ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

A Survey on Single Image Dehazing for Robust Image Matching

Waman Kumar Gangber[1], Mrs. Urmila S. Soni[2]

ME Student, Dept. of ECE, Chhattrapati Shivaji Institute of Technology, Durg, Chhattisgarh, India[1]

Associate Professor, Dept. of ECE, Chhattrapati Shivaji Institute of Technology, Durg, Chhattisgarh, India[2]

ABSTRACT: The visibility of images of outdoor scenes is degraded by bad weather conditions. Atmospheric phenomena like haze and fog reduce significantly the visibility of the captured image. Haze is the atmospheric phenomenon that dims the clarity of an observed scene due to the particles such as smoke, fog, and dust. Due to these atmospheric particles there is a significant degradation in the color and contrast of the captured image in the bad weather conditions. Therefore it becomes difficult to detect the objects in the captured hazy images or scenes. The goal of dehazing or we can say defogging is to enhance the contrast of the hazy images and restores the visibility of the scene. Single image dehazing method recovers the scene information based on the prior information from a single image and becomes more and more researcher's interest. Image matching plays an important role in many remote sensing applications such as change detection, cartography using imagery with reduced overlapping, fusion of images taken with different sensors. Outdoor and aerial images that are subjected to the process of matching, are often degraded by the atmospheric phenomenon of haze. Inorder to perform image matching , the valid corresponding feature points in both images is to be found out. To fulfil this purpose feature point detectors and descriptors are used. Local feature point detectors extract the interest points from images. Descriptor can be used to uniquely identify the found interest points and match them even under a variety of disturbing conditions like scale changes, rotation, changes in illumination or viewpoints or image noise. This literature also gives a description of various local feature detectors and descriptors which are used to detect and describe the local feature points for matching.

KEYWORDS: Single image dehazing; Contrast enhancement; Transmission map; Image matching; Local feature detectors and descriptors.

I. INTRODUCTION

The visibility of images of outdoor scenes is degraded by bad weather conditions. Atmospheric phenomena like haze and fog reduce significantly the visibility of the captured image. This type of degradation in visibility of images is known as hazing effect. To remove effect of haze and enhancing the visibility of image is very challenging task in the area of image processing. Since the aerosol is misted by additional particles, the reflected light is scattered and as a result, distant objects and parts of the scene are less visible, which is characterized by reduced contrast and faded colors. In almost every practical scenario the light reflected from a surface is scattered in the atmosphere before it reaches the device because aerosols such as dust, mist, and fumes deflect light from its original course of propagation.

Haze removal (or dehazing) is highly desired in both consumer/computational photography and computer vision applications and has been a challenging task especially when only a single degraded image is available. Dehazing or defogging is the strategy to enhance images degraded by bad weather condition. The first dehazing approaches employ multiple images of same scene taken from different weather condition. This approach requires additional information such as depth map and specialized hardware. But these strategies are limited to offer a reliable solution for dehazing problem because unavailability of such additional information to the users. The second approach is single image dehazing approach.This method only requires a single input image. This method relies upon statistical assumptions and or the nature of the scene and recovers the scene information based on the prior information from a single image.Therefore most constraint-based defogging methods from a single image are computationally too demanding to fulfil the requirement of a wide range of practical applications.Several single image based techniques have been

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

introduced in this paper. In general these techniques can be divided in two major classes: physically based and contrast-based techniques.

If two or more images of same scene are given, then the process of image matching requires to find valid corresponding feature points in images. For the purpose of image matching, feature point detectors and descriptors are used. Local feature point detectors extract the interest points from images. Descriptor can be used to uniquely identify the found interest points and match them even under a variety of disturbing conditions like scale changes, rotation, changes in illumination or viewpoints or image noise. These matches represent projections of same scene locations in corresponding image. Images for matching are taken at different times, from different sensors/cameras and viewpoints. Therefore image matching is a challenging task. Image matching plays a crucial role in many remote sensing applications such as change detection, cartography using imagery with reduced overlapping, fusion of images taken with different sensors. Nowadays, the task of image matching is done automatically. It is due to progress of local feature point detectors and descriptors. Many local feature point operators have been introduced. Recent local feature operators are invariant to image transformations such as geometric (scale,rotation,affine) and photometric.

SIFT (Scale Invariant Feature Transform) and SURF (Speeded up Robust Feature) are most common algorithms which have been using for image matching. Local feature points (keypoints or interest points) are used for matching images due to their impresive robustness and invariance to different transformations. Typically, the framework of matching images based on local keypoints consists on three main steps. First, the local feature points are extracted from an image based on their neighborhood information. In general the keypoints are those locations of images with important variation in their immediate neighborhoods. The second step is to compute descriptors (signatures) based on the neighbor regions of the keypoints. Different techniques, which describe nearby regions of feature points, considers in general color, structure, and texture. The main goal of them is to increase the distinctness of the extracted feature points to improve the efficiency and to simplify the matching process. Finally, the signature vectors of extracted keypoints are compared using some metrics (e.g., Euclidean distance, earth movers distance) or derived strategies that are based on such distances.

II. SINGLE IMAGE DEHAZING METHODS

2.1 Physically based technique

Physically based techniques restore the hazy images based on the estimated transmission (depth) map.

2.1.1 Independent Component Analysis

Independent component analysis is a statistical method to separate two additive components from a signal. This method assumes that the transmission and surface shading are statistically uncorrelated in local patch. In [14] Fattal proposed a single image dehazing method which produced a haze free image from the hazy image. Fattal formulated the refined image formation model that relates to the surface shading and the transmission function. Fattal grouped the pixel belonging to the same surface having the same reflectance and the same constant surface albedo. The basic key idea of his work is to resolve the airlight albedo ambiguity and assuming that the surface shading and the scene transmission are uncorrelated. This approach is physically valid and can produce good results, but may be unreliable because it does not work well for dense haze.

a) Hazy image b) Dehazed image

Fig.1. Independent component analysis

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

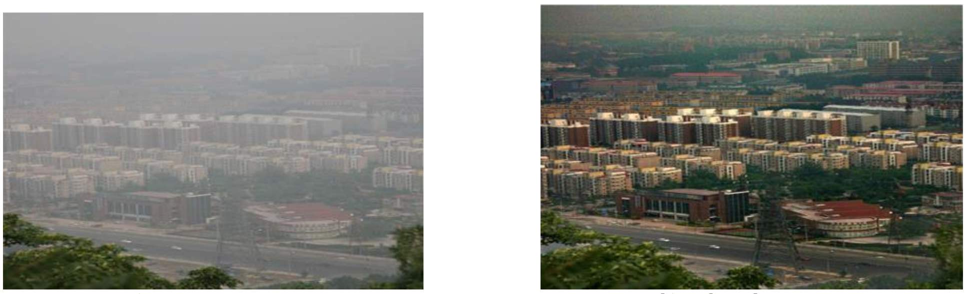
International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

2.1.2 Dark channel prior

In [8] He et al. dark channel prior is based on the prior assumption is basically used for single image dehazing process. This dark channel prior is based on the statistic approach of the outdoor haze free image. It has been observed that in most of the local regions which do not cover the sky, some pixels have very low intensity in at least one colour (RGB) channel and these pixels are known as the dark pixels. In hazy images the intensity of the dark pixels in that colour channel is basically contributed by the airlight and these dark pixels are used to estimate the haze transmission. After estimation of the transmission map for each pixel, combining with the haze imaging model and soft matting technique to recover a high quality haze free image. The dark channel prior does not work efficiently when the surface object is similar to the atmospheric light.



a) Hazy image b) Dehazed image

Fig.2. Dark channel prior

2.1.3 Bayesian probabilistic

In [5] Nishino et al. employs a Bayesian probabilistic model. Their key approach is to model the image with a factorial Markov random field(FMRF) in which the scene albedo and depth are two statistically independent latent layers and to jointly estimate them. They derive a novel joint estimation method based on a Bayesian formulation to factorize a single foggy image into its scene albedo and depth. They exploit natural image and depth statistics as priors on these hidden layers and estimate the scene albedo and depth with a canonical expectation maximization algorithm and resolving bilinear ambiguity.

a) Hazy image b) Dehazed image

Fig.3. Bayesian probabilistic

2.2 Contrast based technique

Contrast-based techniques enhance the hazy images without estimating the depth information. Contrast based techniques enhance visibility of images by restoring the contrast of degraded imges.

In [3] Ancuti et al. described that the haze is the atmospheric phenomenon which degrades the visibility of the outdoor images captured under bad weather conditions. This paper describes the dehazing approach for a single input image. This approach is based on the fusion strategy and it has been derived from the original hazy image inputs by applying a white balance and contrast enhancing procedure. The fusion enhancement technique estimates perceptual based qualities known as the weight maps for each pixel in the image. These weight maps control the contribution of each input to the final obtained result. Different weight maps like luminance, chromaticity and saliency are computed and to minimize the artifacts produced during the weight maps, the multi-scale approach uses the laplacian pyramid representations combination with gaussian pyramids of normalized weights. As this approach tries to minimize the

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

artifacts per pixel based has a greater improvement rather than considering a patch based method due to the assumption of contrast airlight in the patch.

a) Hazy image

b) Dehazed image

Fig.4. Contrast based method

In [13] Robby T. Tan has introduced an automated method that only requires a single input image. Two observations are made based on this method, first, clear day images have more contrast than images afflicted by bad weather; and second, airlight whose variant mostly depends on the distance of objects to the observer tends to be smooth. Tan develops a cost function in the framework of Markov random fields based on these two observations. The results have larger saturation values and may contain halos at depth discontinuities.

In [11] Tarel et al. have demonstrated algorithm for visibility restoration from a single image that is based on a filtering approach. The algorithm is based on linear operations and needs various parameters for adjustment. It is advantageous in terms of its speed. This speed allows visibility restoration to be applied for real-time applications of dehazing. They also proposed a new filter which preserves edges and corner as an alternate to the median filter. The restored image may be not good because there are discontinuities in the scene depth.

In [1] Ancuti and Ancuti presented a novel strategy to enhance images degraded by the atmospheric phenomenon of haze. This single-based image technique does not require any geometrical information and restoring the visibility of hazy image by enhancing the contrast of the degraded image. The degradation of the finest details and gradients is constrained to a minimum level. Using simple formulation that is derived from the lightness predictor contrast enhancement technique, restore lost discontinuities only in regions that insufficiently represent original chromatic contrast of the scene. The parameters of simple formulation are optimized to preserve the original colour spatial distribution and the local contrast. They compare their technique with Tarel and Hautiere (2009) by matching local feature points of hazy image and dehazed image. More number of good matches represents the efficiency of technique.

III. LOCAL FEATURE DETECTORS AND DESCRIPTORS

This section gives an overview of various feature detectors.

In [26] Mikolajczyk et. al compare the performance of descriptors computed for interest regions which are extracted with scale and affine-invariant detection techniques. It is said that the descriptors should be distinctive, robust to changes in viewing conditions and errors of the detector. Here descriptors such as shape context, steerable filters, PCA-SIFT, differential invariants, spin images, SIFT (Scale Invariant Feature Transform), complex filters, moment invariants and cross correlation are compared. Also an extension of SIFT descriptor called GLOH (Gradient Location-Orientation Histogram) has been proposed. GLOH is designed to increase the robustness and distinctiveness of existing SIFT. It is shown that the proposed method, performs in a better way compared to original method.

In [25] Bay et. al describeded a fast interest point detector and descriptor called SURF (Speeded Up Robust Features). It is scale and rotation invariant. SURF is considered important in terms of speed. Speed gain is achieved due to the use of integral images. It is shown that integral images drastically reduce the number of operations for simple box convolutions. SURF is based on the sums of Haar wavelet components. It is shown that SURF outperforms the

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

state-of-art methods with respect to repeatability, distinctiveness and robustness. It is also shown that, the laplacian-based indexing strategy makes the matching step faster without any loss in terms of performance.

In [24] Tuytelaars et. al presented an overview of local invariant feature detectors. According to author, a function is invariant under a certain family of transformations, if its value does not change when a transformation from this family is applied to its argument. The author also defines the properties of ideal local feature detectors such as repeatability, distinctiveness, locality, quantity, accuracy and efficiency. The author organizes feature detectors based on the type of image structures they extract. Feature detectors are classified as corners, blobs and regions.

In [23] Mukherjee et. al presented an algorithm for the extraction of interest points in hyperspectral images. This paper has presented an extension of the SIFT detector that was proposed by Lowe for scalar images to vector images such as multispectral/hyperspectral images.The approach takes the vectorial nature of the hyperspectral images into account. The multiscale representation of the image is generated by vector nonlinear diffusion, which leads to improved detection, because it better preserves edges in the image as opposed to Gaussian blurring, which is used in Lowe's original approach. Experiments with hyperspectral images of the same and different resolutions that were collected with the Airborne Hyperspectral Imaging System (AISA) and Hyperion sensors are presented. Evaluation of the proposed approach using repeatability criterion and image registration is carried out.

IV. CONCLUSION

This paper presented several dehazing approaches, local feature detectors and descriptors which are mostly used for dehazing of image and extracting local feature points from images. A hazy image is characterized by an important attenuation of color that depends proportionally by the distance to the scene objects. As a result, the original contrast is degraded and the scene features gradually fades as they are far away from the camera sensor. From this survey it is clear that contrast based single image dehazing technique is more efficient in dehazing single degraded image. Contrast enhancement technique is simple because it restores lost discontinuities only in regions that insufficiently represent original chromatic contrast of the scene. The process of image matching requires to find valid corresponding feature points in images. Local feature point detectors extract the interest points from images. Descriptor is used to uniquely identify the found interest points and match them even under a variety of disturbing conditions like scale changes, rotation, changes in illumination or viewpoints or image noise. SIFT (Scale Invariant Feature Transform) and SURF (Speeded up Robust Feature) are most common algorithms which have been using for image matching. Among the local feature detectors and descriptors, it can be seen that scale and rotation invariant detector and descriptor coined SURF (Speeded Up Robust Features) performs efficiently. The drawback of SIFT(Scale Invariant Feature Transform) is its high dimensionality at matching step. It is slow. SURF relies on the idea of integral images to obtain a fast approximation of Hessian matrix. The matching step is made faster by utilizing the laplacian based indexing strategy. Therefore in future, the dehazing technique can be used to dehaze hazy pair of images which further results in increasing the feature points for matching that are extracted using SURF.

REFERENCES

1. Cosmin Ancuti and Codruta O. Ancuti, "Effective Contrast-Based Dehazing for Robust Image Matching" IEEE Geoscience And Remote Sensing Letters, Vol. 11, No. 11, 2014.
2. Ruchika Sharma and Dr. Vinay Chopra, "A Review on Different Image Dehazing Methods" International Journal of Computer Engineering and Applications, Volume VI, Issue III, 2014.
3. C. O. Ancuti and C. Ancuti, "Single image dehazing by multiscale fusion" IEEE Trans. Image Process., vol. 22, no. 8, pp. 3271–3282, 2013.
4. Khitish Kumar, Gadnayak Pankajini and Panda Niranjan Panda, "A Survey on Image Dehazing Methods" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 10, 2013.
5. K. Nishino, L. Kratz, and S. Lombardi, "Bayesian defogging" Int. J. Comput. Vis., vol. 98, no. 3, pp. 263–270, 2012.
6. Long, Jiao, Zhenwei Shi and Wei Tang, "Fast haze removal for a single remote sensing image using dark channel prior", International Conference on Computer Vision in Remote Sensing (CVRS), pp. 132-135, 2012.
7. Tripathi, and S. Mukhopadhyay, "Single image fog removal using anisotropic diffusion", Image Processing, Vol. 6, no. 7, pp. 966-975, 2012.
8. K. He, J. Sun, and X. Tang, "Single image haze removal using dark channel prior" IEEE Trans. Pattern Anal. Mach. Intell., vol. 33, no. 12, pp. 2341–2353, 2011.
9. C. Ancuti, C. O. Ancuti, and P. Bekaert, "Enhancing by saliency-guided decolorization" in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., pp. 257–264, 2011.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 9, September 2015

10. Xie, Bin, Fan Guo, and Zixing Cai, "Improved single image dehazing using dark channel prior and multi-scale Retinex" Intelligent System Design and Engineering Application (ISDEA), International Conference Vol. 1. IEEE, 2010.
11. J.-P. Tarel and N. Hautiere, "Fast visibility restoration from a single color or gray level image" in Proc. IEEE Int. Conf. Comput. Vis., pp. 2201–2208, 2009.
12. T. Treibitz and Y. Y. Schechner, "Polarization: Beneficial for visibility enhancement?" in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., pp. 525–532, 2009.
13. R. T. Tan, "Visibility in bad weather from a single image" in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., pp. 1–8, 2008.
14. R. Fattal, "Single image dehazing" ACM Trans. Graph., vol. 27, no. 3, p. 72, 2008.
15. N. Hautiere, J.-P. Tarel, D. Aubert, and E. Dumont, "Blind contrast enhancement assessment by gradient ratioing at visible edges" J. Image Anal. Stereol., vol. 27, no. 2, pp. 87–95, 2008.
16. J. Kopf, B. Neubert, B. Chen, M. Cohen, D. Cohen-Or, O. Deussen, M. Uyttendaele, and D. Lischinski, "Deep photo: Model-based photograph enhancement and viewing" ACM Trans. Graph., vol. 27, no. 5, p. 116, 2008.
17. N. Hautiere, J.-P. Tarel, and D. Aubert, "Towards fog-free in-vehicle vision systems through contrast restoration" in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., pp. 1–8, 2007.
18. A. Wong and D. A. Clausi, "ARRSI: Automatic registration of remotesensing images," IEEE Trans. Geosci. Remote Sens., vol. 45, no. 5, pp. 1483–1493, 2007.
19. S. G. Narasimhan and S. K. Nayar, "Contrast restoration of weather degraded images" IEEE Trans. Pattern Anal. Mach. Intell., vol. 25, no. 6, pp. 713–724, 2003.
20. S. Narasimhan and S. Nayar, "Chromatic framework for vision in bad weather" in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., pp. 598–605, 2000.
21. Afthab Baik K.A and Beena M.V., "Comparative Study Of Various Dehazing Approaches, Local Feature Detectors And Descriptors" International Journal of Engineering Technology Science and Research, Volume 2, Issue 2, 2015.
22. P M Panchal, S R Panchal and S K Shah, "A Comparison of SIFT and SURF" International Journal of Innovative Research in Computer and Communication Engineering Vol. 1, Issue 2, 2013.
23. L. P. Dorado-Muoz, M. Vlez-Reyesa, A. Mukherjee, and B. Roysam , "A vector sift detector for interest point detection in hyperspectral imagery," IEEE Trans. Geosci. Remote Sens., vol. 50, no. 11, pp. 4521–4533, 2012.
24. T. Tuytelaars and K. Mikolajczyk , "Local invariant feature detectors: A survey," Found. Trends Comput. Graph. Vis., vol. 3, no. 3, pp. 177–280, 2008.
25. H. Bay, T. Tuytelaars, and L. Van Gool , "SURF: Speeded up robust features," in Proceedings of the European Conference on Computer Vision, pp. 404–417, 2006.
26. K. Mikolajczyk and C. Schmid , "A performance evaluation of local descriptors," IEEE Trans. Pattern Anal. Mach. Intell., vol. 27, no. 10, pp. 1615–1630, 2005.