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HAZY VIDEO DENOISING USING AN ENHANCED VISIBILITY RESTORATION TECHNIQUE

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Abstract: The visibility of outdoor videos captured in some weather conditions is often degraded due to the presence of haze, fog, sandstorms. Poor visibility causes failure in computer vision applications, object recognition systems, and intelligent transportation systems as well as in traffic analysis. In order to solve this problem different dehazing techniques are employed. This paper proposes a simple video dehazing method that uses a combination of four major techniques: A dark channel prior technique, A refined transmission technique using guided interpolated filter, and an enhanced transmission technique. The proposed refined transmission takes advantage of the guided interpolation filter technique as it is good working with video and adopts adaptive gamma correction technique for enhanced transmission. By doing so, halo effects can be avoided from videos and effective transmission map estimation can be obtained.
Keywords: Hazy image, Bad weather, Depth estimation, Visibility restoration**.**

INTRODUCTION

Their arises many difficulties while processing outdoor videos in the presence of haze, fog or smoke which diminishes the colors and reduces the contrast. Many noise removal approaches have been proposed to restore the visibility of faded videos in order to improve system performance in all weather conditions. These approaches can be further divided into 3 categories. They are

- Additional information approaches
- Multiple image approaches
- Single-image approaches.

Additional information approaches refine hazy images by using scene depth information obtained from additional operations or interactions, such as through user operation to control position of the camera via a given approximation 3-D geometrical model. However, these approaches J. Kopf et. al., [10] are not well suited for real world assumption due to limitations placed on the acquisition of scene depth information by unknown geography information and additional user operation.

Multiple image approaches Schechner et. al., [8] adopt two or more images of the same scene, which are captured by using specific hardware, example; a rotating polarizing filter, to effectively construct the scene depth information and further achieve visibility restoration of incoming hazy images. Unfortunately, the

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use of these multiple image approaches usually requires either excessive hardware expense or special devices.

Recently, many studies have focused on single-image approaches to restore the visibility of a hazy image. These approaches are based on either strong assumptions or priors by which haze thickness is estimated by using only a single image. Tan [2] proposed a method that restores hazy images via a single-input image by maximizing the local contrast of the image based on an observation that haze-free images possess higher contrast than input hazy images. This method can produce acceptable results, yet restored images may contain some block artifacts near depth discontinuities.

LITERATURE SURVEY

The depth information of the degraded image is an important thing in the case of haze removal. Many methods extract depth information from multiple images and extra information. For instance, binary scattering model is used to extract scene information from color images under different weather conditions [1]. In recent years, many researchers focus on achieving haze removal results from a single degraded image. Through statistics, Tan [2] found that clear images had higher contrast compared with foggy images, thus he maximized the local contrast of the restored image for enhancing image visibility. The disadvantage was that the color of the restored image was often too saturated. Based on the assumption that the propagation of light and shading parts of the target surface were locally uncorrelated, Fattal [5] first estimated the scene radiance and then derived the transmission image. As this method requires sufficient color information, it could not process gray level images.

Narasimhan et. al., [3] addressed the problem of restoring the contrast of atmospherically degraded images and video. The methods to locate depth discontinuities and to compute structure of a scene, from two images captured under various weather conditions. Using either depth segmentation i.e., regions within closed contours of depth edges or scene structure, then showed how to restore contrast from any image of the scene taken in bad weather. Although structure computation requires changes in weather, the contrast restoration algorithm do not. The entire analysis is presented for monochrome images. However, this method can be applied to image captured using multispectral cameras, and the usual broadband RGB and gray scale cameras.

Xu et. al., [4] proposes dominant haze removal algorithm dark channel prior and improve the algorithm by replacing the time consuming soft matting part with fast bilateral filter to get higher efficiency. Moreover this analysis the reason why traditional algorithm leads to dim image after haze removal and propose improved transmission rate formula in order to get better visual effects of the image after dehazing. On this basis taking into account that the dark channel prior rule is not suitable for sky area, here decide to process this region with weaker method to improve the adaptability of the algorithm.

Fang et. al., [6] have discussed a new fast haze removal algorithm from multiple images in uniform bad weather conditions is proposed which bases on the atmospheric scattering model. The basic idea is to establish an over determined system by forming the hazy images and matching images taken in clear days so that the transmission and global air light can be acquired. The transmission and global airlight solved from the equations are applied to the local hazy area. This algorithm reduces haze effectively and achieves accurate restoration.

Kaiming He, Jian Sun[13] proposes that, for a better dehazing result we should go with an advanced guided filter rather than using the traditional one. The simple existing guided filters have high computational complexity when working with video.

EXISTING SYSTEM

Haze removal techniques belonging to the multiple image approaches category employ two or more images to estimate scene depth and subsequently remove haze formation. Schechner et. al., proposed a method which uses two or more images of the same scene with different polarization degrees produced by rotation of a polarizing filter to compute scene depth and recover the vivid color of captured images. Methods proposed by Narasimhan et. al., estimate scene depth and then remove haze by comparing two images that are captured under different weather conditions. However, the above haze removal methods using multiple images usually require additional expense or hardware in order to perform effectively.

Recently, research has focused on single image haze removal techniques which use strong assumptions or priors. Tan proposed a method which restores hazy images via a single input image by maximizing the local contrast of the image based on an observation that haze-free images possess higher contrast than input hazy images. This method can produce acceptable results, yet restored images may contain some block artifacts near depth discontinuities. The approach of fatal removes the haze by estimating the albedo of a scene and deducing the transmission medium from a single input image based on the assumption that transmission and surface shading are locally uncorrelated. However, this method may fail when input images contain dense haze. He et. al., proposed a method which uses a key assumption that most local patches for outdoor haze-free images exhibit very low intensity in at least one of color channel, which can be used to directly estimate haze density and recover vivid colors.

In addition to that, all these existing systems are meant to work on images. It does not work well with videos as all these algorithms are complex. The complexity

[14] of the algorithm depends mainly on the edge preserve filtering, which consumes about 70% of the total computing power.

INPUT HAZE IMAGE

The haze should be present in the input image in order to restore the haze free image. If haze free image is given as input image to the proposed visibility approach the estimated image might be in distorted form. The formation of haze in the captured image explained as follows. The optical model has widely used in the computer vision research field, particulary to describe the formation of hazy images captured by digital cameras. It is based on the physical properties of light transmission through atmospheric conditions.

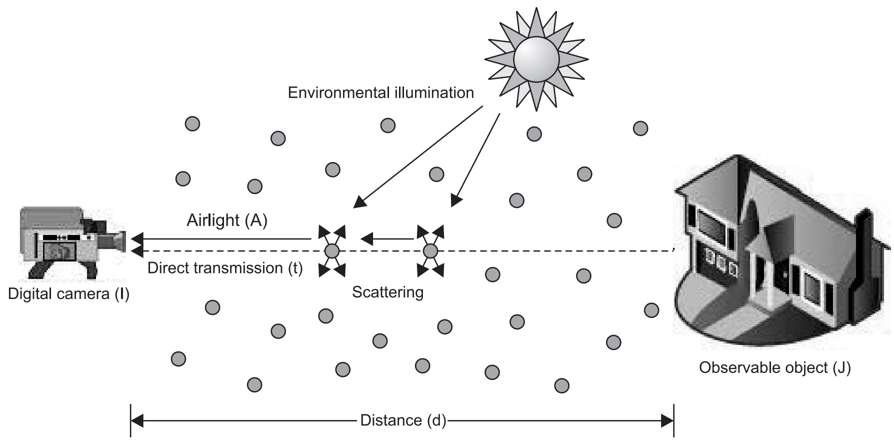

Figure 1: Pictorial description of the formation of hazy images in the optical model.

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

Where $I(x)$ is the intensity of the observed hazy image, $J(x)$ is the scene radiance, A is the global atmospheric light, and $t(x)$ is the medium transmission representing the portion of light, which is not scattered and subsequently is received by the camera. The first term $J(x)\ t(x)$ is called the direct attenuation; the second term $A(1 - t(x))$ is called airlight. The optical model can be described by direct attenuation and airlight. Direct attenuation describes the decay of scene radiance and is dependent upon medium and scene depth, while airlight represents the scattering of light that leads to color shifts in the scene. A hazy image is formed when there are problems with light absorption and scattering by atmospheric particles between the digital camera and the objects being captured. This situation can arise due to inclement weather, such as haze, fog, sandstorms, and so on. If the atmosphere is assumed to be homogenous, and then the transmission $t(x)$ can be expressed as

$$t(x) = e - \beta d(x)$$

where β is the scattering coefficient of the atmosphere and $d(x)$ is the scene depth between the digital camera and the captured objects for each pixel x in the image.

PROPOSED SYSTEM

A novel video dehazing approach is proposed in order to restore hazy videos caught during conditions, such as haze, fog, sandstorms, and so on. This approach along with the atmospheric light estimation involves additional three methods: Dark Channel Prior method, Refined transmission using guided interpolated filter, Enhanced transmission using gamma correction technique and a Visibility Restoration (VR) method.

Initially, the proposed dark channel prior method produces an insufficient transmission map for videos captured under worst weather conditions. Then it undergoes an effective refined transmission procedure that takes advantage of the guided interpolated filter to preserve edge information and thereby avoid generation of block artifacts in the restored image. This is followed by a transmission enhancement procedure, which adjusts the intensity of the transmission map to achieve optimum haze removal results. After these two procedures effective depth information can be obtained. Finally, the VR module recovers a high-quality haze-free video using the depth that adequately conceal the atmospheric particles present in various real-world weather conditions.

Atmospheric Light Estimation

For estimation of the atmospheric light A in the outdoor image, the brightest 0.1% of pixels are chosen from within the dark channel prior. From among these, the pixels with the highest intensity in the input image are determined to be the atmospheric light A.

Dark Channel Prior

The base method used to obtain transmission map of a hazy video is dark channel prior technique. However, as was mentioned here, two prominent problems exist in regard to the dark channel prior technique: generation of halo effects and insufficient transmission map estimation. All these problems are avoided using a refined transmission procedure and an enhanced transmission procedure.

Refined Transmission

Because the primary operation of the dark channel prior depends on the minimum filter, the transmission map will usually experience a loss of edge information when estimation occurs. A refined transmission procedure that uses a guided interpolated filter technique to preserve edge information of input hazy videos and thereby avoid generation of halo effects. The guided interpolated filter technique performs a nonlinear filtering operation that can effectively suppress impulsive noise components while preserve edge information. Now the refined transmission $t_{vr}(x)$ can be obtained as:

$$t_{vr}(x) = t^{p}(x) - \mathrm{VR}(x)$$

where, $t^{p}(x)$ is the transmission and $\mathrm{VR}(x)$ is the corrected atmospheric veil with detailed edge information.

Enhanced Transmission

The dark channel prior depends on the minimum value of the RGB channel and always produces an insufficient transmission map for videos caught during different weather conditions. This is because the intensity value will be lower for at least one RGB channel in sandstorm videos. In order to achieve optimum haze removal results, apply an adaptive gamma correction technique to adjust the intensity of the transmission map during this procedure. The enhanced transmission $et_{\mathrm{small}}(x)$ is formulated using adaptive gamma correction as

$$et_{\mathrm{small}}(x) = (\mathrm{X}_{\max})(t_{vr}(x)/\mathrm{X}_{\max})^{\gamma}$$

$$\gamma = \begin{cases} 1 + \left(\dfrac{t}{\mathrm{X}_{\max}}\right) & \text{if } t \geq \mathrm{T} \\ 1 & \text{if } t < \mathrm{T} \end{cases}$$

where, $\mathrm{X}_{\max}$ represents the maximum intensity of the input, t_{vr} represents the intensity of refined transmission, γ refers to the varying adaptive parameter, t refers to the intensity value when cdf is equal to 0.1 and T is the adaptive threshold value set to 120. This technique also avoids artifact produced by equalization of gamma correction.

Visibility Restoration

The proposed visibility restoration technique uses the adjusted transmission map produced by the depth information to recover high quality haze free video. The experimental results produced were evaluated by qualitative and quantitative comparisons of videos of several realistic scenes with varied weather conditions and features. These analysis illustrate the efficiency of proposed visibility restoration approach. Not only can effectively circumvent significant problems regarding color distortion and complex structure, but it can also produce high quality, haze free videos more effectively than the existing method. At last, the result obtained is used to calculate the final enhanced visibility restoration frame as follows:

$$\mathrm{J}^{\mathrm{col}} = \frac{\mathrm{I}^{\mathrm{col}}(x) - (\mathrm{A}^{\mathrm{col}} - d^{\mathrm{col}})}{\mathrm{ET}} + (\mathrm{A}^{\mathrm{col}} - d^{\mathrm{col}})$$

where, J^{col} is the haze free frame, ET represents enhanced transmission. The frames obtained from hazy videos are turned to clear haze free frames and then by combining all those frames we get the final haze free video as the end result.

CONCLUSION

In this paper, we propose an advanced visibility restoration approach for videos captured using improved depth estimation. The proposed approach uses a combination of four main techniques, dark channel prior technique, refined transmission approach, enhanced transmission approach and finally visibility restoration module. First, the dark channel prior technique is the base method used to obtain transmission map of a hazy video. Then it will undergo a refined transmission using guided interpolated filter so that the halo effects produced are removed in a better way. Subsequently, an effective transmission map is estimated by adjusting its intensity via an enhanced transmission procedure based on the adaptive gamma correction technique. Finally, the visibility restoration module can effectively restore the visibility of input videos and obtain high-quality, haze-free results. This will effectively propose a simple algorithm for video dehazing. Not only it can effectively remove significant problems regarding complex video dehazing algorithm, but it can also produce high quality, haze-free videos more effectively than in the previous method.

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