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A Review on Fog Mist and Haze Removal Techniques

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ABSTRACT: Images captured in poor weather conditions is often get degraded due to suffering from poor contrast and loss of colour characteristics. Poor visibility becomes a major problem for most outdoor vision applications. Contrast and colour of the captured pictures are degraded under foggy weather conditions and this degradation is often attributed to attenuation and air light. To reduce the number of road accidents through vision enhancement in turbid weather, an efficient fog removal technique plays a vital role as fog greatly reduces the visibility and hence affects the computer vision algorithms such as surveillance, tracking and Fog Vision Enhancement System (FVES). Visibility enhancement in bad weather is important in many applications. To restore both contrast and color we propose following methods 1) Low pass and High pass filters; 2) Hue Intensity Saturation (HIS) Model; 3) Homomorphic filter; 4) Masking with histogram equalization. Fog removal algoritham has a wide application in tracking and navigation, entertainment industries, and consumer electronics.

KEYWORDS: Fog removal; image enhancement; HSI model; low pass filter; high pass filter; Homomorphic filter; masking; Histogram equalization

I. INTRODUCTION

Bad weather caused by atmospheric particles, such as fog, haze, mist etc may significantly reduce the visibility and distorts the colours of the scene [4]. The degree of degradation increases exponentially with the distance of scene points from the sensor. The low quality images are a nuisance for object detection algorithms. They generally fail to correctly detect objects due to low visibility. Thus it is very essential to make these vision algorithms robust to weather changes. Foggy conditions drop atmospheric visibility and brings whitening effect on the images causing poor contrast that is called as air light [6]. Hence basic challenge is to nullify the whitening effect thereby improving the contrast of the degraded image.

However, fog removal is a challenging problem because the fog is dependent on the unknown depth information.Depth based methods require the rough depth information either from the user inputs or fromknown 3D
models. Recently, single image fog removal has made significant progresses. The success of these methods lies in using a stronger prior or assumption. Tan observes that the fog-free image must have higher contrast compared with the input.
Fog image and he removes the fog by maximizing the local contrast of the restored image. The results are visually compelling but may not be physically valid. Fattal estimates the scene and then infers the medium transmission, under the assumption [1][7][8][9].From the atmospheric point of view, weather conditions differ mainly in the types and sizes of the particles present in the space. A great effort has gone into measuring the size of these particles [3].Based on the type of visual effects, bad weatherconditions are broadly classified into two categories: steady and dynamic. In steady bad weather, constituent droplets are very small (1-10 micrometre) and steady in air.

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Table 1: Weather conditions and associated particle types and sizes

Condition	Particle type	Radius (μm)
Air	Molecule	10^{-4}
Haze	Aerosol	$10^{-2} – 1$
Fog	Water droplet	1-10
Cloud	Water droplet	1-10
Rain	Water droplet	10^{2} - 10^{4}

In fog degradation in visibility is caused by attenuation and airlight. A light beam travels from a scene point through the atmosphere, gets attenuated due to the atmospheric particles, this phenomena is called attenuation which reduces the contrast in the scene. Light coming from the source is scattered by fog and part of it travels towards the camera. This phenomena is called air light. Air light adds whiteness into the scene [6].

LOW PASS AND HIGH PASS FILTER

[A] LOW PASS FILER

Low pass filters only pass the low frequencies, drop the high frequencies. It cut off all high frequency components that are a specified distance D_0 from the origin of the transform. Smoothing is fundamentally a low pass operation in the frequency domain.

Table 2: Equations of all standard forms of low pass filter

Ideal filters	$H(u,v)=\begin{cases}1 & \text{if } D(u,v)\le D_0\\ 0 & \text{if } D(u,v)> D_0\end{cases}$
Butterworth Lowpass	$H(u,v)=\dfrac{1}{1+\left[D(u,v)/D_0\right]^{2n}}$
Gaussian lowpass	$H(u,v)=e^{-D^2(u,v)/2D_0^2}$

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[B] HIGH PASS FILER

High pass filters – only pass the high frequencies, drop the low ones. High pass frequencies are precisely the reverse of low pass filters.

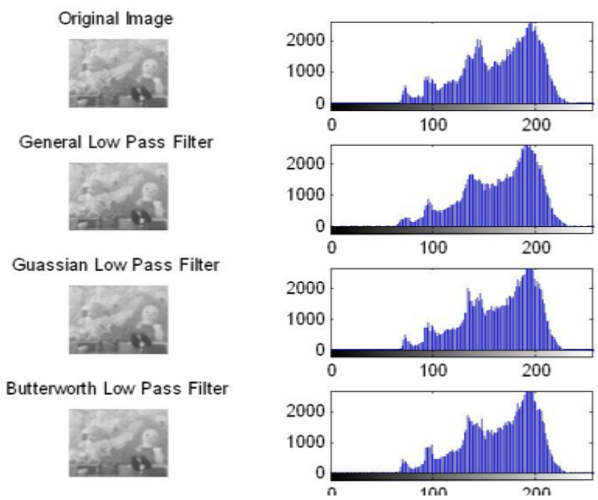
$$\mathbf{H_{hp}(u, v) = 1 – H_{lp}(u, v) \qquad (1)}$$

Table 3: Equations of all high pass filters

Ideal filters	$H(u,v)=\begin{cases}0, & \text{if } D(u,v)\le D_0\\ 1, & \text{if } D(u,v)>D_0\end{cases}$
Butterworth highpass	$H(u,v)=\dfrac{1}{1+[D_0/D(u,v)]^{2n}}$
Gaussian highpass	$H(u,v)=1-e^{-D^2(u,v)/2D_0^2}$

From the fig-1 of fog removal using low pass filters we can conclude that low pass filter can only pass low frequency component and hence no fog can be removed. Low pass filters can allow the frequencies with the given cutoff range. Here we apply different cutoff range and the order of the filter but no effect of fog removal is measured using histogram output

[C] RESULT OF LOW PASS



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From the above outputs of fig-2 we can conclude the high pass filters can pass only high frequency components. High pass filters can do sharpening of the images. High pass filter can sharp the edges. In the foggy images no need to use sharpening so fog cannot be removed using high pass filter

[D] RESULT OF HIGHPASS

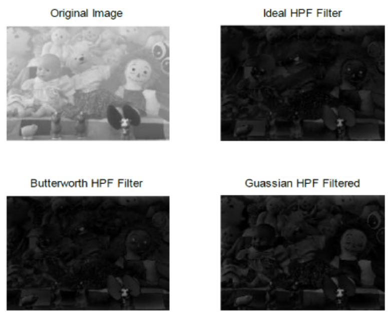

Figure 2: Fog removal using high pass filter

tasks; the wiener2 function handles all preliminary computations and implements the filter for an input image. wiener2, however, does require more computation time than linear filter ing. Wiener works best when the noise is constant-power ("white") additive noise, such as Gaussian noise. Another method for removing noise is to evolve the image under a smoothing partial differential equation similar to the heat equation which is called anisotropic diffusion.

PERFORMANCE PARAMETERS

For comparing original image and filtered image, we calculate following parameters:

Mean Square Error (MSE): The MSE is the cumulative square error between the encodedandthe original image defined

$$MSE = \frac{1}{mn}\sum_{0}^{m-1}\sum_{0}^{n-1}\|f(i,j) - g(i,j)\|^2$$

Where, f is the original image and g is the filtered image. The dimension of the images is m x n. Thus MSE should be as low as possible for effective filtering. Signal to Noise Ratiois defined by the power ratio between a signal and the background noise. WhereP is average power. Both noise and power must be measured at the same points in a system, and within system with same bandwidth.

Peak signal to Noise ratio (PSNR):

It is defined by :PSNR = 10 log (255^2/mse)

II. LITERATURE REVIEW

This chapter covers the literature from the study of various research papers. The papers explored that haze removal from the image depend upon the unknown depth information. This algorithm is based on the atmospheric scattering physics-based model. In this on selected region a dark channel prior is applied to obtain a novel estimation of atmospheric light. This model is based upon some observation on haze free outdoor image. In non-sky patches, at least one colour channel has very low intensity at some pixels. The low intensity in that region is due to shadows, colourful objects and dark objects etc

III. PROBLEM STATEMENT

Fog removal algorithms become more beneficial for numerous vision applications. It has been originated that the most of the existing research have mistreated many subjects. Following are the different research gaps concluded using the literature survey.

1. The presented methods have neglected the techniques to reduce the noise issue which is presented in the output images of the existing fog removal algorithms.
2. Not much effort has focused on the integrated approach of the Adaptive histogram equalization and Dark channel prior.
3. The problem of the uneven illuminate is also neglected by the most of the researchers.

IV. PROPOSED METHODLOGY

HOMOMORPHIC FILTER

PROPOSED WORK

Homomorphic filtering technique is one of the important ways used for digital image enhancement, especially when the input image is suffers from poor illumination conditions. This filtering technique has been used in many different imaging applications, including biometric, medical, and robotic vision. Homomorphic filtering works in frequency domain, by applying a high-pass type filter to reduce the significance of low frequency components.

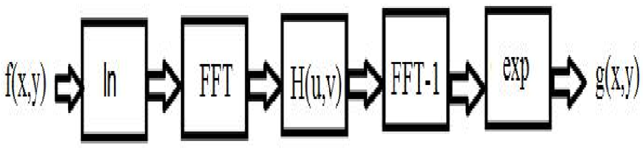

Figure 4.1 Homomorphic filter

Homomorphic filtering technique is one of the important ways used for digital image enhancement, especially when the input image is suffers from poor illumination conditions. Homomorphic filtering works in frequency domain, by applying a high-pass type filter to reduce the significance of low frequency components. By reducing the effect of the dominant illumination components, it became possible for the dynamic range of the display to allow lower intensities to become much more visible [12]. Similarly, because the high frequencies are enhanced by homomorphic filtering, the reflectance components are enhanced by this filter.

V. EXPECTED OUTCOME

We conclude that low pass and high pass filters cannot remove the fog from any types of foggy images. In HSI model fog is removal is done by gamma correction method but it is very time consuming method and result is not satisfactory.

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Homomorphic filter and masking method with histogram equalization can remove the fog that expected result with reduced time.

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