Image Restoration Technique for Fog Degraded Image

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***Abstract* – This Research paper involves Image restoration and Image Enhancement technique which will be used for restoring the clear image from a fog degraded image. Image Restoration is an area that deals with improving the appearance of an image. Restoration techniques tend to be based on mathematical or probabilistic models of image degradation. And Image enhancement is an area which deals with improving the quality measure of image. To improve image quality, image enhancement can selectively enhance and restrain some information about image. It is a method which decreases image noise, eliminate artifacts, and maintain details. Its purpose is to amplify certain image features for analysis, diagnosis and display. The overall objective of this paper is to propose an integrated technique which will integrate the nonlinear enhancement technique with the gamma correction and dynamic restoration technique.**

***Keywords*: Image Restoration, Image Enhancement, Image Degradation.**

I. INTRODUCTION

As per the definition of [1] the field of digital image processing refers to processing digital images by means of a digital computer. It is to be noted that a digital image is composedof a finite number of elements and each of them has a particular location and value. All of these elements are referred as picture elements orimage elements or pels and pixels. Out of all these names pixel is the term most widely used to denote the basic elements of a digitalimage.According to the human senses , vision is the most advanced one, that's why it is not surprising that imagesplay one of the most important role in human knowledge. But unlikehuman beings, those who are limited to the visual band of the electromagnetic (EM) spectrumimaging machines cover almost the whole EM spectrum, which ranges betweengamma and radio waves. All of them can operate on those images which are generated by sources thathumans cannot easily relate with images. These kind of images include ultrasoundelectron microscopy images or computer-generated images. This is primarily due to air-light and attenuation which degrades image quality exponentially with fog depth between the scene and the camera. It is imperative to remove weather effects from images in order to make vision systems more reliable. Research on recovery of image from fog degraded image can be done by two ways – Image Restoration and Image Enhancement. Image restoration is recovering the original image and removing the effect of fog and Image enhancement refers to enhancing the features of image.

Removal of fog is important for the tracking and navigation applications, military purposes and aviation industry. Fog degrades the perceptual image quality. So the computer based algorithms doesn't work properly on those images, because they work on small features or high frequency, which is not clearly defined in fog degraded images [2].

Removal of fog as a pre-processing increases the accuracy of computer vision algorithms. A feature point detector will fail if image have low visibility. If fog is removed and image is enhanced, then feature pointdetector will work with more accuracy and accurate quality measures can be estimated. In image processing, the process of improving the quality of a digitally stored image by manipulating the image with certain methods. Advanced image enhancement techniques also support many filters for altering images in various ways. Programs specialized for image enhancements are sometimes called image digital image filters [10].

In image processing, the process of improving the quality [4] of a digitally stored image by manipulating the image with certain methods and techniques. Advanced image enhancement techniques also support many filters for altering images in various ways. Programs specialized for image enhancements are sometimes called digital image filters [5].

Image enhancement techniques acting as an important part in image processing. Somebody click image from common environment with elevated dynamic range include both dark and bright regions. In outside because of dynamic range of human eyes sensing, those image are not easy to distinguish by human eyes. Image enhancement is a general approach to get enhanced quality measures of those images in terms of human visual observation. There are two techniques for image enhancement one is spatial domain and second is transform domain methods. In spatial domain method [6] an image is enhance by straight dealing with the intensity value in an image. In transform domain enhancement method, transformation of the image intensity data into a specific domain by using different techniques like DFT, DCT, etc. [4].

II.METHODOLOGY

A. Hu and Haan Method

The main origins of blur are objects being out of focus, shadows casted by objects, or objects which are having a physical surface that is perceived as blur. An object that is out of focus will also produce a blur because it is too far away from the focal plane. This already hints to distance or depth of an image. The amount of blur that is in a part of such an image increases with depth. Therefore, if we can estimate the amount of local blur, we can estimate the relative depth.

A method which is straight forward is used for blur estimation is proposed by Hu and Haan (13). In their approach, they reblur the signal to be determined with Gaussian kernels twice, ie. σ_a and σ_b to determine the local blur σ of the signal The signal is convolved with a Gaussian kernel with different standard deviations σ_a and σ_b leading to two signals $b_a(x)$ and $b_b(x)$. To make the blur independent of amplitude and offset, ratio r(x) is computed.

$$\frac{b(x) - b_a(x)}{b_a(x) \; - \; b_b(x)}$$

The difference ratio will now peak where the difference and the reblurred versions is large. This will happen at points where the signal changes significantly in amplitude, exactly the points where the blurring has the most impact. In this local signal, only the point where r(x) is largest is of interest, because it will define σ of the entire area. This is because we assume that locally the blur is the same for that area. Therefore we will apply a maximum filter with a certain window which results in maximum of ratio.

When maximum ratio$\rightarrow$ 0, this shows the largest distinguishable blur of the signal. The relative depth is estimated from the blur [4] [6].

B. Depth Estimation

Depth is an axis of image , which is sometimes known as color depth and this is also known as bit depth, and this depth refers either to the number of bits used to indicate the color of a single pixel, in a bitmapped image or video frame buffer, or the number of bits used for each color component of a single pixel . In video standards, such as High Efficiency Video Coding [18], the bit depth specifies the number of bits used for each color component [4]. When color depth is referred to a pixel the concept can be defined as bits per pixel (bpp), it specifies the number of bits used to represent a single pixel. When referring to a color component the concept of depth can be defined as bits per channel (bpc), bits per color (bpc), or bits per sample (bps) [9]. Color depth is only one aspect of color representation, expressing how finely *levels* of color can be expressed (a.k.a. color precision); the other aspect is how broad a range of colors can be expressed (the gamut). The definition of both color precision and gamut is accomplished with a color encoding specification which assigns a digital code value to a location in a color space[18][1].

A conventional camera captures blurred versions of scene information distant from the plane of focus. Camera systems that are invented that allows not only the recording of all-focus images, or for extracting depth of image, but to record both simultaneously has required more extensive hardware and reduced spatial resolution. for the simultaneous recovery of both (a) high resolution image information and (b) depth information adequate for the extraction which will be semi-automatic in a layered depth representation of the image. The modification within the aperture of the camera lens is creating a coded aperture. A criterion for depth discriminability is use to design the preferred aperture pattern. Using a statistical model of images, both depth information and an all-focus image from single photographs taken with the modified camera can be estimated [7].

Bit depth is the color information stored in an image in a single bit. If the bit depth of an image is higher, then it means more colors it can store. In the simplest image, which will be of 1 bit, can only show two colors i.e. black and white. This is because the 1 bit can only store one of two values either 0 (white) or 1 (black). An 8 bit image can store 256 possible colors, while a 24 bit image can display about 16 million colors [6].

Apart from an image's resolution, the bit depth can also estimate the size of the image. As the bit depth goes increases, the size of the image also increases because large number of color information has to be stored for each pixel in the image [2].

Not only an image has bit depth, even display system also has it. The bit depth of any monitor can be changed by accessing the display properties of the monitor. The bit depth, as well as the resolution, is actually determined by the capabilities of graphics adapter.

When there is any need of calculating the depth of an image, then there are some steps which are needed to be followed.

In this paper the depth of an image will be estimated with the help of estimated value of blurr.

And here is the formula given for estimation of depth:

$$D \approx \frac{F.v_0}{v_0 - f - \sigma.f}$$

Where D is the distance from the lens to the point of interest, v0 the distance between lens and focal plane, F is the focal length, f the aperture number of the lens and σ the Gaussian standard deviation or blur size.Tthis equation for depth estimation will require the complete information of the camera and that is why ths equation is directly used, which is used for capturing the images [4].

C. Adaptive Median Filtering

The application of median filter has been searched.Adaptive Median Filter is an advanced method compared with standard median filtering, which performs spatial processing to preserve detail and smooth non-impulsive noise. Main benefit of this adaptive approach as comparison median filtering is that repeated applications of this Adaptive Median Filter does not disrupt away edges or other small structure of the image.

To understand anything about adaptive median filtering is all about, one needs to understand what a median filter is and what it does. In many different kinds of digital image processing, the basic operation is as follows: at each pixel in a digital image aneighbourhood pixel is placed aroundthat point, analyse the values of all the pixels which are in the neighbourhood according to somealgorithm, and then replace the original pixel's value with one basedon the analysisperformed on the pixels in the neighbourhood. After that the neighbourhood movessuccessively over every pixel in the image, repeating the process.

Median filtering follows this basic prescription. The median filter is normally used to reduce noise in an image, approximately like the mean filter. However, it often does a better job than the mean filter of preserving useful detail in the image. These filters belongs to that class of filters which are used as edge preserving smoothing filters which are non-linear filters. This means that for two images A(x) and B(x):

$$\text{median}[A(x) + B(x)] = \text{median}[A(x)] + \text{median}[B(x)]$$

These filters smooth out the data while without disturbing the small and sharp details of image like edges. The median is just the middle value of all the values of the pixels in the neighbourhood.The median is not very much affected by a small number of discrepant values among the pixels present in the neighbourhood. Concludes that, median filtering is highly effective at removing different kinds of noise.

Instead median filter is a useful non-linear image smoothing and enhancement technique. It also has some disadvantages. The median filter removes both the noise and the fine detail since it can't tell the difference between the two. Anything relatively small in size compared to the size of the neighbourhood will have minimal effect on the value of the median, and will be filtered out. In other words, the median filter can't distinguish fine detail from noise.

Therefore the adaptive median filtering has been applied widely as an advanced method in comparison with standard median filtering. The Adaptive Median Filter performs spatial processing to determine which pixels in an image have been affected by impulse noise. The Adaptive Median Filter classifies pixels as noise by comparing each pixel in the image to its surrounding neighbour pixels. The size of the neighbourhood is adjustable, as well as the threshold for the comparison. A pixel that is different from a majority of its neighbours, as well as being not structurally aligned with those pixels to which it is similar, islabelled as impulse noise. The noise pixels in image are then replaced by the median pixel value of the pixels in the neighbourhood that have passed the noise labelling test.

Purpose

1). Remove impulse noise

2). Smoothing of other noise

3). Reduce distortion, like excessive thinning or thickening of object boundaries

- Adaptive median filter changes size of Sxy (the size of the neighbourhood) during operation.

- Notation

Zmin = minimum gray level value in Sxy

Zmax = maximum gray level value in Sxy

Zmed = median of gray levels in Sxy

Zxy = gray level at coordinates (x, y)

Smax = maximum allowed size of Sxy

- Algorithm

Level A: A1 = Zmed - Zmin

A2 = Zmed - Zmax

if A1 > 0 AND A2 < 0, go to level B

else increase the window size

if window size < Smax, repeat level A

else output Zxy

Level B: B1 = Zxy - Zmin

B2 = Zxy - Zmax

if B1 > 0 AND B2 < 0, output Zxy

else output Zmed

- Explanation

Level A: IF Zmin < Zmed < Zmax, then

• Zmed is not an impulse

(1) go to level B to test if Zxy is an impulse ...

ELSE

• Zmed is an impulse

(1) the size of the window is increased and

(2) level A is repeated until ...

(a) Zmed is not an impulse and go to level B or

(b) Smax reached: output is Zxy

Level B: IF Zmin < Zxy < Zmax, then

• Zxy is not an impulse

(1) output is Zxy (distortionreduced)

ELSE

• either Zxy = Zmin or Zxy = Zmax

(2) output is Zmed (standard median filter)

• Zmed is not an impulse (from level A)

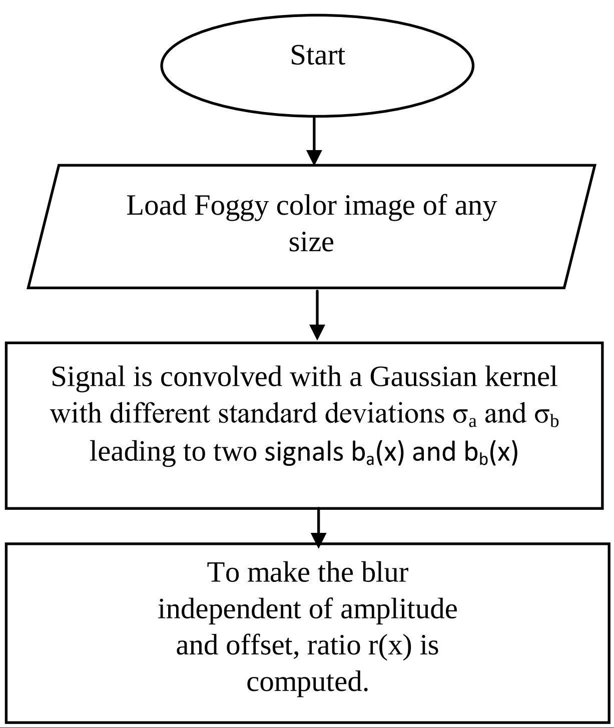
III. PROPOSED ALGORITHM

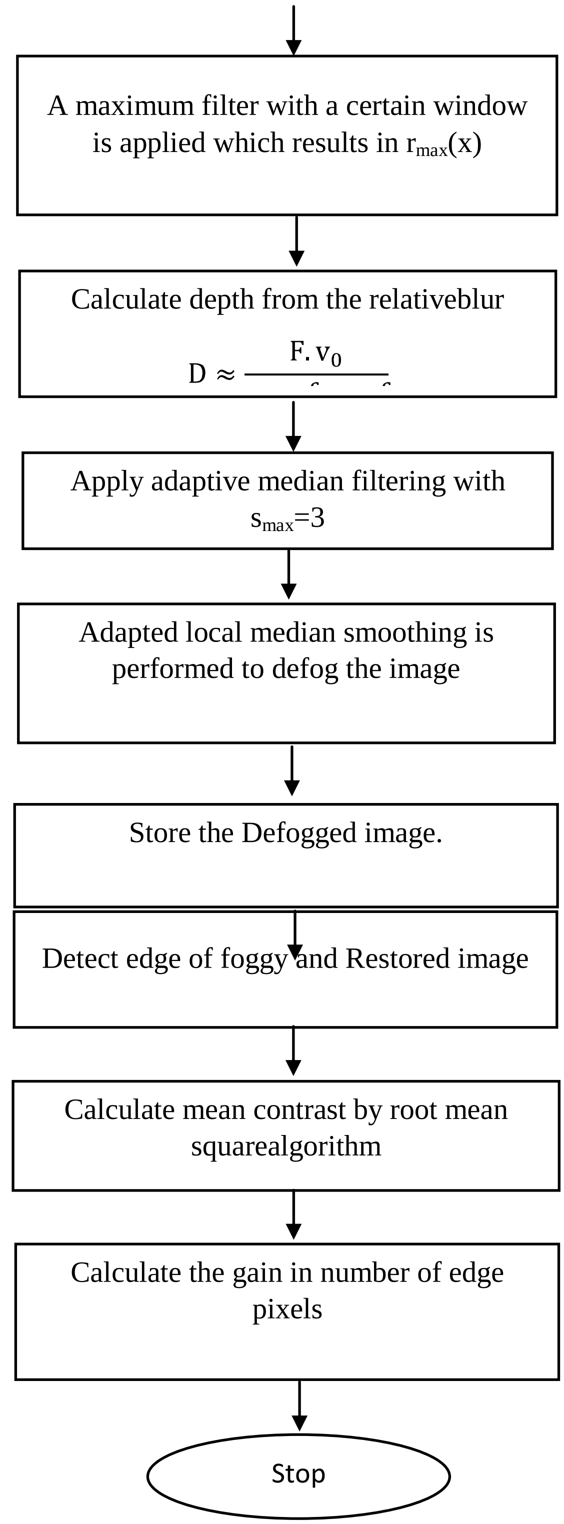
The proposed algorithm have several steps.

The algorithm steps are as follows.

1. Read the input color image.
2. Calculate the blurr of image by Hu and Haan method.
   - Reblur the signal which is to be determined twice with Gaussian kernels σ_a and σ_b.
   - Determine the local blur σ of the signal.
   - The signal is then convolved with a Gaussian kernel with different standard deviations leading to two signals.
   - To make local blur independent of amplitude and offset, ratio is computed.
   - Apply a maximum filter to calculate the maximum ratio.
   - The smallest blur size locally is calculated around the edge.
3. Estimate the absolute depth of image with the help of estimated blurr.
4. Apply depth on image.
5. Apply Adaptive Median Filtering.
6. Calculate the contrast, saturated pixels, number of edge pixels and PSNR of image.

Flow diagram shows the proposed method





IV. RESULTS AND DISCUSSION

In the paper, we are working on color images, we are applying this algorithm on colored image which is blurred and degraded because of fog and hue present in atmosphere, to obtain a restored and clear image. Using a proposed methodology we are trying to obtain better contrast, hue and PSNR value.

A. Contrast

Removal of fog is analyzed qualitatively in image. A Haze-removed image has additional contrast in comparison with the foggy image. Hence, contrast gain can be a parameter for the quantitative analysis of haze removal algorithms. Contrast gain can be described as mean contrast difference between de-foggy and foggy image. Contrast gain for all fog removal algorithms should be positive. High contrast gain indicates better performance of the algorithm. Contrast gain is improved as compared to previous algorithm.

If C_{Idef} and C_{Ifog} are mean contrast of de-foggy and foggy image respectively, then contrast gain is defined as

$C_{gain} = C_{Idef} - C_{Ifog}$

Let an image is of size M*N. then contrast gain is defined by

$$C = \frac{1}{M * N} \sum_{y=0}^{N-1} \sum_{x=0}^{M-1} C(x, y)$$

B. Saturated Pixels

For the count of saturated pixels the hard limits of 0 and 1 are not used because images might often have undergone some kind of transformation such that no pixels ever reach the absolute maximum or minimum of the image format. The noise given typical in images, both high and low measures should be a low percentage but if the images were saturated during imaging. Thesaturation can be calculated by the different color channels.

$$sat=(max(r,g,b)-min(r,g,b))/max(r,g,b)$$

Here, r,g,b refers to the red , green and blue color channels. The Table shows the different format of images according to Parameter and also compares which format and dimensions of images are best for our method.

TABLE I : CONTRAST

Image name	***Original contrast***	***Restored Contrast***
Sweden	0.261	0.482
Village	0.012	0.415
Town	0.012	0.261

TABLE II : SATURATION PIXELS AFTER RESTORATION

Image name	***Saturation value***
Sweden	.1714
Village	0.084
Scene	.0728

TABLE III :NUMBER OF EDGE PIXELS

Image name	***Before Restoration***	***After Restoration***
Scene3	78375	290766
Village	41688	151935
scene	31587	157039

Figure1: Scene3.jpg(Foggy and Restored)

Figure2: Village.jpg (Foggy and Restored)

Figure3: Town.jpg(Foggy and Restored)

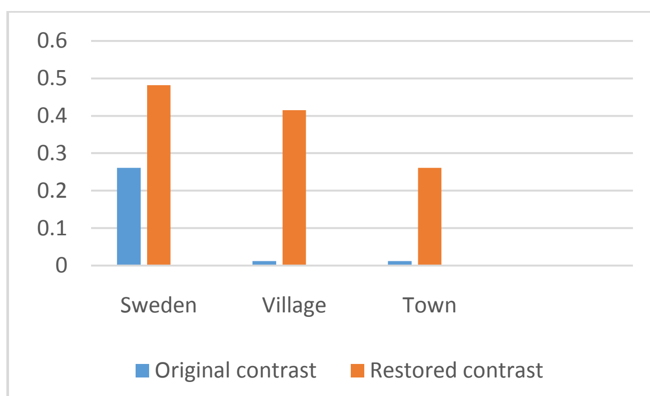


FIGURE 1: Contrast of original and restored image

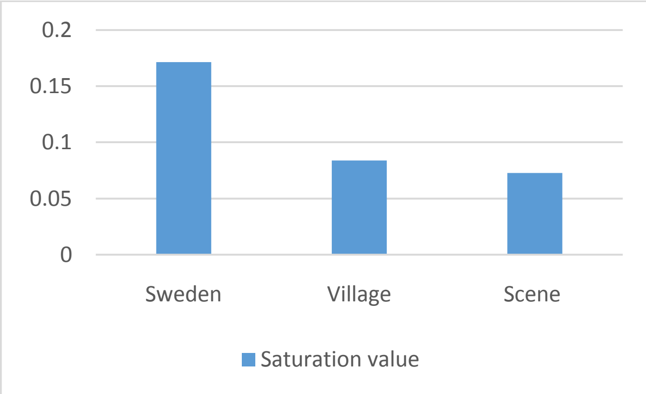


FIGURE 2: Saturation value of restored image with reference of foggy image

Comparative process evaluates that the contrast of Restored image is quite better than the foggy (original) image and Saturation value is too quite good of restored image and since saturation pixels are very less , therefore further processing, enhancement can be done on the resultant image.

V. CONCLUSION

The purpose of this paper is to realize the image to dehaze, proposed a very simple buteffective to dehaze algorithm for foggy images. It improves the image brightness to dehazing image uses the hue values in the field of step brightness as the brightness adjustment factor. The experimental results this paper used a lot of hazy images in different locations to show that, can make dehazed effect of images more ideal, but cannot apply all the hazy images, such as large images. This method is suitable for real-time dehazing for images. For the image 'village' the contrast was 0.012 before restoration and 0.415 after restoration with only 0.084 percentage saturated pixel.

Its fine performance with increase in local contrast and overall sharpness, especially in scenes of poor visibility, make it one of the prime candidate for homeland security and safety duties.

The future Scope of this methodology is that the time will be reduce by some advance technique (neural network, artificial intelligence, fuzzy logic) and the threshold value can be calculated automatically by the different thresholding method. And large size of picture can also be used for restoration by different optimization techniques.

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