

# An Efficient Haze Removal Algorithm for Surveillance Video

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**ABSTRACT:** The reliable method for dehazing in video was proposed by using haze removal algorithm. The simple but effective prior is change of detail prior (CoD) algorithm to remove haze from video. By using Change of detail prior algorithm we can estimate the thickness of Haze from every frame and also effectively recover a high quality video. In this approach first extract the background image by using frames differential method and then estimate the atmospheric light and transmission map from the background image and finally renders the haze-free video according to the haze image model. The performance analysis of proposed method demonstrates that a good haze-free video can be produced effectively and efficiently.

**KEYWORDS:** Video haze removal, Transmission map, Image haze model, Atmospheric light.

## I. INTRODUCTION

In outdoor vision applications such as surveillance camera system require robust detection of image features. Under foggy weather conditions, the contrast and color of images are drastically altered or degraded. Hence, it is imperative to remove weather effects from video in order to make vision system more reliable. So far, there have been many works to remove fog from a single image [1–3], but only a few researches focus on video. These fog removal methods for video sequence mainly use frame by frame strategy. For this kind of methods, the basic idea of most approaches lies in depth-like map computation by using multiple images under different weather conditions [4, 5]. Although the results are satisfactory, strict requirement on the inputs, that two reference images captured in different weather conditions are needed in these methods, limits their applications. Other approaches separate the foreground and background images, and then combined two results to get the haze-free video sequences. For example, John and Wilscy [6] applied the wavelet fusion method on background and foreground pixels separately which reduces the computation time. Xu et al. [7] remove fog from the foreground and background images by using a contrast limited adaptive histogram equalization (CLAHE)-based method. However, these existing algorithms have high complexity with a long computation time. In order to solve these problems, we consider adopting a universal strategy to estimate a depth-like map by only using the background image of video, and then applying this map to a series of video frames. Compared with the existing frame by frame methods, our method calculates transmission map only once, so the fog removal speed is much faster. The remainder of this paper is organized as follows: In Section 2, we review the proposed method. In Section 3, we discuss the background extraction. In Section 4, we estimate the transmission map and pseudo transmission map. In section 5, we estimate the scene radiance restoration. In section 6, we present and analyse the experimental results. Finally, we summarize this paper in Section 7.

### 1.2 HAZE REMOVAL PROCESS FOR VIDEO

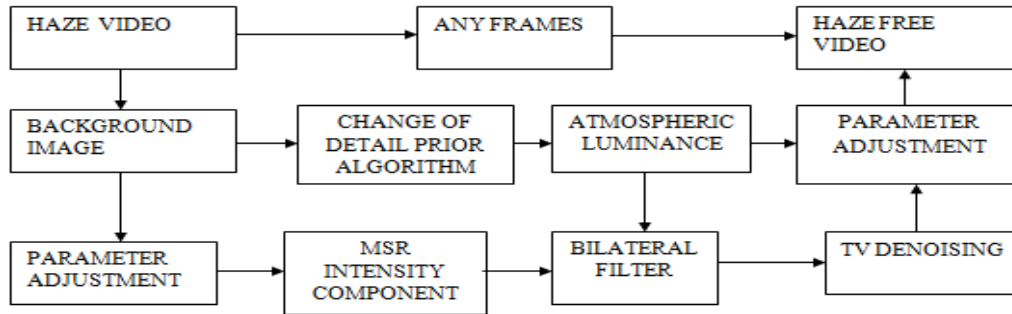


Figure 1 Haze removal process for video.

## II. PROPOSED APPROACH

### 2.1 CHANGE OF DETAIL PRIOR ALGORITHM

In a given video that has a haze, fog or mist, the first step is to extract the background image and then estimate the atmospheric light using the dark channel prior proposed by He et al[1]. In this algorithm the universal Transmission map is estimated based on the intensity component through Bilateral Filter, MSR and total variation (TV) denoising filter. Finally haze free video can be obtained by haze imaging model.

### 2.2 HAZE IMAGING MODEL

In computer vision and computer graphics, most widely used to describe the formation of a haze image model is it can be defined as follows

$$I = L0.T + LA.(1 - T) \quad (1)$$

Where I is the Haze image, L0 represents haze free representation at the same pixel, T represents the Transmission map, which represents the atmospheric light estimation. This method is to enhance the visibility of the entire video not only the single image for surveillance camera systems, traffic monitoring. For this purpose, the haze removal approaches for video adopt a different strategy to deal with video defogging problem. So in this method adopt a universal strategy to restore the video based on haze imaging model.

### 2.3 ATMOSPHERIC LIGHT ESTIMATION

Among these pixels, the pixels with highest intensity in the input image I are selected as the atmospheric luminance. The Dark channel is defined as

$$i^{dark}(x) = \min_{y \in \Omega} (\min_{c \in \{r,g,b\}} i^c(y)) \quad (2)$$

where min represents the minimum operation to find the minimum value among three colour channels,  $i^c$  is a color channel of input image, and  $\Omega(x)$  is a minimum local patch centered at x. Each colour channel of input image is filter by NxN minimum filter with a moving window. The maximum value from each colour channel is selected as atmospheric luminance. This method produces similar results but performs more efficiently.

### 2.4 BACKGROUND EXTRACTION

Our research considers an outdoor surveillance video camera capturing a scene (with moving objects) over an extended period of time. We would like to process it in real-time to obtain a haze-free video. Transmission map is only calculated for the background part of the video, in order to apply the universal transmission map to more frames with tolerable error. For simplicity, we define the static part of the scene as the background part and the moving objects in the scene as the foreground part. The background image can be obtained by using frame differential method.

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## III. TRANSMISSION MAP EXTRACTION

Transmission map is calculated based on the assumption that the intensity of an image reflects the amounts of photons received by every position of the image. The farther distance between the scene points and camera, the fewer photons are received by the sensor, which leads to darker intensity in the image. Thus, the depth information reflected by the transmission map can be measured by intensity, in other words, the transmission map can be obtained by the intensity component of an image. So our objective is to obtain the transmission information from the intensity component of an image. For this purpose, MSR, bilateral filter are used on the intensity component of the background image.

### 3.1 PSEUDO-TRANSMISSION MAP ESTIMATION

For surveillance camera system, the camera is fixed and often positioned high in the air, so the background of each frame is unchangeable and the difference in transmission between a foreground object and the background behind it is usually small. Although the haze removal result obtained by using bilateral filter to obtain transmission map is good for a single image, using the filter to calculate transmission map for each frame is surely time-consuming. In order to make the pseudo-transmission map calculated once and used for all, the map should only contain scene outlier. Therefore, the moving foreground object and image details can be regarded as noise. As the total variation based on Rudin-Osher-Fatemi (ROF) model proved to be quite efficient for denoising and regularizing images without smoothing the boundaries of the objects [11], we use the total variation algorithm to calculate the pseudo-transmission map obtained by bilateral filter. This pseudo-transmission map is applied to all video frames without creating significant errors in the enhanced video.

### 3.2 BILATERAL FILTER

Bilateral filter is a non linear technique, edge preserving, and noise reducing for images. In bilateral filter each pixels is replaced by weighted average of its neighbours, in a manner very similar to Gaussian convolution. This filter preserves edges while smoothing and for each pixel is to influence another pixel, it should not occupy nearby pixel location but also have a similar value. The bilateral filter, denoted by  $BF$

$$BF[I_p] = \frac{1}{\sum_{q \in S} W_p} \sum_{q \in S} G \sigma_s(\|p - q\|) G \sigma_r(|I_p - I_q|) I_q \quad (3)$$

Where,  $I$  is the input image,  $p$  and  $q$  are the pixel coordinates,  $G \sigma_s$  is a spatial domain Gaussian weighting for distant pixels,  $G \sigma_r$  is a range Gaussian that decreases the influence of pixels  $q$ . An important characteristic of bilateral filter is that the weights are multiplied, but if the weights are close to zero no smoothing will occurs.

### 3.3 TV DENOISING

Total variation Denoising is often used for image filtering and restoration, noise reduction so as to preserve sharp edges in the underlying signal. The total variation based on model proved to be quite efficient for denoising and smoothing the boundaries of the objects. So we use the total variation algorithm to calculate the pseudo-transmission map obtained by bilateral filter.

## IV. SCENE RADIANCE RESTORATION

According to the haze image model we can recover the scene radiance of each frame with the same transmission map obtained by the algorithm presented above. Because the direct attenuation term  $I(x)t(x)$  can be very close to zero, so the transmission map  $t(x)$  is restricted to a lower bound  $t_0$ , which means that a small amount of haze are preserved in very dense haze regions. A typical value of  $t_0$  is 0.1. The final scene radiance  $I(x)$  is then recovered by:

$$LO = \frac{I(X) - L_A}{\max(t(x), t_0)} + L_A \quad (4)$$

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Since from the first frame, the transmission map  $t(x)$  and the atmospheric light  $A$  can be estimated, so we can apply this equation to each frame of the original video in order to obtain the final haze-free result.

## V. RESULTS AND DISSCUSION

In this section the change of detail prior algorithm results are discussed. The execution is carried out in MATLAB 2013a tool. The PSNR value of output image is found to be better than the input image.

### 5.1 SIMULATION RESULTS USING MATLAB

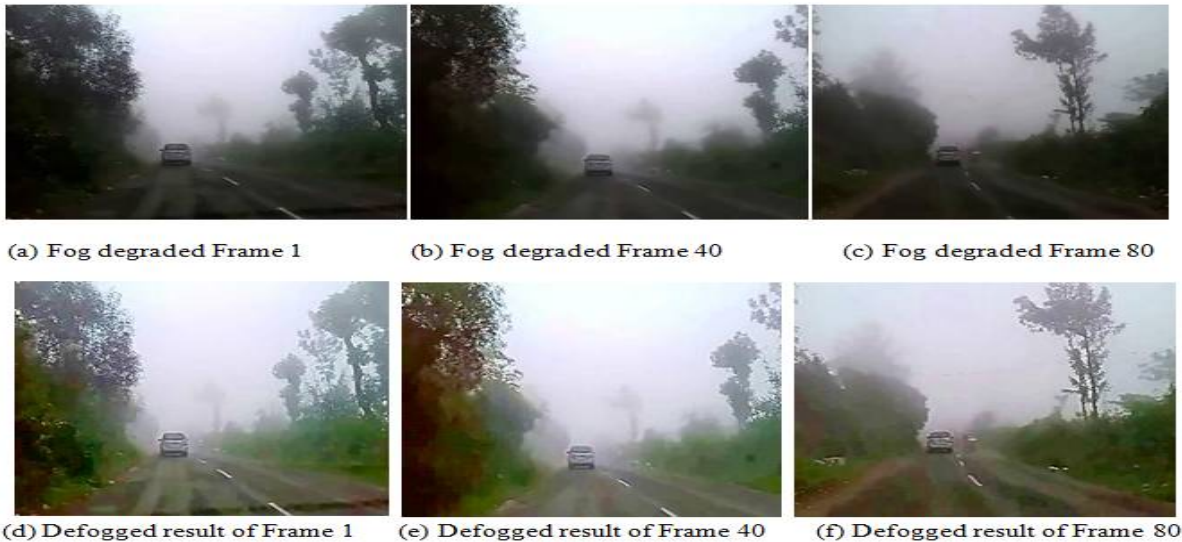


Figure 2 Fog degraded frames defogged by our method

### 5.2 ANALYSIS REPORT FOR VIDEO FRAMES

Table I analysis report

S.NO	Parameters	Existing method	Proposed method
1	PSNR	67.9435	69.3837
2	MSE	0.0104	0.0075

Table 1 shows the analysis report of PSNR value and MSE value is compared with the existing technique and proposed technique. Input hazy image contain more error by using visibility approach the error has been minimized.

## VI. CONCLUSION AND FUTURE WORK

This paper proposes a fast video defogging approach using haze image model with the same atmospheric light and transmission map. The proposed method is applicable under the situation that the camera is fixed and positioned high above the ground. Given a haze video, continuous haze-free video can be produced through haze image model

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with universal estimated atmospheric light and trans-mission map. The experiment results show that our method is effective and efficient.

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