A Review on Video Dehazing Techniques

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Abstract--Dehazing or removing visibility loss from a video includes techniques that try to remove the amount of fog, mist in a hazy or a foggy video and gives the degraded video a complete sharpened look to get a better visibility and smooth image. After the study of several fast dehazing methods like Tan's dehazing technique, Fattal's dehazing technique and Kaiming He et al dehazing technique, Dark Channel Prior (DCP) intended by He et al is most substantive technique for dehazing. Explanation of use of DCP to remove haze from an image and equivalency was made between DCP and other dehazing techniques in order to know the best technique. Results came after application of DCP on number of images prove that DCP is better than other techniques of dehazing.

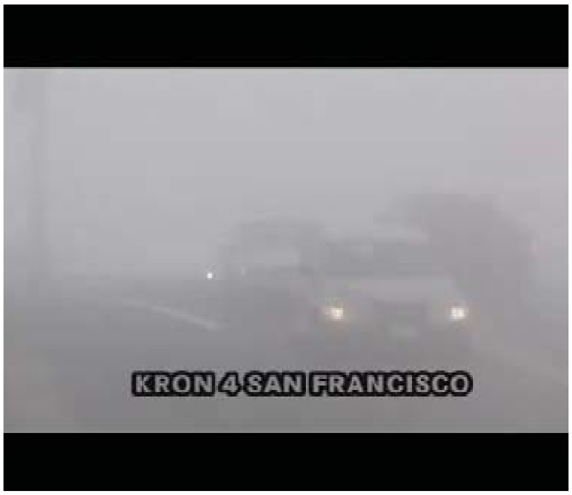
Index Terms--Single Image Dehazing, Contrast enhancement, Adaptive gamma correction, DCP-Dark Channel Prior, Image Fusion Technique.

I. INTRODUCTION

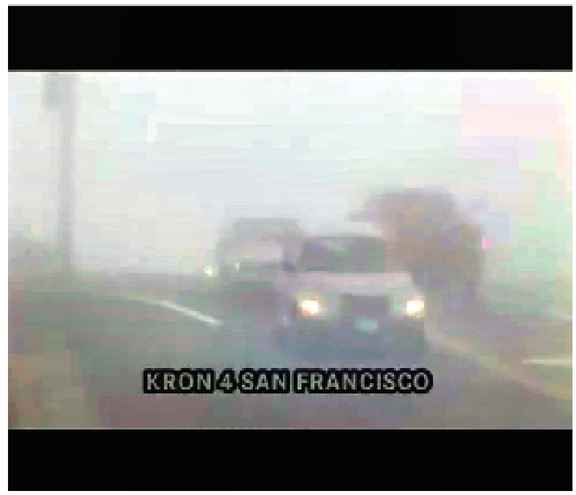
A Video, captured in bad weather, often yields low contrast due to the presence of haze in the atmosphere, which attenuatesscene radiance. Dehazing is the process of removing haze from hazy images and enhancing the image contrast. Image Processing for dehazing an image or avideo is a promising technology to satisfy theincreased demand for Television, Remote Surveillance; Intelligent means oftransportation, Remote Sensing, Satelliteimaging, underwater photography. Dark Channel Prior (DCP) is a roottechnology for dehazing an image or a video. DCP along with extended window along with filtering concept is in conclusively better technique among all for contrast enhancement and dehazing the video. Basically, a video is a group of frames where a frame is nothing but an image. So individual frame or image when undergoes the dehazing algorithm and then dehazed frames are recombined to form a video. Time complexity matters in case of video for real time applications and size of frame must be taken care of on the basis of compression technique or default capturing resolution.

II. LITERATURE SURVEY

Kristofor B. Gibson et. al (2012) [1] have proposed a method that can avoid *halo* effects by using the median operation and he consider the dehazing effects in compression and motion estimation in cases of applying any dehazing method before or after compression. Jiawan Zhang et. al (2011) [2] have first extracted the transmission map frame-by-frame as they used guided filter, after that judging the forward and backward optical flow between two neighboring frames to find the matched pixels. Zhenwei Shi et. al (2014) [3] have proposed a fast speed achieving technique by dehazing the frame or an image through guided filter through transmission map. Jin-Hwan Kim et. al (2013) [4] proposed a method based on the observation that a hazy image exhibits low contrast in general, they restore the hazy image by enhancing its contrast. Y.-H. Shiau et. al (2014) [5] have applied a weighted technique that automatically calculates light present in the atmosphere of the picture, and then adds these particulars to refine the light along with Dark Channel Prior. Shih-Chia Huang et. al (2013) [6] have used the intensity transformation module which can enhance the image with complete brightness preservation for each generated sub-histogram. Z. Wang et. al (2014) [7] have proposed approach that simultaneously dehazes image and enhances sharpness by means of individual treatment of the model component and the residual. Jin-Bao Wang et. al (2015) [8] have proposed a method that can achieve accurate dehazing results and improve the operational efficiency. Robby T. Tan et. al (2008) [14] have introduced technique to be implemented on single image. It is observed that there is more contrast in clear day images relative to the bad weather and also the air light tends to be smooth for distant objects.



(a)



(b)

Figure 1.(a) Hazy Frame of the Video (b) Haze Free Frame of the Video

III. GAPS IN LITERATURE SURVEY

Dehazing algorithms are becoming more useful nowadays as according to requirement of intelligent vehicles and hazy images captured through satellites. Various research flaws can be seen while going through the literature survey are as follows:-

1. Time to process the frame extracted from the video depending on frame size is not much adequate so as to implement real time application.
2. Noise issues are there which makes the frame or an image dull as large sized pixels after the algorithm like DCP and CLAHE are applied.
3. There is lack of combining the filters and masking techniques to dehaze along with De-noising the frame or an image.
4. Presence of irregular brightness and contrast reduces the performance of dehazing algorithms.

IV. DEHAZING METHODS

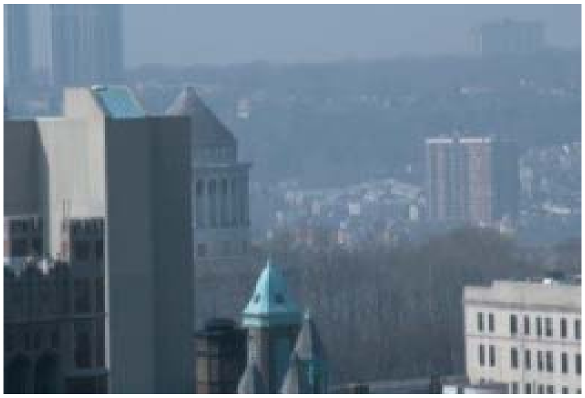
There are two ways of haze removal *i.e.*, multiple images fog removal method and single image fog removal method. For multiple images fog removal, image fusion techniques are used. Following are the dehazing techniques:

A. Polarization Based

Polarization-based dehazing methods are part of the multi-image group taken with two differently polarized filters they usually use two input images, one after another, to produce one dehazed image. ‘Air light is at least partially polarized’ this fact is used in this technique, and the direct transmission of the object is un-polarized. To remove haze, at least two images with different polarization filter states are necessary.

B. Fusion Based

It requires multiple images of the same scene. There is high complexity of time to remove haze. Thus, the proposed technique is multiple image dehazing technique that takes lesser time and just a single image per scene.

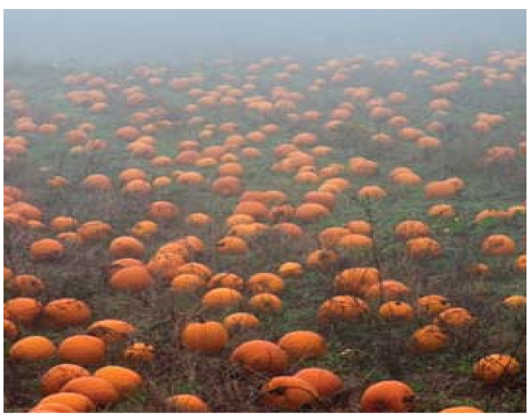


(a) (b)

Figure2. (a) Hazy Image (b) Haze Free Polarized Image

C. Histogram Equalization

The histogram equalization is a method using the image's histogram in order to improve contrast. Since only so much of brightness values can be displayed, all gradations of brightness and therefore contrasts must be within the brightness bandwidth. Thus the best results can be obtained, when spreading out the most frequent intensity values over the entire histogram. A disadvantage of this method is that it may increase the noise by discriminating it from the actual usable signal.



(a) (b)

Figure 3.(a) Hazy Image (b) Histogram Equalized Haze Free Image

D. Dark Channel Prior

The success of recently developed techniques such as [Fattal, 2008], [Kopf et al., 2008] and [Tan, 2008] compared to earlier dehazing methods lies in using stronger assumptions. A very promising new single image technology, developed in 2010 called the Dark Channel Prior comes from He, Sun and Tang. This method does not rely on significant variance on transmission or surface shading in the input image and the output image is less effected by halos than in [Tan, 2008]. Although every assumption limits the algorithm to specific use cases, the main assumption here seems to work for most outdoor scenes, except for those where "the scene object is inherently similar to the air light over a large location and no shadow is cast on the object" [He et al., 2010a]. Dark Channel Prior is a statistical based assumption of haze-free outdoor images. The prior says, that in most of the local regions means non-sky regions, and some pixels have a very low intensity very often in at least one of its color channels (RGB). In the hazy image then, these dark pixels can be used to determine the true air light, since the air light is apparent on a dark object. The dark channel J^{dark} of J (the haze-free image) is defined as:

$$J^{dark}(x) = \min_c (\min_{y \in \Omega(x)} (J^c(y))) \quad (1)$$

(a) (b)

Figure 4. (a) Hazy Image (b)DCP based Haze Free Image

where J^c is a color channel of J and (x) is a local patch centered at x. This statistical observation is called the dark channel prior. These low intensities come from natural phenomena such as shadows or just really dark or colorful surfaces. The final scene radiance may be then calculated by adding Air light estimation.

E. Un-sharp Masking

The idea behind un-sharp masking is to emphasize edges. An un-sharp masking algorithm can detect edges and alter the levels of brightness on both sides of the edge in a way that the darker side gets even darker towards the edge and the lighter parts get even lighter towards the edge. High frequency components are amplified by an un-sharp mask. It is resulting to be sharper image, and thus locally, contrast is increased. The ideal brightness curve would be a step function.

F. Fattal's Method

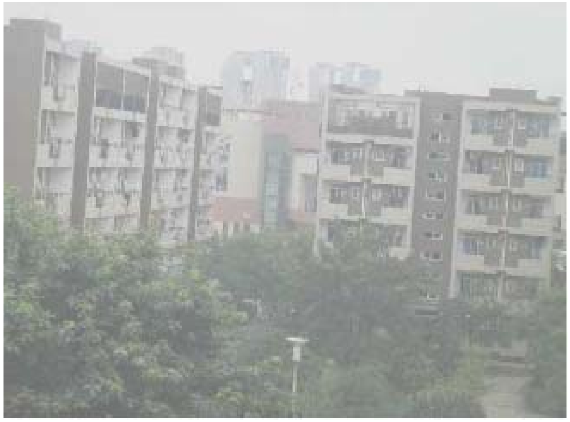
Fattal introduced a new technique in 2008 for single image dehazing that produces qualitatively great results on hazy images. It gives a refined image formation model. Quoting Fattal: "This allows us to resolve ambiguities in the data by searching for a solution in which the resultant shading and transmission functions are locally, statistically uncorrelated." An analogous standard is used in approximation of the color of the haze.

G. Gamma Correction

Gamma correction refers to a nonlinear operation that amplifies or reduces the luminance intensity of an image. Every pixel goes through this operation, without taking original value into the consideration. The power-law expression for the gamma correction by lowering in:

$$H_{out} = (H_{in})^{\Upsilon} \quad (2)$$

In dark images with low contrasts, the contrast levels may be raised. H_{in} and H_{out} here, signify the brightness levels before and after the Υ is gamma correction respectively.


(a)


(b)

Figure5. (a) Hazy Image (b) Fattal's Haze Free Image

H. Tan's Method

He used contrast increment for dehazing the image and distant objects to the viewer seems to be smooth. Over saturation of the image visibility is the only drawback of the algorithm. High contrast makes visually dehazed image but natural vision seems more artificial.


(a)

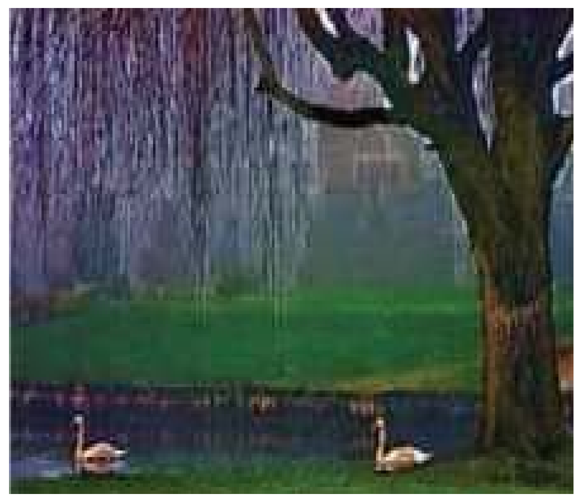

(b)

Figure 6.(a) Hazy Image (b) Tan's Haze Free Image

V. CONCLUSION

Importance of Haze removal algorithm is increasing day by day. With the increment of pollution, mist and haze in our environment, vision needs to be improvised through the technical ways of MATLAB which are not yet fitting best with any atmosphere. Negligence of concept of exact or approximately exact estimation of haze or mist present in any environment is degrading the research about dehazing. The survey has shown the do and don'ts about the fog removal algorithms so that vision in vehicles can be proper and noise free. Extended windows concept along with DCP has improved much through proper estimation of light and mixing the transmission map.

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