

# Rain Streaks Removal in an Image by using Image Decomposition

Priyanka A. Chougale<sup>1</sup>, J. A. Shaikh<sup>2</sup>

<sup>1</sup>Research Student, Electronics Dept., PVPIT, Budhgaon

<sup>2</sup>Associate Professor, Electronics Dept. PVPIT, Budhgaon

**Abstract:** *Decomposition of an image into multiple components has been an effective research topic for various image processing applications. In this paper, we propose self learning based image decomposition based on morphological component analysis (MCA). Instead of applying conventional image decomposition, we focuses on the learning the basic information from an input image and thus the rain streaks patterns present in it can be identified by performing dictionary learning and sparse coding. By using PCA and SVM classifiers on the learned dictionaries, our framework aims at automatically identifying the common rain patterns present in them and thus we can remove rain streaks as a high frequency components from the input image. Different from prior image processing works with sparse representation, our method does not need to collect training images or any other assumption. Our result confirms, the rain streaks can be successfully removed from the image without losing original image details.*

**Keywords:** Low frequency and High frequency image, Image Patches, Image Denoising, Sparse representation, Self learning, Image Decomposition

## 1. Introduction

In many applications, image Denoising is generally used to produce a good estimate of the original image from noisy states. In this project, we propose a rain streaks removal from single image by using image decomposition based on morphological component analysis. In our method, an image is first decomposed into the low frequency and high frequency parts using a bilateral filter. The high frequency part is then decomposed into “rain component” and “non - rain component” by performing dictionary learning and sparse coding based on morphological component analysis (MCA). Our method is first to achieve rain streaks removal from an image which is capture from camera or downloaded from internet, which is fully automatic and self-contained, where no extra training samples are required. To remove rain streaks and improves the performance of the image detection. For example, to identify streaks from rainy image [6]. In rainy image, not all the target objects will be detected. But performance accuracy of the rain

Removed version is better to remove noise from an image different methods are utilized. Use of sparse and redundant representation over learned dictionary has become one of the specific approaches for image Denoising.

Computer vision is a part of everyday life. One of the most important goals of computer vision is to achieve visual recognition. Bad weather degrades the image quality. . Many image based applications such as mobile visual search, object detection, recognition, Image registration and region detection based on gradient based features that are rotation and scale invariant. Some widely-used descriptors such as SIFT (scale-invariant feature transform) [7], SURF (speeded up robust features) [8], and HOG (histogram of oriented gradients) [9] are mainly based on computation of image gradients. Computer algorithms which use feature information such as object detection, segmentation and recognition. In our method, first briefly review

morphological component analysis (MCA) which is a sparse representation based image decomposition algorithm and has been successfully applied and proceed to solve problems of image Denoising, image inpainting and rain removal. There are many papers that describe the applications of rain streaks removal. Lots of research has been made .The rain streaks removal from single image have the ability to work with image decomposition for original image. De-An and Huang [10] proposed a method to implement context-constrained image segmentation, and using dictionaries for the high frequency components in different context categories via sparse coding for reconstruction the image. The disadvantage is lost details and complexity time. Kshitiz Garg and Shree K. Nayar [1] in 2007 present the first complete analysis of the visual effects of rain on an imaging system and the various factors that affect it.

## 2. Design Considerations

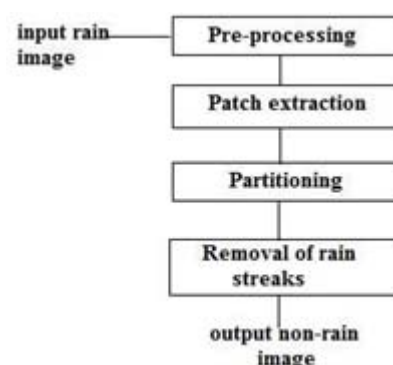


Figure 1: Steps for removal of rain streaks

Step 1:Pre-processing

For the input rain image in the pre-processing step we have to apply edge preserving smoothing filter called Using bilateral filter [4] image is decomposed into Low-frequency part and High-frequency part, where the basic information is

in the LF part while the rain drops or rain streaks and the other edge or texture information will be in the HF part of the image.

**Step 2: Patch extraction**

High frequency part is extracted from input image. For learning dictionary of HF part ( $D_{HF}$ ) a set of overlapping patches are extracted from HF part. Then separate atoms in the dictionary into two sub-dictionaries [6-7] for representing rain component and textural component of HF part.

**Step 3: Partitioning**

For representing the rain and non-rain component of HF part, the atoms which consists of dictionary of HF part is Divided into two sub-dictionaries i.e. rain and non-rain sub-dictionaries. In this rain removal method, HOG (Histogram of Oriented Gradient) feature descriptor [5] is used to describe each atom in  $D_{HF}$ . After extracting the each atom in  $D_{HF}$  by using HOG feature, then applying K -means algorithm for separating all of the atoms in  $D_{HF}$  into two sub-dictionaries  $D_1$  and  $D_2$  based on HOG feature descriptors. For identifying which cluster consists of rain atoms and which cluster consists of non-rain atoms.

**Step 4: Removal of rain streaks**

Sparse coding is performed on these two sub-dictionaries for finding sparse coefficients for each patch extracted from the HF part. Then we get the rain-removed version of the input rain image by combining LF and non-rain image of HF part by separating rain component.

**3. Algorithm: Rain streaks Removal from Single Image**

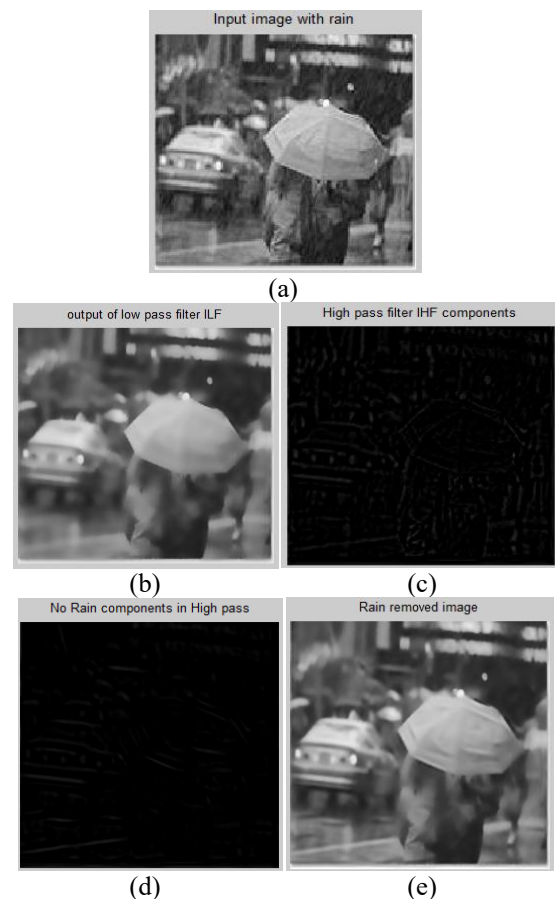
Input: a rain image  $I$ .

Output: the rain-removed version  $I^{Non\_Rain}$  of  $I$ .

- 1) Apply the bilateral filter to obtain the LF part  $I_{LF}$  and HF part  $I_{HF}$ , such that  $I = I_{LF} + I_{HF}$ .
- 2) Extract a set of image patches  $y^k, k = 1, 2, \dots, P$ , from  $I_{HF}$  Apply the online dictionary learning to obtain the dictionary  $D_{HF}$  consisting of the atoms that can sparsely represent  $y^k, k = 1, 2, \dots, P$ .
- 3) Extract HOG feature descriptor for each atom in  $D_{HF}$ . Apply K-means algorithm to classify all of the atoms into two clusters based on their HOG feature descriptors.
- 4) Identify one of the two clusters as "rain sub-dictionary,"  $D_{HF,R}$  and the other one as "geometric sub-dictionary,"  $D_{HF,G}$ .
- 5) Apply MCA by performing K-means clustering algorithm for each patch in with respect to  $D_{HF}$ .
- 6) Reconstruct each patch  $b_{HF}^k$  to recover either geometric component or rain component of  $I_{HF}$  based on the corresponding sparse coefficients.
- 7) Return the rain-removed version of  $I$  via  $I^{Non\_Rain} = I_{LF} + I_{HF}^G$ .

**Table 1: Notations**

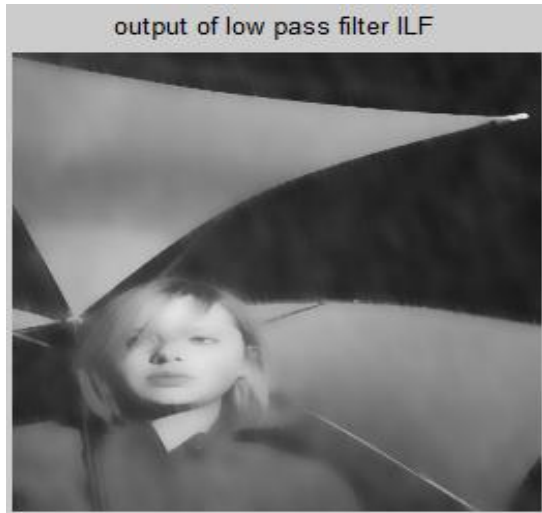
Symbol	Meaning
$I$	Input rain image
$I_{LF}$	Low frequency part of input image
$I_{HF}$	High frequency part of input image
$D_{HF}$	Dictionary learned from each patch of image
$D_{HF,R}$	Rain sub dictionary of dictionary $D_{HF}$
$D_{HF,G}$	Geometric sub dictionary of dictionary $D_{HF}$
$I_{HF}^G$	Geometric component of $I_{HF}$
$I_{HF}^R$	Rain component of $I_{HF}$
$y^k$	Set of image patches
$b_{HF}^k$	$k^{th}$ image patch extracted from $I$



**Figure 2:** (a) Input Rain image (b) LF Component (c) HF Component (d) Non-rain component of HF (e) Rain removed image.

**4. Experimental Result**

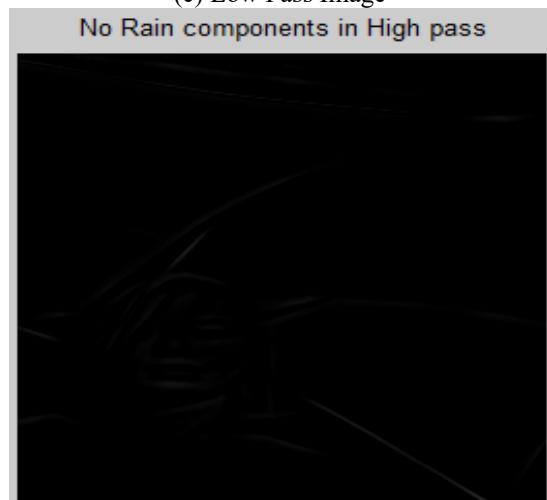




(b) High Pass Image



(c) Low Pass Image



(d) Non rain Component of HF



(e) Non Rain Image

**Table 2:** Result showing the values of different parameters

Parameter	Our Approach
Peak Signal to noise ratio	7.07
Mean Squared Error	0.00006

## 5. Conclusion

In this method, we extracted single image based rain streaks removal is automatic and self-contained. The results obtained are as shown which can effectively remove rain streaks without

blurring the original image. Peak signal to noise ratio and mean squared error of the rain streaks removed image is much better compared with the original image.

## References

- [1] J. M. Fadili, J. L. Starck, J. Bobin, and Y. Moudden, "Image decomposition and separation using sparse representations: An overview," *Proc. IEEE*, vol. 98, no. 6, pp. 983–994, Jun. 2010.
- [2] Ming Zhou, Zhichao Zhu, Rong Deng, Shuai Fang, Rain, "Rain Detection and Removal of Sequential Images", *IEEE Chinese Control and Decision Conference (CCDC)*, pp. 615-618, 2011.
- [3] Li-Wei Kang, Chia-Wen Lin, and Yu-Hsiang Fu, "Automatic Single-Image-Based Rain Streaks Removal via Image Decomposition", *IEEE Image Processing*, vol. 21, no. 4, April 2012
- [4] O. Ludwig, D. Delgado, V. Goncalves, and U. Nunes, "Trainable classifier-fusion schemes: An application to pedestrian detection," in *Proc. IEEE Int. Conf. Intell. Transp. Syst.*, St. Louis, MO, Oct. 2009, pp. 1-6
- [5] J. Bobin, J.L. Starck, J. Fadili, Y. Moudden, and D.L. Donoho, "Morphological Component Analysis: an Adaptive Thresholding Strategy," *IEEE Trans. Image process.*, Vol 16, no. 11, pp. 2675-2681, Nov. 2007.
- [6] De-An Huang, Li-Wei Kang, Min-Chun Yang, Chia-Wen Lin, and Yu-Chiang Frank Wang, "Context-Aware Single Image Rain Removal," *Proc. IEEE Int. Conf. Multimedia and Expo*, Melbourne, Australia, July 2012.
- [7] Duan-Yu Chen, Chien-Cheng Chen, and Li-Wei Kang, "Visual Depth Guided Color Image Rain Streak Removal using Sparse Coding," *IEEE Trans. Circuits*

and System for Video Tecnology,Vol.24, No.8, Aug.2014.

- [8] “Single-frame-based rain removal via image decomposition,” in Proc. IEEE Int. Conf. Acoustics, Speech and Signal Process., May 2011, Prague, Czech Republic.
- [9] Huang, D. A., Kang, L. W., Yang, M. C., Lin, C. W., Wang, Y. C. 2012. Context-Aware Single Image Rain Removal. In: IEEE International Conference on Multimedia and Expo (ICME). IEEE Press, New York 164-169.
- [10] N.Dalal and B. Triggs, “ Histograms of oriented gradients for human detection,”in Proc. IEEE Conf. Comput. Vis. Pattern Recognil., San Diego, CA, Jun. 2005, vol. 1, pp. 886-893
- [11] C. Tomasi and R. Manduchi, “ Bilateral Filtering for gray and color images,” in Proc. IEEE Int. Conf.Comput. Vis., Bombay, India, Jan. 1998, pp. 839-846