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Rain Streaks Removal in an Image by using Image Decomposition

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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 dictionar y 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

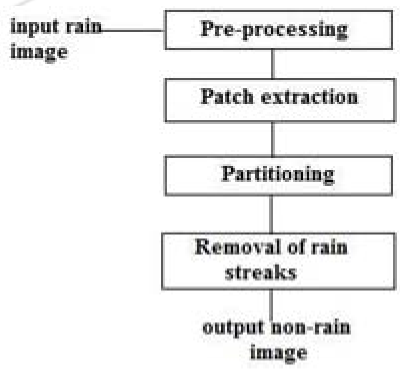


Figure 1: Steps for removal of rain streaks

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^k_{HF} 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
$$I^{Non\_Rain} = I_{LF} + I^G_{HF}.$$

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
$b^k{}_{HF}$	k^{th} image patch extracted from I

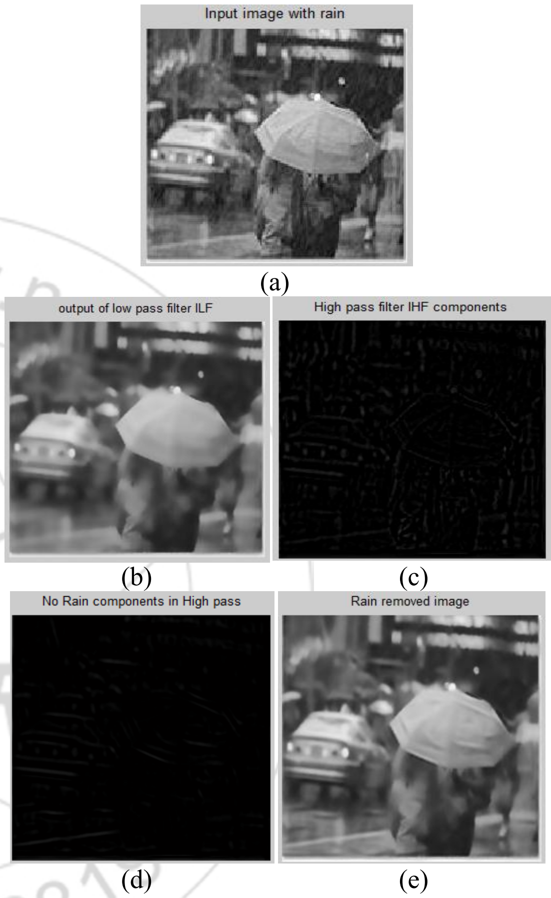
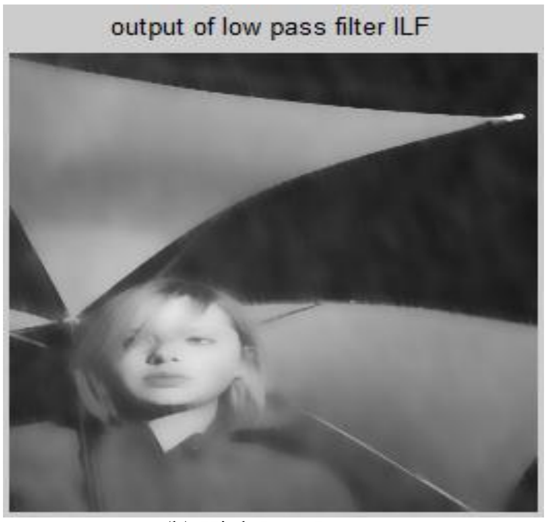


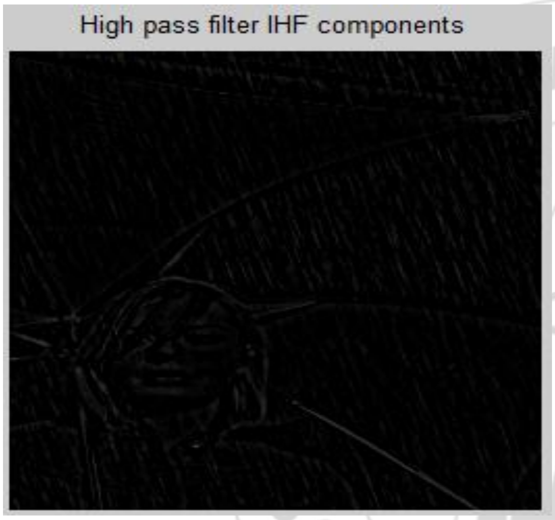
Figure 2: (a) Input Rain image (b) LF Component (c) HF Component (d) Non-rain component of HF (e) Rain removed image.

4. Experimental Result

(a) Rain Image



(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.

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