Rain Removal in the Images Using Bilateral Filter

Selvarasu Ranganathan
Professor
School of Electrical Engineering and Computing
Adama science and Technology University
Adama
E-mail: selvarasu.ranganathan@astu.edu.et

Abstract

Rain removal in the image is the challenging task. The rain removal image is useful for the crime scene analysis to identify crime. In this study a novel method is used for rain removal in images using bilateral filter is discussed. Initially, the input rain images are given to rain histogram for the enhancement. Then the bilateral filtering is applied to remove the rain water areas. Then the streak of the rain image is removed. The rain region and non rain regions are separated. Finally the rain removed is obtained. The experimental result shows the performance of the proposed system using bilateral filter.

Keywords: Rain Removal Images, Bilateral Filter, Rain Streak, Rain Region Removal

1. Introduction

Rain removal using rain map for consumer imaging applications is described in [1]. The input rain video is given to rain map estimation to estimate the process. Then the rain map refinement is made. Finally the rain streaks are removed to form derained video. Effective single image rain removal algorithm for contrast restoration is described in [2]. At first, the low pass filter is applied to input images. Then the approximate low frequency rain streaks are extracted. Then the detailed layer is connected to convolution neural network to pertain the de rained area.

Single image rain removal for exploiting image structural similarity is described in [3]. The incremental learning dictionary is taken for the input rain images. Structural similarity of the image is calculated. The rain and non-rain dictionary atoms are learned to form clear image. Single image rain removal for context aware is described in [4]. The bilateral filtering is applied to the input rain water images, then the constrained segmentation and categorization technique is applied. Then the configuration is mapped for the content category configuration. The high frequency component is taken. Then the context aware image decomposition and rain pattern removal is used to remove rain components.

Pure rain dictionary learning for single rain removal model for image is discussed in [5]. The propagated filtering is applied for the input rainy image. Then the low frequency and high

frequency components are separated and extracted. Then the rain streaks are detected by pure rain dictionary learning. Then the sparse reconstruction is applied to get rainy mask. Then the improved bilateral filter is applied for the de rained high frequency components to get restored image. Single image rain streaks removal for tensor based low rank model is described in [6]. The input rain images are given to stack of rain patches in the direct smooth of rain patches. The tensor nuclear normalization is regularized with the low-rankness and alternating direction method of multipliers for the model. This experiment shows the state-of-art methods for the quantitative analysis.

Single color image snow removal for hierarchical approach for rain or snow is described in [7]. The input rain or snow images are given to dictionary learning for classification and reconstruction. The guided and mean filter is applied for the image to recognize the rain. Learned rain dictionary based rain removal using sparse codes is discussed in [8]. The input rain image is given to shrinkage strategy, and then the database is constructed by masked rain. The offline dictionary learning method is also used. Shrinkage map design is also used for clearing the rain water in the image. The rain and non-rain sparse codes are shrinkage to obtain the rain removal images.

A novel method for removal of rain water in the images is presented. The paper is organized as follows: Section 2 describes the Methods and materials used for rain removal in images. The experimental results of rain water removal in images are shown in section 3. The last section concludes the proposed system.

2. Methodology

Initially the input rain images are enhanced by rain histogram method. The bilateral filtering is applied to remove the rain water regions. The rain streak removal is used to separate the rain and non-rain areas. Finally the rain removed image is obtained Figure 1 shows the work flow of rain removal images using bilateral filter.

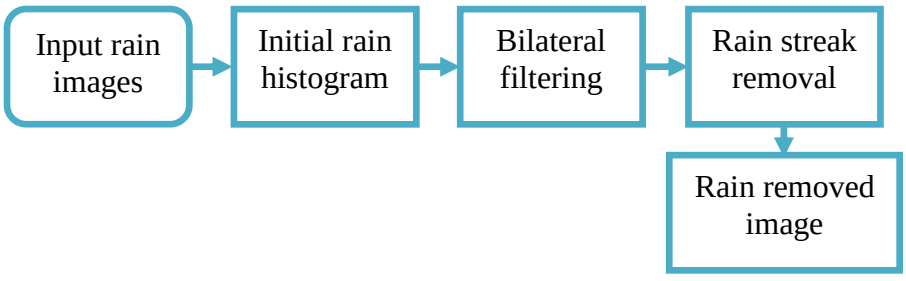

Figure 1 Work flow of rain removal images using bilateral filter

2.1. Rain Removal using bilateral filtering

The noise reducing smoothing filter, edge preserving and non-linear filter used in images is known as bilateral filter. The weighted average of intensity values are replaced by each pixel. Gaussian distribution is used for weight. The Euclidean distance of the pixels depends on the weights and radiometric differences. The sharp edges are preserved by it. The bilateral filter is defined by,

$$BI_{filter}(v)=\frac{1}{z_c}\sum_{v_j\notin\zeta} BI(z_j)g_r\left(\left\|BI(v_j)-BI(v)\right\|\right)f_s\left(\left\|z_j-z\right\|\right) \quad (1)$$

The term, Z_c is defined by,

$$Z_c=\sum_{v_j\in\zeta} g_r\left(\left\|BI_{filter}(v_j)-BI_{filter}(v)\right\|\right)f_s\left(\left\|v_j-v\right\|\right) \quad (2)$$

where BI_{filter} is the filtered image, BI is the input image, z is the coordinates of the current pixel for the filter, ζ is the window centered for z, so $Z_j\in\zeta$ is another pixel. g_r is the kernel range for smoothing images in intensities. f_s is the spatial kernel for smoothing different coordinates. The Z_c is assigned for the smoothness. The bilateral filter is also used in other fields like image diffusion [9] and restoring the noisy image [10]. In this study, the rain histogram is used to enhance the image, then the bilateral filter is applied to remove the bilateral filter is used to remove the rain region areas to detect the original image. The rain streak removal is used to remove the rain and non-rain areas. Finally, the rain removed image is detected.

3. Results and Discussion

The performance of proposed system is evaluated by using 100 rain images in the database. Some sample images in the database is shown in the figure 2.

Figure 2: Sample images in the database

Initially, the input rained images are given to rain histogram to enhance the image. Then the bilateral filter is applied to remove the rained regions. The rain stroke is used to separate the non-rained regions. Then the two regions are combined to form the rain detected images. Figure 3 shows the rain detected images using bilateral filter.

Figure 3: Rain detected images using bilateral filter

4. Conclusion

A novel method for rain removal images using bilateral filter is presented. The input rain images are enhanced by using rain histogram method. Then the bilateral filter is applied to remove the rain water region. The rain stroke removal is used to remove the non-rained regions. Finally the rain removed images are detected. The performance of the proposed system is evaluated by using 100 rain images. The experimental results show the performance of proposed system using bilateral filtering.

References

[1] K. Park, M. Kim, H. Lim, S. Yu, and J. Paik, “Fast Rain Removal Using Rain Map and Temporal Filtering for Consumer Imaging Applications”, International Conference on Consumer Electronics-Berlin, 2018, pp. 1-2.

[2] K. Park, S. Yu, and J. Jeong, "A contrast restoration method for effective single image rain removal algorithm", International Workshop on Advanced Image Technology, 2018, pp. 1-4.

[3] S.H. Sun, S.P. Fan, and Y.C.F Wang, "Exploiting image structural similarity for single image rain removal", International Conference on Image Processing, 2014, pp. 4482-4486.

[4] D.A. Huang, L.W. Kang, M.C. Yang, C.W. Lin, and Y.C.F. Wang, "Context-aware single image rain removal", International Conference on Multimedia and Expo, 2012, pp. 164-169.

[5] H. Tang, L. Zhu, D. Zhang, and X. Wang, "Single image rain removal model using pure rain dictionary learning", IET Image Processing, vol. 13, no. 10, 2019, pp. 1797-1804.

[6] Y. Wang, and T.Z. Huang, "A Tensor-Based Low-Rank Model for Single-Image Rain Streaks Removal", IEEE Access, vol. 7, 2019, pp. 83437-83448.

[7] Y. Wang, S. Liu, C. Chen, and B. Zeng, "A hierarchical approach for rain or snow removing in a single color image", IEEE Transactions on Image Processing, vol. 26, no. 8, 2007, pp. 3936-3950.

[8] C.H. Son, and X.P. Zhang, "Rain removal via shrinkage of sparse codes and learned rain dictionary", International Conference on Multimedia & Expo Workshops, 2016, pp. 1-6.

[9] Xie, J., Heng, P. A., & Shah, M. (2008). Image diffusion using saliency bilateral filter. IEEE Transactions on Information Technology in Biomedicine, 12(6), 768-771.

[10] Yu, H., Zhao, L., & Wang, H. (2011). An efficient edge-based bilateral filter for restoring real noisy image. IEEE Transactions on Consumer Electronics, 57(2), 682-686.