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**International Journal of Computer Science and Mobile Computing**

**A Monthly Journal of Computer Science and Information Technology**

**ISSN 2320–088X**
**IMPACT FACTOR: 5.258**

***IJCSMC, Vol. 5, Issue. 4, April 2016, pg.338 – 343***

# Single Image Based Rain Streaks Detection and Removal

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***Abstract— Outdoor vision system are implemented in numerous applications such as tracking, surveillance in navigation also. Rain is the one kind of barrier for the outdoor vision system. Rain, snow, fog, mist and haze are several kinds of weather condition which degrade the visual quality also the performance of outdoor vision system. Rain is one of the kind of weather condition and significant element for the dynamic bad weather condition. Rain streaks degrades visual quality of an image so it is required to remove this rain streaks. After Removal of rain streaks we can easily recognize important feature from the image furthermore the pre-processing of several computer vision algorithms which gives various important feature information i.e. object detection, tracking, segmentation and recognition. This paper reviews various techniques or methods used for the removal of rain streaks in single image.***

***Keywords— Weather Condition, Dynamic weather, Steady weather***

## I. INTRODUCTION

With the increasing improvement in computer technology, outdoor vision system is mainly used and it plays important part in traffic surveillance and military surveillance. Weather can diminish the performance of outdoor vision systems. Outdoor vision systems has different advantages in many applications such as surveillance and navigation. So it is necessary that we must need to remove the effects of weather for making outdoor vision systems effective that perform in each and every weather conditions. Rain creates defective visibility at outdoor vision systems. The images taken by outdoor vision system in the rain have low contrast and are blurred and that can produces serious degradation. Also mostly images taken in the rain have high pollution levels and are blurred, and the identification of features makes it impossible for the application process together with the important feature extraction and target recognition. So it has more important approach to the images acquired in the rain which can help to create outdoor vision system reliable.

Images in an outdoor condition, bad weather like rain obscure human viewers also brings obstacle to performing different image processing operation and also the performance of vision algorithms diminish. An area enclosed by a falling raindrop appear brighter than its original background. But it is very tough to identify rain only using the property of intensity changes. Though in some cases, it is essential approach to remove the rain from only outdoor image, this image is used to get better information. If rain steaks are exist in the climate which indicates that, it will not only deteriorate the important characteristics of the scene but also it will deteriorate the importance of computer vision algorithm. For example, consider the instance when the object trackers may stop there working if small portion of the image become occluded.

 

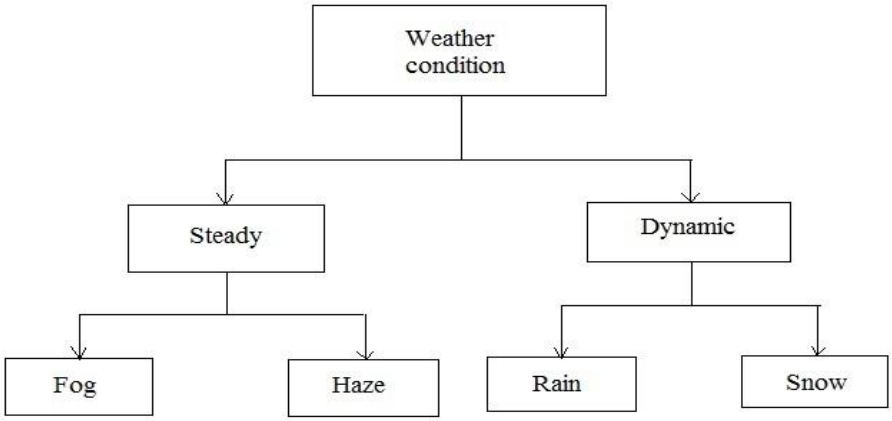


Fig 1 Weather condition classification

Rain is one of the important type weather condition. Reducing or removing the effects of rain while protecting image information is a hard job, as rain streaks move very suddenly through a image and are tough to separate from other motion from the image. Figure 1 shows that weather condition classification.

Garg and Nayar categorized the weather basis on the size of the weather particles into two kinds fog and haze are the kind of steady weather, and rain and snow are the kinds of dynamic weather. In steady weather, particles are extremely tiny and steadily float in the air. In dynamic weather, rain drops are scattered anywhere in the scene and changes position all the time. This makes confusing to distinguish in vision applications. Vision systems are used for numerous role such as tracking, recognition and navigation. In order to enhance vision systems that suitable for all weather conditions, it is mandatory to expand algorithms that remove visual effects of the many weather conditions. In dynamic weather likely rain, snow, and haze usually brings annoying visual artifacts in outdoor vision system and decrease the performance of vision tasks[1-2].

(a) Fog (b) Mist

Fig 2 Visual Appearance of Steady Weather Condition

 

(a)Rain

(b)Snow

Fig 3 Visual Appearance of Dynamic Weather Condition

## II. RELATED WORK

Many Many authors operating single image for rain streaks removal and presented different techniques or methods for that rain removal. L-W Kang, C-W Lin and Y.-H. Fu proposed a single image based rain streaks removal framework by operating image decomposition in the basis of Morphological Component Analysis (MCA).Instead of directly implementing a traditional image decomposition technique, this proposed method initially decomposes input rain image into the low-frequency (LF) and high-frequency (HF) parts by implementing bilateral filter. Bilateral filter is also called as smoothing filter. The LF part included the most basic information and HF part included rain streaks, edges or texture information. Dictionary learning and sparse coding is further implemented for decomposing HF part into rain component and non-rain component. By integrating non rain component of high frequency part together with low frequency part they got the required non rain image by removing rain component [3-6].

Y-L Chen and C-T Hsu proposed model such as a generalized low-rank appearance model for rain streaks removal. This method does not basically focus on rain pixel detection nor dictionary learning stage. Alternatively rain streaks normally release similar and repeated patterns on imaging scene. They presented generalized low-rank model from matrix to tensor structure with respect to illustrate the spatio-temporally correlated rain streaks. By implemented this appearance model they discarded rain streaks from respective rain image[7].

X. Zheng, Y. Liao, W. Guo, X. Fu, and X. Ding proposed new process for rain removal by utilizing low frequency part of the image. This process depends on a key variations between clear background edges and rain streaks, normally low frequency part can shows the various properties. Low-frequency part is the non rain or it is called geometric component, then this low-frequency part is then altered as a guidance image. The high-frequency part is served as an input image of the guided filter, so that a non-rain also called as geometric component of the high-frequency part can be achieved. After acquiring non-rain component of high-frequency part ,add low-frequency component in it they got desired image [8].

D-An Huang, L-Wei Kang, M-Chun Yang, C-Wen Lin, Wang proposed another method i.e. a learning-based structure for single image rain removal which basically concentrates on the studying of context information from respective input rain image and hence the rain patterns remained in it can be automatically identified and eliminated. This method for single image rain removal is the fusion of image decomposition and self learning processes.This method initially performs context-constrained image segmentation on the input rain image, and they also considered dictionaries for the high-frequency part in different context categories by using sparse coding for reconstruction value.For an image regions with the rain streaks, dictionaries of dissimilar context categories will allocate common atoms which correspond to the rain patterns. By employing Principal Component Analysis and SVM i.e. Support Vector Machine classifiers on the learned dictionaries of high frequency part, this structure focus at automatically identifying the common rain patterns include in them, and thus rain streaks can be discarded from the respective high-frequency components from the input image[9].

D-Yu Chen, C-Cheng Chen, and L-Wei Kang, proposed another framework for single color image based rain removal structure by carefully considering rain removal as an image decomposition that is based on sparse representation. In this structure, basically input rain image is subdivided into a low-frequency part and a high frequency part by implementing the guided image filter so that high-frequency part included the rain streaks. High-frequency part contains with rain streaks, textures or edges. High-frequency part is further subdivided into a rain and a non-rain i.e. geometric component by operating dictionary learning and sparse coding. After that

 

separate rain streaks from the high-frequency part, for this separation a hybrid feature set is utilized, together with the depth of field, eigen color and histogram of oriented gradients is carried out to moreover decomposed the high-frequency part. By manipulating hybrid feature set, almost all rain streaks can be withdraw; at the same time non-rain component can be enhanced. This method concentrates single image rain removal and gave good results with not only the entire rain component being eliminated, but also the visual quality of deteriorated non-rain images being improved[10-11].

J-H Kim, C Lee, J-Young Sim, and C-Su Kim proposed another algorithm such as an adaptive rain streak removal algorithm for a single image. They took into consideration that a particular rain streak had an elongated elliptical shape of vertical direction. So, by utilizing this algorithm they first require to identify an area of rain streak by considering the angle of rotation and the aspect ratio of the elliptical kernel at each and every pixel location. After this they performed the nonlocal filtering on the knowing rain streak regions by specifying nonlocal neighbor pixels and their weights [12].

C-H Yeh, P-Hsian Liu, C-En Yu, and C-Yang Lin, proposed another method i.e. NMF-based rain removal method. This method was implemented for rain removal of single image, basically in this method rain image is split into the high frequency and the low frequency part by implemented Gaussian filter. Non-negative matrix factorization (NMF) is used to discard the rain streaks in the low frequency part.NMF is convenient for noise filtering. Then, Canny edge detection is applied to concern with the rain in the high frequency, they used block copy method to preserve the image quality. Moreover, they applied a rain dictionary to further divided into the high frequency into rain and non-rain parts**.** This method not only discarded most of the rain from rain image, but also maintained the image quality [13].

S Yu , X You, Yi Mou , X Jiang ,Y Tang proposed another process for rain streaks removal from single image which is on the basis of self-learning framework and structured sparse representation. This algorithm basically divided input rain image into rain streaks regions and non-rain i.e. geometric regions through texture analysis. They also decomposed input image into high-frequency (HF) and low-frequency (LF) parts by implementing bilateral filtering. They introduced another structured dictionary learning to further decomposed HF part into rain details and non-rain details, in which patches of training rain and non-rain sub-dictionaries are taken from rain streaks and non-rain geometric regions. At last, they integrated LF part with non-rain geometric details and they obtained rain streaks-removal image [14].

## III. COMPARATIVE ANALYSIS

From We noticed that with the help of image decomposition, separation of rain component and non rain component is achieved. Most of the authors used image decomposition method for the rain streaks removal because of this rain component removed while maintaining original image quality. Also they took into consideration many parameter i.e. patch size, number of atoms which is also known as dictionary size, number of iterations in their respective proposed method. In Table 1 we shows summary of methods with name of authors , method used and related parameter also we mention advantage of their method.

Table 1:Comparative Analysis of different method

| Sr No | Author | Method used | Parameter | Advantages |
|---|---|---|---|---|
| 1 | L.W. Kang, C.W. Lin, Y.H. Fu | MCA based Image Decomposition | Patch size , number of atoms, number of iterations | This method discarded rain streaks while maintaining original image contents as it is. |
| 2 | Y.H. Fu, L.W. Kang, C.W. Lin, and C.T. Hsu | Image Decomposition by MCA | Dictionary | This method eliminate rain streaks from an image without blurring original image details |
| 3 | L.W. Kang, C.W. Lin, C.T. Lin, and Y.C. Lin | Self-learning based method | Patch size, dictionary size, number of iterations | This method removes rain streak from an image while maintaining safely original image. |
| 4 | Li-Wei Kang, Yu-Hsiang Fu, | MCA based Image Decomposition | Patch size, number of atoms, number of iterations | This method remove rain streaks in an image without blurring. |

 

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|---|---|---|---|---|
| 5 | Y.-L. Chen and C.-T. Hsu | Generalized low rank appearance model | Patch size, patch offset | This method is helpful to various inputs without pre-processing. |
| 6 | X. Zheng, Y. Liao, W. Guo, X. Fu, X. Ding | By using multi-guided filter | - | This method is effective and efficient in rain removal and snow removal. |
| 7 | D.-A. Huang, L.-W. Kang, M.-C. Yang, C.-W. Lin, Y.-C. F. Wang | Context aware image decomposition and dictionary learning | Patch size, dictionary size , number of iterations | This proposed method is able to extract image specific context information and thus rain patterns can be identified and removed from the image. |
| 8 | D-Yu Chen, C-Cheng Chen, Li-Wei Kang | Image decomposition by using sparse representation | Minibatch size, number of atoms, number of iterations, patch size | This method shows that rain components can be removed more effectively, but also the visual quality of degraded images can be improved. |
| 9 | D.Y. Chen, C.C. Chen, L.W. Kang | Visual depth guided filter via Sparse Coding | Dictionary | This method eliminates rain streaks as well as visual quality of rain image can be improved. |
| 10 | J H Kim, C Lee, J Y Sim, C S Kim | adaptive non-local means filter | Size of window, size of block | This method discard rain streaks, without producing visual artifacts. |
| 11 | C-Hung Yeh, P-Hsian Liu, C-En Yu, and C-Yang Lin | Negative Matrix Factorization based rain removal method | Size of block, number of iterations, sigma | This method can discard most of the rain, also maintain the image quality. |
| 12 | S Yu ,W Ou , X You, Y Mou , X Jiang ,Y Tang | Self learning structure and structured sparse representation | Dictionary, patch size | This method is good for extracting and identifying rain streak regions automatically. |

## IV. CONCLUSION

In this paper, we studied how rain streaks disturb the outdoor vision system because of this visual quality of an image diminish and we also studied different methods used for removal of rain streaks in an images. From the comparative analysis of different method from which we conclude that many authors used image decomposition process from which they got better result. Rain streaks removal is helpful in many applications such as image enhancement, image editing, image forensics. It is also used in pre-processing of various computer vision algorithms which use important feature details such as object detection, tracking, recognition also in segmentation.

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