is done by two principal factors. First, color may be a powerful descriptor that always simplifies object identification and extraction from a scene. Second, humans can discern thousands of color shades and intensities, compared to about only twenty-four reminder gray. This second factor is especially important in manual image analysis.

3.1. Segmentation:

Segmentation procedures partition a picture into its constituent parts or objects. In general, autonomous segmentation is one among the foremost difficult tasks in digital image processing. A rugged segmentation procedure brings the method an extended way toward successful solution of imaging problems that need objects to be identified individually.

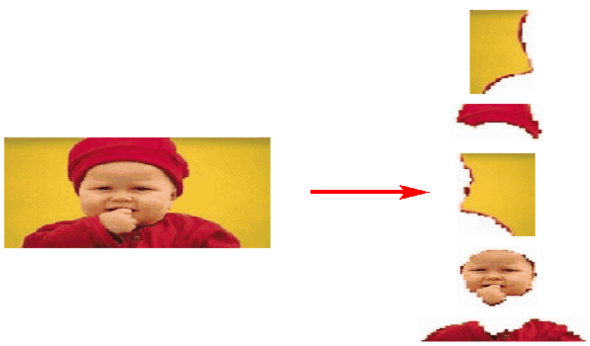

Fig 2 Image Segment Process.

On the other hand, weak or erratic segmentation algorithms almost always guarantee eventual failure. In general, the more accurate the segmentation, the more likely recognition is to succeed. Digital image is defined as a two dimensional function f(x, y), where x and y are spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x, y) is called intensity or grey level of the image at that point. The field of digital image processing refers to processing digital images by means of a digital computer. The digital image is composed of a finite number of elements, each of which has a particular location and value. The elements are referred to as picture elements, image elements, pels, and pixels. Pixel is the term most widely used.

3.2 Image Compression

Digital Image compression computes the problem of reducing the amount of data required to represent a digital image. The underlying basis of the reduction process is removal of redundant data. From the mathematical viewpoint, this amounts to transforming a 2D pixel array into a statically uncorrelated data set. The data redundancy is not an abstract concept but a mathematically quantifiable entity. If n1 and n2 denote the number of information-carrying units in two data sets that represent the same information, the relative data redundancy of the first data set (the one characterized by n1) can be defined as,

$$R_D = 1 - \frac{1}{C_R}$$

Where called as compression ratio [2]. It is defined as

$$C_R = \frac{n1}{n2}$$

In compression, three basic data redundancies are often identified and exploited: Coding redundancy, interpixel redundancy, and phychovisal redundancy. Image compression is achieved when one or more redundancies were reduced or eliminated. The compression is especially used for image transmission and storage. Image transmission applications are in broadcast television; remote sensing via satellite, air-craft, radar, or sonar; teleconferencing; computer communications; and facsimile transmission. Image storage is required most commonly for educational and business documents, medical images that arise in computer tomography (CT), magnetic resonance imaging (MRI) and digital radiology, motion pictures, satellite images, weather maps, geological surveys, and so on. There are two types image compression techniques. Lossy Image compression and Lossless Image compression.

3.2.1. Lossy Image compression:

Lossy compression provides higher levels of information reduction but end in a but perfect reproduction of the first image. It provides high compression ratio. Lossy compression is helpful in applications like broadcast television, videoconferencing, and facsimile transmission, during which a particular amount of error is a suitable trade-off for increased compression performance.Originally, PGF have designed to perform quick and progressive decode lossy compressed aerial images. A lossy compression mode has been preferred, because in an application sort of a terrain explorer texture data (e.g., aerial orthophotos) is usually mid-mapped filtered and therefore lossy mapped onto the terrain surface. In addition, decoding lossy compressed images is typically faster than decoding lossless compressed images. In the next test series we examine the lossy compression efficiency of PGF. One of the most effective competitors during this area is as expected JPEG 2000. Since JPEG 2000 has two different filters, we used the one with the higher trade-off between compression efficiency and runtime. On our machine the 5/3 filter set features a better trade-off than the alternate. However, JPEG 2000 has in both cases a stimulating good compression efficiency for very high compression ratios but also a really poor encoding and decoding speed. The other competitor is JPEG. JPEG is one among the foremost popular image file formats.

	JPEG 2000 5/3			PGF		
Ratio	enc	dec	PSNR	enc	dec	PSNR
2.7	1.86	1.35	64.07	0.34	0.27	51.10
4.8	1.75	1.14	47.08	0.27	0.21	44.95
8.3	1.68	1.02	41.98	0.22	0.18	40.39
10.7	1.68	0.98	39.95	0.14	0.13	38.73
18.7	1.61	0.92	36.05	0.12	0.11	35.18
35.1	1.57	0.87	32.26	0.10	0.09	31.67
72.9	1.54	0.85	28.86	0.08	0.08	28.37

Fig no. 3 Trade-off between quality and speed for the kodak test set.

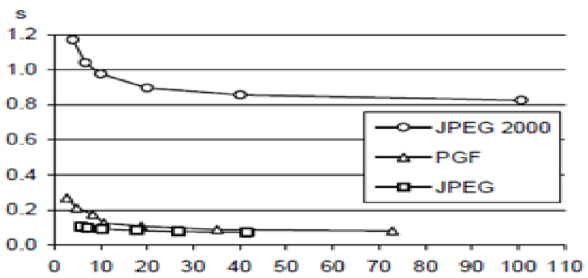

Fig no. 4 Decoding time in relation to compression ratio.

3.2.2.Lossless Image compression:

Lossless compression is that the solely acceptable quantity of data reduction. It provides low compression magnitude relation whereas compared to lossy. In lossless compression techniques area unit composed of 2 comparatively freelance operations: (1) fashioning another illustration of the image during which its interpixel redundancies area unit reduced and (2) coding the illustration to eliminate coding redundancies.

Lossless compression is beneficial in applications like medical imagined, business documents and satellite pictures.Table 2 summarizes the lossless compression potency and Table 3 the coding times of the PGF take a look at set. For WinZip we have a tendency to solely offer average runtime values, as a result of missing source code we've to use associate degree interactive testing procedure with runtimes measured by hand. All alternative values area unit measured in batch mode.

	WinZip	JPEG-LS	JPEG 2000	PNG	PGF
aerial	1.352	2.073	2.383	1.944	2.314
compound	12.451	6.802	6.068	13.292	4.885
hibiscus	1.816	2.200	2.822	2.087	2.538
houses	1.241	1.518	2.155	1.500	1.965
logo	47.128	16.280	12.959	50.676	10.302
redbrush	2.433	4.041	4.494	3.564	3.931
woman	1.577	1.920	2.564	1.858	2.556
average	9.71	4.98	4.78	10.70	4.07

Fig no. 5 Lossless compression ratios of the PGF test set.

In Table 2 it can be seen that in almost all cases the best compression ratio is obtained by JPEG 2000, followed by PGF, JPEG-LS, and PNG. This result is different to the result in [SEA+00], where the best performance for a similar test set has been reported for JPEG-LS. PGF performs between 0.5% (woman) and 21.3% (logo) worse than JPEG 2000. On average it is almost 15% worse. The two exceptions to the general trend are the 'compound' and the 'logo' images. Both images contain for the most part black text on a white background. For this type of images, JPEG-LS and in particular WinZip and PNG provide much larger compression ratios.

3.3.A Foggy Image Enhancement Algorithm

Image Enhancement Algorithm with Wavelet Transform For imaging of moving objects in ITS, the distance range of interest is relatively short, normally not more than a few hundred meters. It is therefore assumed that there is no spatial change in the properties of foggy weather and homogeneous atmosphere is considered. Under this assumption, the following algorithm is proposed to enhance foggy image clarity based on the optical imaging model.The main idea is to remove the medium scattered light effect and enhance the contribution from direct incident light. The flowchart of the algorithm.

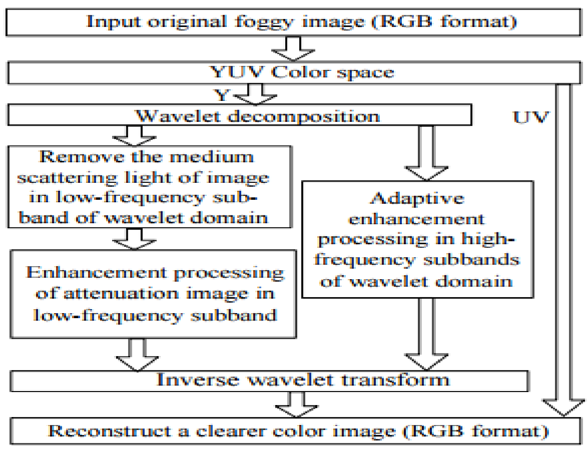

Fig no 6 A foggy image enhancement algorithm.

The algorithm consists of four major steps explained as follows. Step 1. Color space transformation and wavelet transform. The original foggy image in RGB (Red-Green-Blue) color format is transformed to the YUV color space that comprises of a luminance component (Y) and two chrominance components (U, V). Apply wavelet decomposition to the luminance component Y to get a low-frequency subband, LLn, and multiple high-frequency subbands LH HL HH iii , , (1, 2, ,i n), where n is the order of wavelet decomposition. Here LL, LH, HL and HH stands for low-low, low-high, high-low and high-high subbands, respectively. Step 2. In the low-frequency subband of wavelet domain, the medium scattered light component of a foggy image is estimated and removed. Then, the image is enhanced adaptively via employing the corrected attenuation factor following the local complexity.

Step 3. In the high-frequency subbands of wavelet domain, adaptive enhancement of a foggy image is conducted. Step 4. Inverse wavelet transform and image color space conversion. Apply inverse wavelet transform to the enhanced wavelet coefficients and obtain the enhanced luminance component ′ . Y′Y and UV components are reconstructed to form a clearer YUV image, and this YUV image is converted back to an RGB colored image. In this algorithm, the image transform to YUV space separates the luminance component, Y, from the chrominance components. The wavelet transform decomposes Y further into a low-frequency subband and several high-frequency.om LL n to get Y1 . Step 2. Since the values of Y1 are relatively small and some are negative, a correction value of Y is added to Y1 so as to be match the overall brightness of LLn.

4.Visibility Restoration (VR):

For removing haze, fog, mist from the image varied technique are used. Typical ways of image restoration to the fog are:

4.1. Dark channel prior:
Dark channel previous is employed for the estimation of part light-weight within the dehazed image to urge the a lot of correct result. This system is usually used for non-sky patches, as a minimum of one color channel has terribly low intensity at some pixels. The low intensity within the dark channel are preponderantly attributable to 3 components:-

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

So can |we are able to} say dark channel of haze image will have higher intensity in region with higher haze. So, visually the intensity of dark channel may be a rough approximation of the thickness of haze. In dark channel previous we have a tendency to conjointly use pre and post process steps for recouping results. In post process steps we have a tendency to use soft matting or bilateral filtering etc.

Let J(x) is input image, I(x) is foggy image, t(x) is that the transmission of the medium. The attenuation of image because of fog may be expressed as:
$Iattx = (x)$ t(x)------ (1)
the result of fog is Air light result and it's expressed as:
$Iairlig\ h\ tx = (1-(x))$ --------(2)
Dark channel for associate absolute image J, expressed as J dark is outlined as:
$Jdarkx = miny \in \Omega\ x$ (min$J$)------------ (3)

In this Jc is color image comprising of RGB elements, represents an area patch that has its origin at x. The low intensity of dark channels is attributed in the main thanks to shadows in pictures, saturated color objects and dark objects in pictures.

once dark channel previous, we want to estimate transmission t(x) for continuing more with the answer. Another assumption required is that permit part light-weight A is additionally illustrious. we have a tendency to normalize (4) by dividing either side by A:

$IcAc\ (x)$ = t(x) $JcAc\ (x)$ + 1-t(x) -------(4)

In this Jc is color image comprising of RGB elements, represents an area patch that has its origin at x. The low intensity of dark channels is attributed in the main because of shadows in pictures, saturated color objects and dark objects in pictures. once dark channel previous, we want to estimate transmission t(x) for continuing more with the answer.

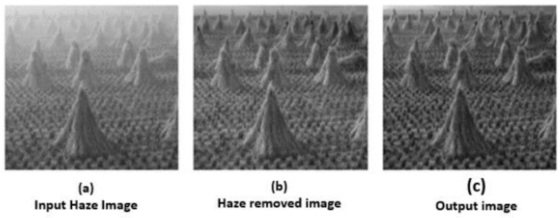

Fig no 7 (a), (b), & (c).

IV. CONCLUSION

In our work, we propose a Laplacian-based visibility restoration approach to effectively solve inadequate haze thickness estimation and alleviate color cast problems.By doing so, a high-quality image with clear visibility and vivid color can be generated to improve the visibility of single input image (with fog or haze), as well First, the famous dark channel prior, a statistics of the haze-free outdoor images, can be used to estimate the thickness of the haze; and second, gradient prior law of transmission maps, which is based on dark channel prior.Theexperimental results show that the proposed approach can effectively improve the visibility and keep the details of fog degraded images in the meanwhile. Experimental results via qualitative and quantitative evaluations demonstrate that the proposed method can dramatically improve images captured during inclement weather conditions and produce results superior to those of other state-of-the-art methods.

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