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Image Restoration of Foggy Images Using Markov Random Field Algorithm.

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Abstract: This paper presents an algorithm to remove fog from a single image using a Markov random field (MRF) framework. 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. This method estimates the transmission map of an image degradation model by assigning labels with a MRF model and then optimizes the map estimation process using k-means technique. The algorithm employs two steps. Initially, the transmission map is estimated using a dedicated MRF model combined with An-isotropic filter. Next, the restored image is obtained by taking the estimated transmission map and the ambient light into the image degradation model to recover the scene radiance. The algorithm is controlled by just a few parameters that are automatically determined by a feedback mechanism. Results from a wide variety of synthetic and real foggy images demonstrate that the proposed method is effective and robust, yielding high contrast and vivid defogging images.

I. INTRODUCTION

IMAGES of outdoor scene often contain haze, fog, or other types of atmospheric degradation caused by particles in the atmospheric medium absorbing and scattering light as it travels from the scene points to the observer. In the robust fog removal, two main characteristics that we notice in a fog image are the decrease of the visibility distance on the image, and the scene blurring due to the loss of high frequency components. 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.

Defogging is an important issue in the field of computer vision. There are many circumstances in which defogging algorithms are needed, such as automatic monitoring systems, automatic guided vehicle systems, outdoor object recognition and visual navigation in low visibility environments, etc.

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 point detector will work with more accuracy and accurate quality measures can be estimated. 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.

The main contribution of this paper can be described as follows:

- A novel MRF-based method is proposed which applies an optimization library to estimate a transmission map. Experiments on both synthetic images and real-world images show the effectiveness of the proposed method. Compared with existing defogging methods, the proposed algorithm can remove fog more thoroughly without producing any halo artefacts, and the colour of the restored images is natural in most cases.

- We extend our proposed method to foggy video applications using a universal strategy, which greatly improves computational efficiency and enhances the visual

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effect. The application of our transmission map, such as fog simulation, is also implemented based on the estimated transmission map.

- The adaptive adjustment of the algorithm's parameters using a defogging effect measurement index is realized in this paper. Thus, a static, open loop parameter estimation issue is transformed into a dynamic parameter adjustment issue. In addition, the performance of the defogging algorithms is effectively measured using appropriate qualitative and quantitative evaluations.

II. PREVIOUS WORKS

Given the importance of defogging algorithms, many studies on defogging have been conducted. Previous defogging research can be divided into two categories: image enhancement methods and image restoration methods [1]. Image enhancement methods tend to increase the dynamic range and contrast of images degraded by fog. Classic image enhancement algorithms include histogram equalization and a Retinex algorithm. Image restoration methods cover the intrinsic luminance of an object using additional information or prior information. Representative algorithms include the dark channel algorithm [2] and the fast filter algorithm [3]. The dark channel algorithm [2] is recognized as one of the most effective ways to remove fog. The algorithm estimates the transmission map of each patch as the minimum color component within that patch and employs a soft matting algorithm to refine the map. The fast filter algorithm [3] has been proven to be faster than most other algorithms for outdoor scenes. The algorithm uses a fast median filter to infer the atmospheric veil and further estimate the transmission map. The main advantage of this method is its speed. However, The defogging algorithm in [2] is based on an image prior- dark channel prior, which is a kind of statistics of FOG free outdoor images, and the dark channel prior will be invalid when the scene objects are inherently similar to the ambient light and no shadow is cast on them; in addition, the defogging method in [3] is unable to remove the fog between small objects and the colour of the scene objects is unnatural for some situations.

Tarel proposed a bilateral filter to replace the optimization method, which improves the efficiency of algorithm and can be used in real-time system [4]. But the defogging result is not so good when there are discontinuous in the depth of scene. The haze among gaps cannot be removed.

Tripathi proposed the algorithm that uses anisotropic diffusion theory to recover scene contrast, and then they conducted a post-processing for the contrast enhancement like histogram equalization, and histogram specification [5].

Graphical models (GMs) are probabilistic models combining probability with a graph, and comprise an important means for solving this problem. Such models can be divided into two categories: directed graphs and undirected graphs. Generally, a directed GM is a Bayesian network (BN) when the graph is acyclic, meaning there are no loops in the directed graph. The relationships in a BN can be described by local conditional probabilities [4]. In [5, 6], a Bayesian defogging method that jointly estimates the scene depth from a single foggy image is introduced by leveraging their latent statistic structure. Christo Ananth et al. [7] proposed a method in which the minimization is per-formed in a sequential manner by the fusion move algorithm that uses the QPBO min-cut algorithm. Multi-shape GCs are proven to be more beneficial than single-shape GCs. Hence, the segmentation methods are validated by calculating statistical measures. The false positive (FP) is reduced and sensitivity and specificity improved by multiple MTANN.

III. MARKOV RANDOM FIELD (MRF)

A Markov random field is a probabilistic model defined by the local conditional probabilities. Consider the discrete 2-D random fields defined over a finite M*N rectangular lattice of pixels. Consider a set of sites,

$$S= \{(i,j) \mid 1\leq i\leq M, 1 \leq j \leq N\}$$

Firstly, a definition of a neighborhood system on lattice S and the associated cliques is given. A neighborhood system is used to relate the pixels in S. A neighborhood system over S is defined as

$$N= \{N_t \mid \text{for all } t \in S\}$$

Where N_t is the neighboring sites of pixel t, i.e., a neighborhood of pixel t. The neighborhood system has the following properties:

- A pixel is not neighboring to itself
- The neighboring relationship is mutual.

In image modeling, a hierarchically ordered sequence of neighboring systems is most commonly used. In the first-order neighborhood system, every pixel has four neighbors.

MRF was introduced into the image processing field in the mid-1980s and was widely used in low-level computer vision problems. Markov random field (MRF) image models are popular in application to image reconstruction problems like deconvolution, denoising, interpolation, segmentation, etc. MRF models are flexible in finding the expected solution constraints derived from available a priori information. This information which is expressed in the form of Gibbs priors, can be used in a Bayesian framework to derive a posteriori probability which accounts for both data consistency and the a priori constraints. The solution is usually calculated as the maximizer of this posterior probability (maximum a posteriori (MAP) estimate) or, as the minimizer of the associated posterior energy.

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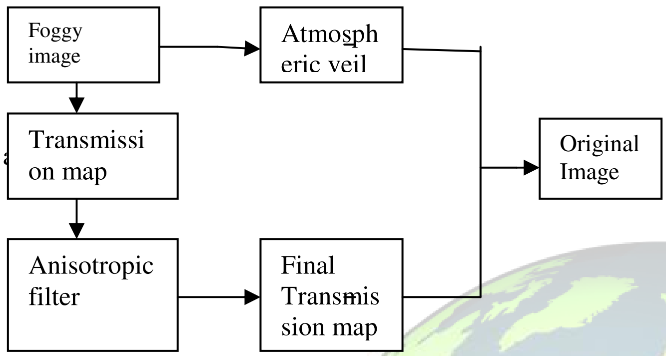
IV. PROPOSED ALGORITHM



In the proposed algorithm, the foggy images from the camera is given as an input and the scene depth of the image is calculated and the transmission map of the foggy image is calculated and then the output of the mapped image is given as an input to the anisotropic filter.

The filtered output is once again mapped using transmission map and by using mapped image and atmospheric veil calculation, a degradation model is formed. The original image is restored from the degradation model.

III.ESTIMATING PARAMETERS

The parameters which have to be calculated in the restoration of foggy images are

A. *Ambient light estimation*

Estimating ambient light A should be the first step in restoring the foggy image. To estimate the ambient light, three distinctive features of the sky region are considered here, which is a more robust approach than that of the 'brightest pixel' method. The distinctive features of the sky region are: (i) a bright minimal dark channel, (ii) a flat intensity, and (iii) an upper position. For the first feature, the pixels that belong to the sky region should satisfy $Imin(x) > Tv$, where Imin(x) is the dark channel and Tv is 95% of the maximum value of Imin(x). For the second feature, the pixels should satisfy the constraint $Nedge(x) < Tp$ where Nedge(x) is the edge ratio map and Tp is the flatness threshold. Due to the third feature, the sky region can be determined by searching for the first connected component from top to bottom. Thus, the atmospheric light A is estimated as the maximum value of the corresponding region in the foggy image I(x).

B. *Transmission Map Estimation*

In this section, we present the outdoor geometry that is used in the transmission map estimation of the proposed algorithm. Light passing through a scattering medium is attenuated and distributed in other directions. This can happen anywhere along the path and leads to a combination of radiances incident towards the camera.

Formally, to express the relative portion of light that managed to survive passage along the entire path between the observer and a surface point within the scene, the defined transmission map ti combines the geometric distance d and the medium extinction coefficient β (the net loss from scattering and absorption) into a single variable

$$t=e^{-\beta d}$$

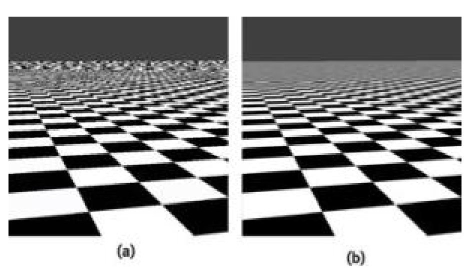
According to (2), the following outdoor geometry is reasonable: assuming that β is constant over the image, the variations in transmission are due to the distance d between the scene point and the camera such that, the greater the distance, the lower the intensity in the transmission map. For most outdoor images, an object which appears closer to the top of the image is usually further away. Thus, the distance along the ground to the object is a monotonically increasing function of the image plane height, which starts from the bottom of image going up to the top. For example, from Figure 3(a) one can clearly see that the distance between the scene point R and the camera is smaller than that between scene point S or T and the camera.

Transmission map estimation is the most important step for image defogging. Here, we use the graph cut-based α expansion method to estimate the map t(x), as it is able to handle regularization and optimization problems, and has a good track record in energy minimization.

IV.AN-ISOTROPHIC FILTER

Anisotropic filtering (abbreviated **AF**) is a method of enhancing the image quality of textures on surfaces of computer graphics that are at oblique viewing angles with respect to the camera where the projection of the texture.

Like bilinear and trilinear filtering, anisotropic filtering eliminates aliasing effects, but improves on these other techniques by reducing blur and preserving detail at extreme viewing angles.



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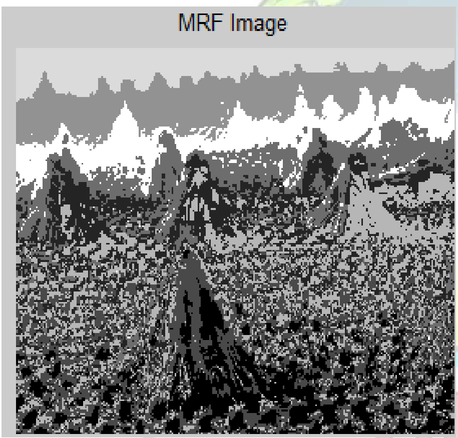

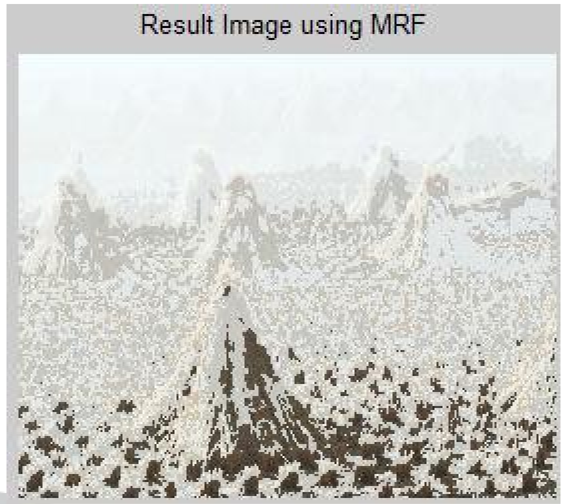

CONCLUSION:

We have shown our performance of fog removal using the MRF based technique. We have shown our performance through the image which is mentioned above. Here we are using the MRF function for transmission mapping and anisotrophic filter for image enhancement and the degradation model is to be found using that, which is in progress.

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