A NEOTERIC APPROACH FOR RESTORATION OF FOGGY VIDEOS

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ABSTRACT:

This work focus on haze removal which is also known as visibility restoration refers to different methods that aim to reduce or remove the degradation. The degradation may be due to various factors like relative, relative atmospheric turbulence, object-camera motion, and miss-focus. Restoration of hazy videos is important in computer graphics. In this paper, the process of restoration can be processed by using dark channel method followed by Guided filtering. Guided filter has better filtering capability and fast running time and gives a clear haze free video. So, it can be used in real time video applications.

INTRODUCTION:

The images or videos taken in bad weather conditions may degraded due to the presence of the turbid medium (e.g., particles and water droplets) in the atmosphere. They reduce the visibility of the scenes and lower the reliability of outdoor surveillance systems. So in bad weather the effect of such phenomenon needs to be removed, to recover clear haze free images or videos.

Therefore, removing haze from frames of hazy videos is an important and widely demanded topic in computer vision and computer graphics areas. For this purpose we propose the method with, dark channel calculation combined with guided filtering. In this method first the hazy video is divided into frames. The number of frames depends on the size of the video. Then each frame can be considered as similar to a single hazy image, and on each of those hazy images our method is applied.

With the target of haze removal, multiple image haze removal methods are first introduced. In the multiple image haze removal method take two or more images of the same scene. This strategy increases the number of known variables, at the same time it brings more unknown so special settings must be needed to avoid too many unknown being introduced.

The dichromatic method [7], takes multiple images of the same scene, under different atmospheric conditions. The main problem of this method is that weather may remain unchanged in several minutes or even hours. Polarization based method is another multiple image haze removal technique. Its main problem is their setting that is, capturing two strictly aligned polarized images is trouble.

To overcome the limitation of multiple image haze removal another strategy, single image haze removal introduced. It is based on some assumption or knowledge.

This strategy become more popular since, it requires only one image. Besides of quality and speed our new method, combining dark channel with guided filtering in video dehazing is introduced. So, it is practically applicable to real time video applications.

EXISTING METHOD:

In this, haze is removed from the image by using Cross bilateral filtering technique. The steps of this method are as follows.

Input RGB:

The input image is a hazy image which can be represented as

$$I(x)=J(x)t(x)+A(1-t(x)).$$

Where, I=intensity ,J=original scene radiance

Calculating dark channel prior and air light:

He et al. proposed dark channel based on the observation that atleast one color channel has some pixels whose intensity values are very low and close to zero. It is computed as follows:

$$J^d = \min_{y \in \Omega}((1-\sigma_{rgb}) * \mu_{ce[r,g,b]} (J^c(y)))$$

Where, J^c is a color channel of J, μ is a mean and σ_{rgb} is standard deviation of r,g,b intensity values and Ω(x) is a local path centered at x.In this present work, we consider top 1% pixels in computing air light and find the pixel which has maximum value of J^d in its dark channel among the pixels based on the above equation.

Calculating the transmission map and radiance map:

It is observed that the saturation of color in a foggy image decreases with the density of fog which in turn depends on depth of the object. The proposed transmission is calculated s follows:

$$T=1-f(s)(J^d=\min_{y\epsilon\Omega}((1-\sigma_{rgb})^* \mu_{ce[r,g,b]} (\frac{I^c(y)}{A^c}))) \quad (3)$$

Where f(s) depends on the saturation of the input image at x.

$$f(s)=0.8-(0.2*S)$$

where s is saturation of the pixel($0\leq s \leq 1$).

We estimate the scene radiance as $J(x)=\frac{t(x)-A}{\max(t(x),t0)}+A$

Where to is a factor to restrict the noise level. It is observed that the transmission map based fog removal approach creates blocks and articrafts along the edges. To avoid such articrafts, soft matting was proposed .But it takes more time to remove articrafts. In this, we avoid soft matting by computing 3 transmission maps using three different block sizes (3×3 ,5×5 ,7×7)and generate radiance map for all block sizes followed by cross bilateral filtering.

This approach reduces the noise and eliminates the need for soft matting thus improving the time required for processing. It does weighted averaging of pixels across multiple frames obtaining in previous section. The filtering is performed on intensity of the radiance image. It is defined as

$$Y_{ij}=\frac{1}{k}\sum_{k=1}^{N}\{e^{(\frac{-\left(Y_{ij}(3\times3)-y_{ij}(k_1\times k_1)\right)^2}{2\sigma^2})}\}$$

Where Y_{ij} is the filtered output at (i,j) pixel location ,N is the number of frames ,K1 indicates block size ,σ is a constant.

Contrast enhancement:

As discussed earlier, presence of fog or haze in the image reduces the contrast. Hence ,contrast enhancement is performed to restore the contrast. The contrast enhancement is expressed as

$$I(x,y) =\frac{1}{1-m\gamma+{}^{m}/_{r(x,y)}}$$

Where m is a threshold ,r(x,y) is a input intensity and γ is a contrast enhancement factor. We assume m to be 0.8 times the mean intensity of the image and γ=2.0 in the present work.

Drawbacks:

The cross bilateral filter has some defects as given below:

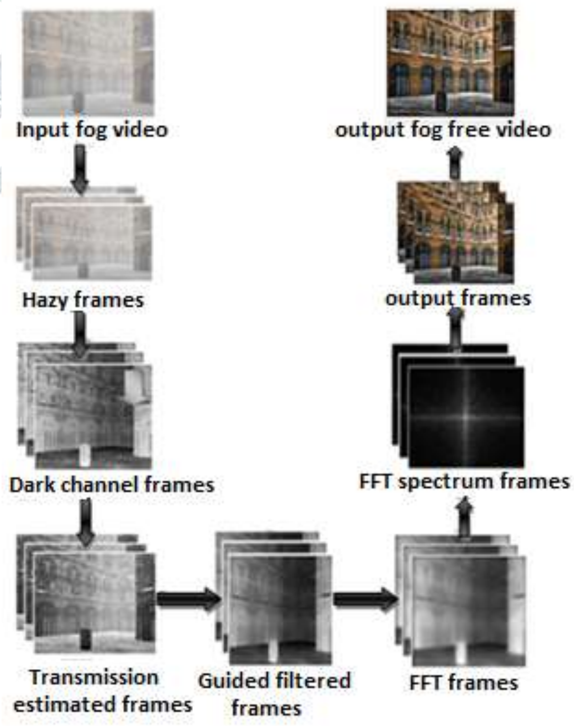
- Noise and JPEG artifacts – amplified defects.
- Can lead to unexpected results if the image content is too different from the model – Portraits.

There exist several extensions to the filter that deal with these artifacts. Alternative filters, like the guided filter, have also been proposed as an efficient alternative without these limitations.

PROPOSED METHOD:

Here we explain how our proposed method works. We know video can divided into frames and each frame is equivalent to a single image. So our hazy video is first divided into hazy frames and upon each such frame our method for haze removal is applied to obtain haze free frames.

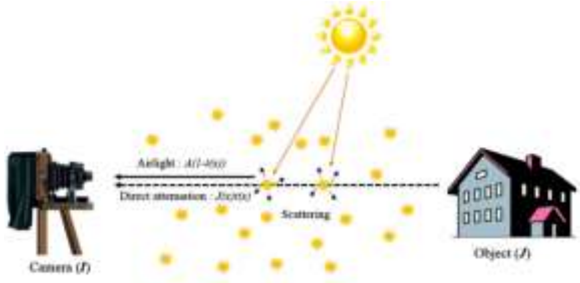
Finally by combining all these frames a haze free video is obtained. In our proposed haze removal method each frame undergoes two phases; transmission estimation and guided filtering. It is depicted as follows:



Flow chart of proposed system

A. Haze image formation

A hazy image formed as shown in Fig. 1. This model used for the formation of image in the presence of bad atmospheric conditions. Image quality is degraded due to the presence of substantial particles in the atmosphere which have significant size between 1-10 µm. The light coming from a camera is absorbed and scattered by these atmospheric particles. It can be mathematically modeled as follows



I(x)=J(x)t(x)+A(1-t(x)) (1)

Where I(x) is an observed intensity, J(x) is the actual intensity reflected from the scene point, t(x) transmission or transparency of haze and A denotes the atmospheric light.

B. Atmospheric light

Atmospheric light is considered as the color of the atmosphere, horizon or sky. The dark channel of a hazy image can be calculated as follows:

Darkchannel (x) = $\min_{c\in\{r,g,b\}}(\min_{y\in\Omega(x)} I^c(y))$ (2)

Where, I^c color hazy input image, Ω(x) is local patch centered at x.

The brightest local region of a dark channel is considered as atmospheric light, since it appears as most opaque. In haze free image, most of the local area, which does not cover sky, has very low intensity value in at least one of the color channel red, green and blue. Since the most opaque region gives the estimation of atmospheric light, region that has the high value in the dark channel is taken as the constant atmospheric light. while taking the concept of dark channel it is clear that in almost all local region which do not cover sky has very low intensity value and its tends zero. Therefore dark channel of image J becomes zero

$$J \longrightarrow 0$$

C. Improved Dark Channel Prior

Improved Dark Channel Prior (IDCP) This method is improved version of Dark Channel Prior (DCP). Improvement is that soft-matting will be done using Gaussian low pass filter. The aim of applying Gaussian low pass filter is to smoothen the small scale textures of image. Improved Dark Channel prior is based on dark channel concept to estimate the atmospheric light and obtain better results. Most image dehazing methods only consider that use a hard threshold assumptions or user to estimate atmospheric light. The brightest pixels are sometimes the objects such as car lights or streetlights. So the wrong atmospheric light estimation may affect the dehazing results. It is resolves the problem of significant region which contains sky. Means in that sky regions also take as patches for obtain the atmospheric light. Results of the dark channel prior gives dim image after the haze removal. So, this method has greater efficiency, less execution time and improves the original algorithm.

Advantages:

1. Estimation of air light is accurately.
2. Complexity of soft matting for refined transmission is not requiring.
3. So computation time is requiring less.
4. Sky regions become bright and smoother

D. Transmission Estimation

Transmission is the part of light reaches camera without attenuation from the part of light reflected from the scene point. Since it is a fraction its, value ranges between 0 and 1. The value of 0 means it's completely haze and nontransparent, 1 means no haze and completely clear, value in between 0 and 1 means semitransparent. Using the above described equations 1 and 3 and by above calculated we can easily estimate the transmission value as follows; normalize haze image equation 1 by A^c:

$$\frac{I^c(x)}{A^c} = t(x)\frac{J^c(x)}{A^c} + 1 - t(x) \quad (3)$$

Applying dark channel method on the above equation 4, then it becomes:

$$\text{Darkchannel}\left(\frac{I^c(x)}{A^c}\right) = \text{Darkchannel}\left(t(x)\frac{J^c(x)}{A^c} + (1 - t(x)\right) \quad (4)$$

By equating equation 3, on equation 4 it will give final transmission estimation as follows:

$$t(x) = 1\text{-}w^* \text{ Darkchannel}\left(\frac{I^c(x)}{A^c}\right) \quad (5)$$

We can optionally introduce a constant parameter w(0 < w≤1) , its value depends on the application to keep a very small amount of haze since if we remove the haze thoroughly, the image may seem unnatural.

E. Guided Filtering

On the above obtained haze free image J, apply an image filter here. We are using a guided filter so we get a better restored image. Let q be the output of guided filtering that is our required restored image, and I and J be the two images used for filtering. Guided filtering works on input image I under the guidance of another reference image J. Here we are taking initial hazy image I as input image that is filtered under the guidance of image J, that is obtained as the haze free image in above section. Based on the application both input image and guidance image [9] can be same.

The output image can be represented as a linear transform of guidance image J as:

$$q_i = a_k J_k + b_k, i \in w_k \qquad (6)$$

Here (a_k ,b_k) are linear coefficients assumed to be constant in window w_k considering square window of radius r. We model the q by subtracting noise components n from p by:

$$q_i = I_i - n_i \qquad (7)$$

We aim a solution that minimizes the difference between q and p and at the same time maintaining linear model. So our needs are to minimize the following cost function:

$$E(a_k,b_k) = \sum_{i \epsilon w_k} (a_k J_k + b_k - I_i)^2 + \in a_k^2 \quad (8)$$

Here, ∈ is a regularization parameter avoiding large a_k .

Its solution is given by the appropriate calculation of a_k and b_k as follows:

$$a_k = \overline{\sigma_k^2 + \epsilon} \frac{1}{|w|} \sum_{i \in w_k} J_i J_i - \mu_k \overline{p_k} \quad (9)$$

$$b_k = \overline{p_k} - a_k \mu_k \qquad (10)$$

Advantages:

- The method of removing haze from video using Guided filter is iterative, generic, inherits the robustness properties of the robust filter, and uses a guide image.
- It can be used edge preserving technique, non iterative, more generic than "smoothing".
- In this method Halo effects is remove efficiently.
- Refined transmission is done by guided filter so it gives good result.
- It avoids gradient reversal artifacts that appear in bilateral filter.

F. Fast Fourier transform

Snappy Fourier Transform (FFT) is the snappier and capable procedure for Discrete Fourier Transform (DFT). Discrete Fourier Transform is the change which takes the discrete banner in time territory and changes that banner in its discrete repeat space depiction. This property of DFT means the centrality of DFT in the area of range examination.

FFT being the quick and discrete nature similarity DFT is suitable for the banner's range examination in MATLAB dynamically. Discrete Fourier Transform empowers us to figure an estimation of the Fourier Transform on a discrete course of action of frequencies from a discrete game plan of time tests. A snappy Fourier change (FFT) computation figures the discrete Fourier change (DFT) of a gathering, or its retrogressive. Fourier examination changes over a banner from its special region (consistently time or space) to a depiction in the repeat space and the a different way. A FFT rapidly procedures such changes by factorizing the DFT grid into a consequence of pitiful (generally zero) factors. as needs be, it makes sense of how to reduce the multifaceted way of enrolling the DFT from,

$$F(x,y) = \sum_{m=0}^{M-1} \sum_{n=0}^{N-1} f(m,n) e^{-j2\Pi(x\frac{m}{M}+y\frac{n}{N})} \quad (11)$$

F. Haze Free Image

From the above calculated parameters actual image intensity J can be calculated as:

$$J(x) = \left(\frac{I^c(x)-A^c}{t(x)}\right) + A^c \quad (12)$$

APPLICATIONS:

1. Object Detection
2. Video Surveillance
3. Remote Sensing Systems
4. Underwater

RESULTS AND DISCUSSIONS:

In this section, first introduce experimental settings, and then present the experimental results that validate the effectiveness of the approach. The experiments actually contain two parts. This work is compare with other previous work.

Two of the error metrics used to compare the various image compression techniques are the Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR). The MSE is the cumulative squared error between the compressed and the original image, whereas PSNR is a measure of the peak error. The mathematical formulae for the two are

$$MSE = \frac{1}{mn}\sum_{y=1}^{m}\sum_{x=1}^{n}[I(x,y) - I'(x,y)]^2$$

$$PSNR = 20 * \log10\ (255 / \text{sqrt}(MSE))$$

Where I(x,y) is the original image, I'(x,y) is the approximated version and m, n are the dimensions of the images. A lower value for MSE means lesser error, and as seen from the inverse relation between the MSE and PSNR, this translates to a high value of PSNR. Logically, a higher value of PSNR is good because it means that the ratio of Signal to Noise is higher. Here, the 'signal' is the original image, and the 'noise' is the error in reconstruction. So, if you find a compression scheme having a lower MSE (and a high PSNR), you can recognize that it is a better one.

NCC computes the normalized cross-correlation of the matrices A and B. The resulting matrix C contains the correlation coefficients.

In this section, we are discussing about the experimental results shows input hazy image and its dark channel obtained. From the dark channel the most opaque region is taken as atmospheric light. From which we can easily estimate transmission and recover haze free image. The method is implemented by using the Intel Core2Duo processor with 4GB RAM with speed is 2.93GHz.

Input hazy video **Output haze free video**

Input hazy video **Output haze free video**

Comparison

The proposed system for images

Types of images	Proposed method			Existing method		
	MSE	PSNR	NCC	MSE	PSNR	NCC
Cones	1.4	43.13	0.0049	2.6	38.23	0.0013
Pumpkins	1.1	45.17	0.0050	2.0	40.12	0.0024
Stadium	7.7	48.55	0.0051	9.5	41.24	0.0036
2_input	1.0	46.18	0.0049	3.1	42.13	0.0016

Proposed system for videos			
Videos	**MSE**	**PSNR**	**NCC**
TestFogvideo4	0.1579	72.31	0.5144
TestFogvideo2	0.1298	74.06	0.4651

CONCLUSION:

This paper proposed a method for dehazing video. A new combination of guided filter with dark channel method is used in this work for dehazing videos from different scenes. The algorithm removes spatially varying haze based on the haze thickness estimation. As experiment is done on videos of different environment and it is obtained that proposed work is better on all the evaluation parameters of de-hazing images. The computational cost also decreased very much due to its low complexity In Future improvements of the method will deal with possible corner, and histogram effects caused by the image processing.

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