iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: II Month of publication: February 2018

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue II, February 2018- Available at www.ijraset.com

Murk Removal and Object Detection in Foggy Image using CLAHE and CURVELET Transform

P.Subathra[1], K. Rajasaranya[2], E.Suresh[3]
[1, 2 ,3]*Department of ECE, Jerusalem College Of Engineering, Chennai.*

***Abstract:** Images taken in poor weather conditions has a high amount of murk and haze in it. It degrades the visibility and clarity of the image. In this project, we propose the technique to enhance the murk image and to detect the object present in it. The enhancement technique used here is Contrast Limited Adaptive Histogram Equalisation (CLAHE). The enhanced image is segmented and the objects are detected using Curvelet Transform. Initially the RGB image is converted to gray scale image. The gray scale image is then filtered using median filter. The filtered image is enhanced using CLAHE. The enhanced image is segmented and the parameters such as Mean, Standard Deviation, Peak Signal to Noise Ratio, Mean Square Error are obtained and based on these parameters Curvelet Transform is applied and the objects are detected.*

I. INTRODUCTION

Murk is a thick cloud of tiny water droplets suspended in the atmosphere which obscures visibility. Diverse weather situations such as murk, smoke, rain or snow will cause multifaceted visual effects of spatial or temporal domains in images or video. Such artifacts may appreciably humiliate the performances of outdoor vision systems relying on image/video feature extraction or visual attention modelling such as event detection, object detection, tracking and recognition, scene analysis and classification, image indexing and retrieval. Images or video bear from lack of quality taken under such conditions, unless the hazy appearance is needed for artistic reasons [8]. By the use of murk removal methods of picture we can improve the stability and strength of the visual framework. First, removing murk can significantly increase the visibility of the scene and correct the color shift caused by the air light [1]. In general, the murk-free image is more visually pleasing. Second, most computer vision algorithms, from low-level image analysis to high-level object recognition, usually assume that the input image (after radiometric calibration) is the scene radiance. The performance of many vision algorithms (e.g., feature detection, filtering, and photometric analysis) will inevitably suffer from the biased and low-contrast scene radiance [6]. A bad hazy image can be put to good use. However, murk removal is a challenging problem because the murk is dependent on the unknown depth. The problem is under constrained if the input is only a single hazy image. Therefore, many methods have been proposed by using multiple images or additional information. Polarization based methods remove the murk effect through two or more images taken with different degrees of polarization. Depth-based methods require some depth information from user inputs or known 3D models. Recently, single image murk removal has made significant progresses. The success of these methods lies on using stronger priors or assumptions. The results are visually compelling but may not be physically valid [6]. In this paper, we propose CLAHE algorithm and Curvelet Transform technique for murk removal and object detection respectively. This paper is organized as follows. The existing model is presented in Section II which is based on dark channel prior and histogram equalization concepts. The proposed model is presented in Section III. The flowchart and its process are described in Section IV. Results and acknowledgements are presented and discussed in Sections V and VI respectively.

II. EXISITING METHODS

With the development of digital image processing technology, video surveillance system had been used widely. The quality of the image depends upon the condition of the weather. Image obtained from the foggy weather condition has low contrast and clarity and the particles in atmosphere cause absorption and scattering which affects the analysis and recognition. Hence removal of fog from the image has high application value. The tradition methods for image degradation use all kind of low filters to get rid of the noise but they are not much effective in foggy images as there are many aerosol molecules in the atmosphere, the diameter of these molecules are bigger than light which affects the strength distribution of the light scatter, so it affects the quality of the image and the contrast of the image is lost [2]

A. Dark Channel Prior Method

It was projected to banish cloudiness from a single image, where the key perception is that most local patches in outside fog free images hold a few pixels whole intensity is low in no less than one shade channel .The low intensity channel are due to three

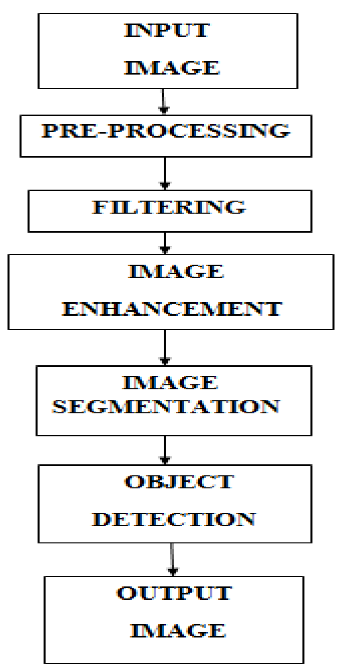
segments - colourful things or surfaces (grass, tree etc), shadows (shadows of structures, auto and so forth), dim things or surfaces (dark tree trunk, stone). As the outdoor pictures are often full of shadows and color, the dark channels of these pictures will be really dark. Due to fog , a haze picture is brighter than its picture without haze .So we can say dim channel of haze image will have higher intensity in area with higher haze [3].The steps of dark channel prior is as follows :
is smaller than a constant and the pixel is one of the top 0.5% brightest pixels in dark channel. N Choosing the max R, G and B values in haze image as the estimated atmospheric light among the haze opaque pixels. If atmospheric light is zero, constant increases and then go to step1 [4].

B. Adaptive Histogram Equalization (Ahe)

AHE is an extension to traditional Histogram Equalization technique. Unlike Histogram equalization HE, it operates on small data regions (tiles), rather than the entire image. The contrast of each region is enhanced, so that the histogram of the output region approximately matches the specified histogram. The neighbouring regions are then combined using bilinear interpolation in order to eliminate artificially induced boundaries. In adaptive histogram equalization, the main idea is to take into account histogram distribution over local window and combine it with global histogram distribution. The size of the neighbourhood region is a parameter of the method. It constitutes a characteristic length scale contrast at smaller scales is enhanced, while contrast at larger scales is reduced. When the image region containing a pixel's neighbourhood is fairly homogeneous, its histogram will be strongly peaked and the transformation function will map a narrow range of pixel values to the whole range of the result image. This causes AHE to over amplify small amounts of noise in largely homogeneous regions of the image [1].

III. PROPOSED MODEL

The proposed model follows contrast limited adaptive histogram equalization for enhancement and curvelet transform for object detection. It consists of four steps.
Step 1: It involves pre-processing techniques where RGB image are converted into gray image.
Step2: The pre-processed gray scale image is filtered using median filter.
Step 3: The filtered image is enhanced using CONTRAST LIMITED ADAPTIVE HISTOGRAM EQUALIZATION (CLAHE).
Step 4: The enhanced image is segmented where parameters such as mean square error, standard deviation, peak signal to noise ratio etc has been extracted from the segmented image and the objects are detected based on those parameters by applying CURVELET TRANSFORM.



Flowchart

A. Pre- processing

The image is pre-processed by following steps:

1) The input image format is calculated.
2) The dimension, length and size of image are calculated.
3) The image is resized to be fit on the screen.
4) The resized RGB image is converted to gray level image for further processing.

B. Median Filtering

Median filtering is a nonlinear method used to remove noise from images. It is widely used as it is very effective at removing noise while preserving edges. It is particularly effective at removing 'salt and pepper' type noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighbouring pixels. The pattern of neighbours is called the "window", which slides, pixel by pixel over the entire image pixel, image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value. 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 belong 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): 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.

C. Clahe

The CLAHE method applies histogram equalization to sub-images. Every pixel of original image is in the foci point of the sub-image. The first histogram of the sub-picture is cut and the cut pixels are redistributed to each gray level. The new histogram is not quite the same as the first histogram on the grounds that the intensity of every pixel is inhibited to a client determined maximum. Consequently, CLAHE can lessen the enhancement of noise.

The various steps of CLAHE method are divided as follows:

Step 1: The original picture should be divided into sub- pictures which are continuous and non-overlapping. The size of each sub-picture is M×N.

Step 2: The histograms of the sub pictures are plotted.

Step 3: The histograms of the sub-pictures are clipped. The number of pixels in the sub-picture is uniformly distributed to each gray level. Then the average number of pixels in each gray level is given as

$Navg = NSI{-}XP * NSI{-}YP$ (1)

$Ngraylevel$

where ,

$Navg$ is the average number of pixels,

$Ngraylevel$ is the number of the gray levels in the sub-picture.

$NSI{-}XP$ is the number of pixels in the x dimension of the sub-picture.

$NSI{-}YP$ is the number of pixels in the y dimension of the sub-picture.

Based on the Eq. (1), the actual clip-limit is calculated as

$NC{-}L = Nc * Navg$ ..... (2)

Where $NC{-}L$ is actual clip-limit.

Nc is the maximum multiple of average pixels in each gray level of the sub-image.

In the original histogram, if the number of pixels is more than Nc then the pixels will be clipped. The number of pixels scattered averagely into each gray level Nd is defined by the total number of clipped pixels NTC as

$Nd = NTC$

$Ngrayscale$

… … (3)

$If\ HSI > NC{-}L$ … … (4)

D. curvelet Transform

The curvelet transform is a multiscale directional transform that allows an almost optimal non adaptive sparse representation of objects with edges .To overcome the missing directional selectivity of conventional two-dimensional (2-D) discrete wavelet transforms (DWTs), a multiresolution geometric analysis (MGA), named curvelet transform was proposed . In the 2-D case, the curvelet transform allows an almost optimal sparse representation of objects with singularities along smooth curves. Unlike the isotropic elements of wavelets, the needle-shaped elements of the curvelet transform possess very high directional sensitivity and anisotropy. Such elements are very efficient in representing line-like edges. The curvelet transform uses angled polar wedges or angled trapezoid windows in frequency domain to resolve directional features. The discrete curvelet transform is very efficient in representing curve-like edges.

Curvelet constructions require a rotation operation and correspond to a partition of the 2-D frequency plane based on polar coordinates. The initial approach of curvelet transform implements the concept of discrete ridgelet transform. Ridgelet based curvelet transform has been successfully used as an effective tool in image denoising, image decomposition , texture classification , image deconvolution , astronomical imaging and contrast enhancement . However, ridgelet based curvelet transform is not efficient as it uses complex ridgelet transform.

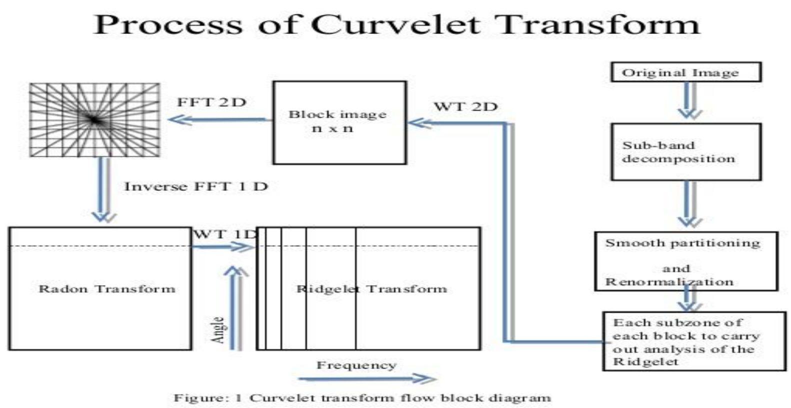


Fig.1 curvelet transform based on rigilet

The newly constructed and improved version of the curvelet transform is known as Fast Discrete Curvelet Transform (FDCT). The new constructed version is faster, simpler and less redundant than the original curvelet transform, which based on Ridgelets. The fast discrete curvelet transform can be implemented in two ways.

Unequally spaced Fast Fourier Transform (USFFT).

Wrapping Function.

Both implementations of FDCT differ mainly in choosing the spatial grid that used to translate curvelet at each scale and angle. Both digital transformations return a table of digital curvelet coefficients indexed by scale, orientation and location parameters. Wrapping based curvelet transform is a multi-scale pyramid which consists of different orientations and positions at a low frequency level. Basically, multi resolution discrete curvelet transform in the spectral domain utilizes the advantages of fast Fourier Transform (FFT).

During FFT, both the image and the curvelet at a given scale and orientation are transformed into the Fourier domain. At the end of this computation process, we obtain a set of curvelet coefficients by applying inverse FFT to the spectral product. This set contains curvelet coefficients in ascending order of the scales and orientations

Step1: Read the input image.

Step2: Select the number of scales and angles as input parameters.

Step3: Apply fast discrete curvelet transform via wrapping function on the input image.

Step4: Apply the inverse curvelet transform.

Step5: Use a morphological filter to extract the objects.

Step6: Return the binary objects back to the original objects

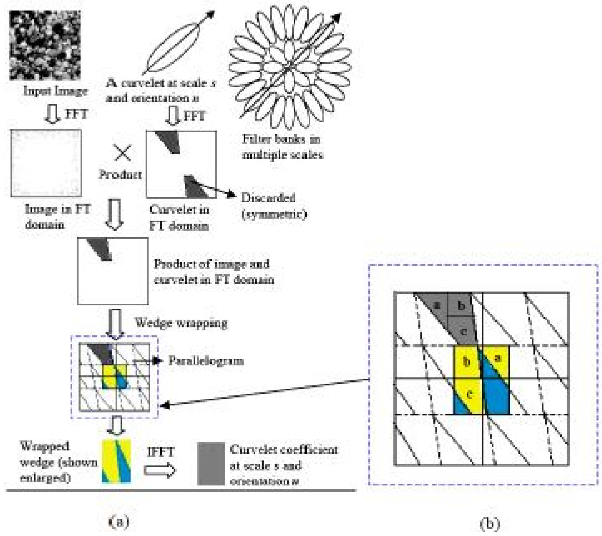


Fig.2 Fast discrete curvelet transform

IV. RESULT

a.Input

b.Pre-processed image

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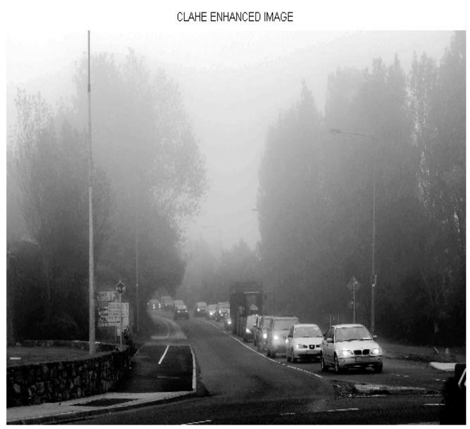
c .filtered image

d.histogram image



e.Enhanced image

V. CONCLUSION

The image Enhancement has become one of the active areas in the field of image processing. In this paper the murk images are filtered using contrast limited adaptive histogram equalization(CLAHE) and objects are yet to be extracted from the murk image based on the curvelet transform. The curvelet transform allows an almost optimal sparse representation of objects with singularities along smooth curves.

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