International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 04 | Apr -2017 www.irjet.net p-ISSN: 2395-0072

SINGLE IMAGE & VIDEO DEHAZING USING COLOR ATTENUATION PRIOR

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Abstract-*Outdoor images Outdoor images that are captured in inclement weather are degraded due to factors like haze and fog. This factor diminishes the visibility of the image. Haze is formed due to two fundamental phenomena namely, attenuation and the air light. Attenuation reduces the scene contrast and air light increases the whiteness in the scene. Images may also contain impulse noises which are produced by the sensor and circuitry of image-capturing devices like digital cameras. This project presents a dehazing a single hazy image and video. A linear depth model is used to obtain the scene depth of the hazy image. With the depth map, we can easily estimate the airlight and transmission map. Now the scene radiance can be restored via atmospheric scattering model to obtain the haze-free image. The visual quality of the output image is much better than the original input image.*

Key Words: Dehazing, Attenuation, Airlight, Depth map, Outdoor images and videos.

1. INTRODUCTION

Images of outdoor scenes typically contain haze, fog, or alternative forms of atmospheric degradation caused by particles in the atmospheric medium. Here propose a simple but powerful color attenuation prior, for haze removal from a single input hazy image. By creating a linear model for modelling the scene depth of the hazy image below this novel previous and learning the parameters of the model by employing a supervised learning methodology, the depth knowledge are going to be well recovered. With the depth map of the hazy image, we easily remove haze from a single image. In color attenuation prior algorithm states that the haze is a difference between the brightness and the saturation of the pixels. By creating a linear model for the scene depth of the hazy image with this simple but powerful prior and learning the parameters of the model using a supervised learning method, the depth information can be well recovered. By means of the depth map obtained by the proposed method, the scene radiance of the hazy image can be recovered easily

1.1 General Background

Among current haze removal research, haze estimation methods can be divided into two broad categories of either relying on additional data or using a prior assumption. Methods that rely on additional information include: taking multiple images of the same scene using different degrees of polarization, multiple images taken during different weather conditions, and methods that require user supplied depth information or a 3D model. While these can achieve good results, the extra information required is often not available, and so a more flexible approach is preferable

Haze removal is the challenging problem. Since the degradation is spatial variant, it depends on the scene quality. Several existing techniques are used for dehazing purpose. The contrast restoration of the image solves the dehazing problem with one or more input image that have been taken in the uniform bad weather conditions. Some additional information are used in the polarization based dehazing technique, it take the advantage of partially polarized airlight. The depth based method is used to estimate the scene depth information from the multiple images captured under different weather condition. In video processing, the input hazy video is divided into frames containing group of pictures; where the first frame is known as I frame and the remaining frames are known as P frames. In our technique each frame in a video is considered as a separate input. In first step, the first frame is considered as the input. Then subsequent frames are considered for same.

2. METHODOLOGY

2.1 Atmospheric Scattering Model

Haze removal is the challenging problem. Since the degradation is spatial variant, it depends on the scene quality.

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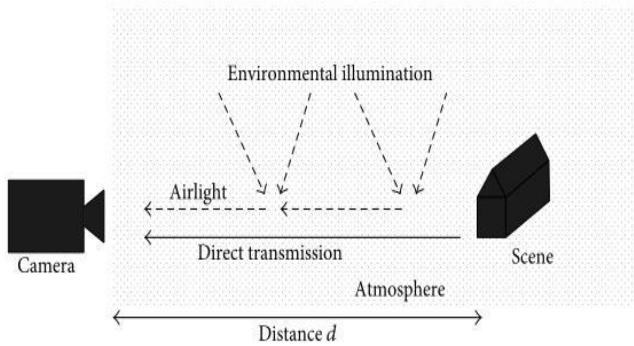

Fig-1: Scattering of light by atmospheric particles

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Some additional information are used in the polarization based dehazing technique, it take the advantage of partially polarized airlight. The depth based method is used to estimate the scene depth information from the multiple images captured under different weather condition. Light passing through a scattering medium is attenuated and distributed to alternative directions. This can happen anywhere along the path and leads to a combination of radiances incident towards the camera, as shown in Figure 1

In computer vision community, the atmospheric scattering model widely used to describe the formation of a hazy image I(x), where x is the pixel index, is shown as:

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

$$t(x) = e^{-\beta d(x)}\ldots\ldots\ldots\ldots(2)$$

Where I is the hazy image, J is the scene radiance representing the haze-free image, A is the atmospheric light, t is the medium transmission, is the scattering coefficient of the atmosphere , d is the depth of scene and t(x) is the medium transmission indicating the portion of the light that reaches the camera without getting scattered.

The major goal of single image dehazing is to recover a haze-free image J(x), A, and t(x) from the received image I(x), which is a under-constrained problem. In this model, the term J(x) t(x) is called direct attenuation and the term A (1-t(x)) is called air light. The direct attenuation is a multiplicative distortion of the scene radiance, while the air light is an additive one. This haze optical model has been employed in most works of single image dehazing.

To understand this, we review the atmospheric scattering model. The term J(x) t(x) in atmospheric scattering model is used for describing the direct attenuation. It reveals the fact that the intensity of the pixels within the image will decrease in a multiplicative manner. So it seems that the brightness tends to decrease below the influence of the direct attenuation.

3. SCENE DEPTH RESTORATION

3.1 The Linear Model Definition

As the difference between the brightness and the saturation can approximately represent the concentration of the haze,
We can create a linear model, i.e., a more accurate expression, as follows:

$$d(x) = \theta 0 + \theta 1v(x) + \theta 2s(x) + \varepsilon(x) \ldots\ldots\ldots (3)$$

Where *x* is the position within the image, *d* is the scene depth, *v* is the brightness component of the hazy image, *s* is the saturation component, $\theta 0$, $\theta 1$, $\theta 2$ are the unknown linear coefficients, *ε(x)* is a random variable representing the random error of the model, and *ε* can be regarded as a random image.

3.2 The Linear Model Definition

In this section, we describe the method in more detail. As the depth map of the input hazy image has been recovered, the distribution of the scene depth is thought. Bright regions in the map stand for distant places. We pick the top 0.1 percent brightest pixels in the depth map, and select the pixel with highest intensity in the corresponding hazy image I among these brightest pixels as the atmospheric light A.

The block diagram of haze removal model is given below.

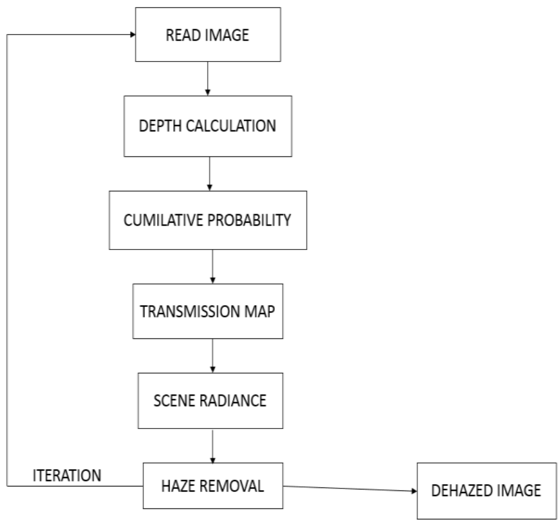

Fig-2: The block diagram of the dehazing model

3.3 Scene Radiance Recovery

Currently the depth of the scene *d* and the atmospheric light A are known, we can estimate the medium transmission *t* simply in keeping Equation (2) and recover the scene radiance J in Equation (4). For convenience, we rewrite Equation (1) as follows. For avoiding producing too much noise, we restrict the value of the transmission *t (x)* between 0.1 and 0.9.

$$J(x) = ((I(x) - A) / t(x)) + A \ldots\ldots\ldots (4)$$

The white objects in an image are usually with high values of the brightness and low values of the saturation. Therefore, the proposed method tends to consider the scene objects with white color as being distant. On one hand, the direct attenuation caused by the reduction in reflected energy leads to low intensity of the brightness.

4. LITERATURE REVIEW

Various literatures reviewed on dehazing are presented in this section. A review of literatures is presented in brief summarizing the work done by different scholars and researchers.

Kaftory, R., Schechner, Y., and Zeevi, Y. (2007) R. Kaftory et.al presents a variational method for image restoration the paper presents a regularization operator which is distance dependent, in addition to being edge preserving and color channel coupled. Minimizing this functional results in a scheme of reconstruction while denoising. It preserves important features, such as the texture of close by objects and edges of distant ones. A restoration algorithm is also introduced in the paper for reconstructing color images taken through haze. The algorithm also restores the path radiance, which is equivalent to the distance map. The method requires only a few general assumptions and can restore a high quality haze-free image with faithful colors and ne image details. But the method has a problem of ambiguity between image color and depth.

R. Fattal, (2008) Based on this estimation image formation model is formulated that accounts for surface shading in addition to the transmission function. In this new approach a resolve ambiguities in the data by searching for a solution in which the resulting shading and transmission functions are locally statistically uncorrelated. Results demonstrate that strategy has a capability to get rid of the haze layer moreover as given a reliable transmission estimate which might be used for extra applications like image focalisation and novel read synthesis. The method is passive; it does not need multiple pictures of the scene, any light-blocking based mostly polarization, any sort of scene depth info, or any specialized sensors or hardware. The method also has the minimal requirement of a single image acquired by an ordinary consumer camera. But the method cannot be used for gray scale image dehazing.

C. O. Ancuti, C. Ancuti, C. Hermans (2010) Ancuti et.al proposes a novel approach to restore a single image degraded by atmospheric phenomena such as fog or haze. By applying a single per pixel operation on the original image, a semi-inverse of the image is produced. Based on the hue disparity between the original image and its semi-inverse, hazy regions are identified on a per pixel basis. This enables for a simple estimation of the airlight constant and the transmission map. The algorithm is straightforward and performs faster than existing strategies while yielding comparative and even better results. The algorithm is straightforward and performs faster than existing strategies while yielding comparative and even better results with low processing time. But the method doesn't have any edge preserving property.

S Shrestha (2014) S Shrestha gives a comparison of known image Denoising techniques and uses a new technique using the decision based approach for the removal of impulse noise. All the methods can primarily preserve image details while suppressing impulsive noise. The principle of these techniques is at first checked and then analysed with various simulation results using MATLAB. Most of the previously known techniques are applicable for the Denoising of images corrupted with less noise density. A new decision based technique has been presented in the paper which shows better performances than those already being used. The comparisons are made based on visual appreciation and further quantitatively by Mean Square error (MSE) and Peak Signal to Noise Ratio (PSNR) of different filtered images. The decision based median filtering technique and adaptive decision based median filtering technique are found better techniques than any other techniques for filtering impulse noises and the computation time for these techniques are considerably less making them the ideal techniques for use in real time applications.

Qingsong Zhu, Jiaming & Ling Shao (2015) proposes a simple but powerful color attenuation prior for haze removal from a single input hazy image. By creating a linear model for modelling the scene depth of the hazy image under this novel prior, and learning the parameters of the model with a supervised learning method, the depth information can be well recovered. With the depth map of the hazy image, the transmission map and the airlight coefficient can be easily estimated and the scene radiance can be restored via the atmospheric scattering model. The haze can thus be effectively removed from a single image. The potency of this dehazing methodology is dramatically high and therefore the dehazing effectiveness is additionally superior thereto of prevailing dehazing algorithms. The method provides better efficiency and dehazing effects compared to others and the obtained output image doesn't suffer from over enhancement. The white objects in hazy images are not treated as haze, which is another advantage. But the algorithm used in this paper is based on constant assumption.The high efficiency of the proposed method mainly benefits from the fact that the linear model based on the color attenuation prior is simplifies the estimation of the scene depth and the transmission map. Although we have found this scene depth with the brightness and therefore the saturation of the hazy image, there's still a typical drawback to be resolved.

5. EXPERIMENTAL RESULTS

In order to verify the effectiveness of the planned dehazing methodology, we tend to check it on numerous hazy pictures and compare with alternative ways. All the algorithms are implemented in the MatlabR2013a environment on a P4-3.3GHz PC with 6GB RAM. The parameters used in the proposed method are initialized as follows: $r = 15$, $\beta = 1.0$, $\theta 0 = 0.121779$, $\theta 1 = 0.959710$, $\theta 2 = -0.780245$ and $\sigma = 0.041337$. As all the dehazing algorithms are able to get really good results by dehazing the general outdoor images, it is difficult to rank them visually. In order to compare them, we carry out the algorithms on some challenging images with large white or gray regions, since most existing dehazing algorithms are not sensitive to the white color. Figure 3 representing input hazy image. Next we calculate Restored depth map using Equation (4) and that shown in Figure 4.

Fig-3: Input hazy image

Fig- 4: Restored depth map

It is worth noting that the depth of the scene d is the most important information. Since the scattering coefficient β can be regarded as a constant in homogeneous atmosphere Condition the medium transmission t can be estimated easily according to Equation (2). By learning the parameters of the linear model with a supervised learning method, the bridge between the hazy image and its corresponding depth map is built effectively. Figure5 representing Restored transmission map and Figure 6 indicate dehazed image.

Fig-5: Restored transmission map

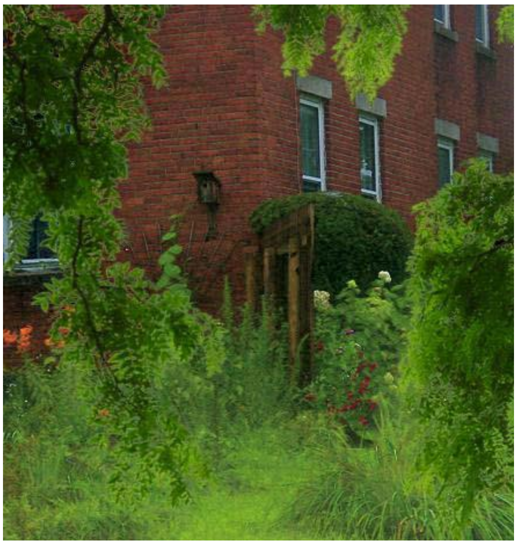

Fig-6: Dehazed image

6. VIDEO DEHAZING

The input generation process seeks to recover optimal region visibility in the frames of video. In practice, there is no enhancing approach that is able to remove the entire haze effect of degraded video inputs.

6.1 Frames Generation

Video means motion of many images (frames). Our proposed system employs hazed video as input. Our aim is to remove the haze effect from video. So firstly we convert the video into a no of frames based on its length or duration. A frame is assumed as one image of the video. If a particular video have long duration the frame count is high. In the first step, the first frame is considered as input and performs the dehazing operation. In the next step, second frame is considered as input and operate the same function. Similarly each consecutive frame is considered for the same with the aim of dehaze the video.

6.2 Dehaze video creation

The final output dehaze video creation is based on the number of frames, which are operated in a color Attenuation strategy. Based on the frames analysis, we obtain the data information and color maps of particular hazed video. By combining each dehaze frames; the final haze- free output is obtained

7. CONCLUSIONS

In this paper we introduce a dehazing technique using color Attenuation prior, which can effectively remove the haze from images or videos. The concentration of haze is positively correlated with the difference between brightness and saturation. So the difference between brightness and saturation close to zero we get haze free image or video. A linear depth model is used to obtain the scene depth of the hazy image. With the depth map, we can easily estimate the airlight and transmission map. Now the scene radiance can be restored via atmospheric scattering model to obtain the haze-free image. The method is quicker than existing video dehazing ways and yields correct results. After obtaining the dehazed image, the elapsed time for the entire process is calculated. The Mean Square Error, PSNR Ratio and Normalized Correlation are also determined as a part of quantitative analysis.

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