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EFFICIENT DETECTION AND REMOVING OF RAIN OR SNOW IN A SINGLE COLOR IMAGE USING MULTI-GUIDED FILTER

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ABSTRACT: An effectual procedure to remove rain or snow from a single color image. Our system takes benefit of two popular methods engaged in image processing. It is denoted as image disintegration and lexicon learning. It attains the low and high frequency parts by implementing a rain/snow. In this framework, suggested an innovative and resourceful rain and snow removal method using Multi-Guided Filter over low frequency part of a single image. It is parallel to key variance among clear contextual edges and rain streaks or snowflakes, low frequency part can noticeably discriminate the dissimilar possessions of the image. Low frequency part is the non-rain or non-snow component. The high frequency also contains the non-rain and non-snow component but also contains some details of the image. Clear contextual edges are also enhanced based on their properties. Our results show that it has good performance in rain removal and snow removal. A much more interesting problem associated with over detection now detection and applying a Multi guided filtering. Mistakes is that some or even many details of the image are detected as rain/snow components because they also have high intensities as compared with their neighbors.

Keywords: Image Disintegration, Lexicon Learning, Multi-Guided Filter.

1. INTRODUCTION

A photo taken in the rainy day or snowy day is covered with bright streaks. The streaks not only cause a bad human vision, but also significantly degrade effectiveness of any computer vision algorithm, such as object recognition, tracking, retrieving and so on.

Outdoor vision systems employed for various tasks such as navigation, data collection and surveillance, can be adversely affected by bad weather conditions such as rain, haze and snow. In a rainy day, raindrops inevitably adhered to windscreens, camera lenses, or protecting shields. These adherent raindrops occlude and deform some image areas, causing the performances of many algorithms in the vision systems such as feature detection, tracking, stereo correspondence, etc., to be significantly degraded.

This problem occurs particularly for vision systems that use a hand-held camera or a top-mounted vehicle sensor where no wipers can be used. Identifying raindrops from images can be problematic due to various reasons. To address the problems, we analyze the appearance of adherent raindrops from their local spatio-temporal derivatives. A clear, non-blurred adherent raindrop works like a fish-eye lens and significantly contracts the image of a scene. Consequently, the motion inside raindrops is distinctively slower than the motion of non-raindrops. Besides, unlike clear raindrops, blurred raindrops are mixtures of light rays originated from various points in the background scene causing the intensity temporal derivatives of blurred raindrops to be onsiderably smaller than those of non-raindrops.

These two clues are the key to our detection method. Relying on them we propose a pixel based detection method, which is generally applicable to handle any shape and size of raindrops. A result of our detection method. Having detected the raindrops and analyzed the image formation of raindrops, we found that some areas of a raindrop completely occlude the scene behind, and the remaining areas occlude only partially. For partially occluding areas, we restore their appearance by retrieving as much as possible information of the scene, namely, by solving a blending function on the detected areas using the intensity change over time.

Removal of rain streaks has recently received much useful for object identification in rainy images. There are the lots of topics that the researcher focuses that cover the field of image and signal processing. The field extends from the basic level first the basic images are improved and then the images in the bad weather as the rain, snow or fog (or haze) etc. The removal of rain streaks has recently received much attention in the research work in the field of image processing. The rain removal is just like the image enhancement and may come in the category of image noise removal or image restoration. That by altering some camera parameters as exposure time and depth of field the appearance can be enhanced and mitigate the effects of rain without the scene appearance alteration. Presented a selection rules based on photometry. The photometry and size reused in selection rules to select the latent rain streaks in a video, in which the rain streaks orientations histogram is estimated with computed geometric moments. Meanwhile some researchers focused on raindrop recognition in images or videos that is different from rain streaks detection.

The rain and non-rain parts in a single image are very closely mixed up and the identification of rain streaks is not an easy task. In this research, we compare a single-image rain streak removal based on morphological component analysis by decomposition of rain streaks. The signal and image processing for the filtering and region specification are discussed in the previous works. In this method, a Multi-Guided filter is applied for an image to decompose it into the low-frequency (LF) and high-frequency (HF) parts. The HF part is then decomposed into rain component and non-rain component by performing Image Disintegration and lexicon learning.

2. LITERATURE SURVEY

Several researches were studied about the detection and removal of rain and snow from videos extensively, while removal of raindrop and snow from single image not got the same interest. Hence this work focuses on single image.

Li-Wei Kang et al [14] (2012) proposed a single-image-based rain removal framework via morphological component analysis. The authors used a bilateral filter to decompose the conventional image into the low- and high-frequency (HF) parts instead of applying it directly. The High Frequency portion is further decomposed into a rain and non rain component by applying sparse coding and dictionary learning. As a result, the rain part can be removed from the image while observing most original image details.

Duan-Yu Chen et al [13] presented a framework for single-color-image, for raindrop removal process. Based on sparse representation this system will work. The author converts the input image as high frequency from low frequency by using the guided image filter. With nonrain textures/edges the rain streaks would be in the high-frequency. Using the dictionary learning and sparse coding the high-frequency part is decomposed into a rain and non rain component. Finally the hybrid feature set is utilized to separate rain streaks from the high-frequency part. Most rain streaks can be removed by this technology.

All the mentioned work above shares some similar limitations. They are;

1. They focused only on rain and snow removal in a single image using guided filter.
2. The details of the image is sometimes lost when compared to the related works.
3. Accuracy part of the filtering methods are not calculated.

3. PROPOSED METHODOLOGY

3.1 Proposed Theory

In proposed system, an efficient algorithm Multi-Guided Filtering is used to remove rain or snow from a single color image. Our algorithm takes advantage of two popular techniques employed in image processing, namely, Image Disintegration and Lexicon Learning. It acquires the low and high frequency parts by implementing a rain/snow.

The recovered output contains clear image without losing any information of the original image. The experimental results are shown and compared with other filter such as bilateral and guided. The accuracy values are also displayed according to the type of filters.

3.2 Preprocessing

First, guided filter is applied to input image using the same as guidance. Since guided filter is a low pass filter, low frequency part of the image is obtained. We subtract the low frequency part from the image to get high frequency part. We adjust the degree of smoothness for the guided filter to get the low frequency part as it is free from rain components of image.

$$I = I\_L + I\_H$$

$$I\_H = I\_HR + I\_HNR$$

Where I_HR is the rain components present in high frequency part and I_HNR is the non-rain particles present in high frequency part.

Using guided filter, edges of the image is getting smoothed very much. So the low frequency part contains only these smoothed edges. An edge enhancement is recommended to improvise the edges and to make them close to image.

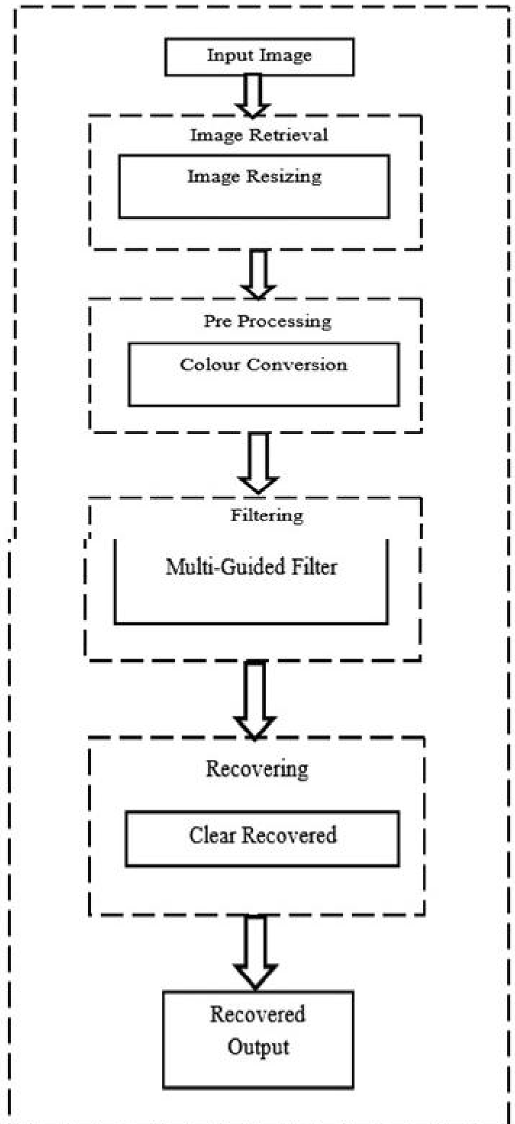


Figure1. System Flow Diagram

Laplacian filter to perform edge enhancement of low frequency part. Thus we get an enhanced version of low frequency part which is denoted as I_LF. I_LF then used as the guidance image for the coming guided filter. Edge enhancement to realize this process as following expression:

$$I_{LF}^{*} = I_{LF} + \omega \cdot \nabla I_{LF}$$

Where *ILF* is the gradient of *ILF* and $\omega = 0.1$

3.3 Filtering

After preprocessing, we use guided filter once again with high frequency part as the input image. In order to get rain free high frequency part we adjust degree of smoothing for guided filter. The resulting high frequency part contains only non-rain particles. After using multi guided filter, high-frequency part remains the non-rain or non-snow component and obtained a clear image.

3.4 Recovering

To bring a more refined and clear results, we go through certain recovery mechanisms. These mechanisms drive to form a good result which is more close to input image. First of all we want to restore the input image. For that we add the low frequency to the high frequency part.

The resulting image contains the combination of low frequency part and filtered high frequency part. On the other hand, using guided filter also makes recovered image blurred. So we change it to make recovered image clear as follow:

$$\mathrm{I}_{cr} = \min(I_r, I_{in})$$

So we take a weighted summation of *Ir* and *Icr* to get the refined guidance image and then use guided filter once again to get the final result.

$$\mathrm{I}_{ref} = \beta I_{cr} + (1-\beta) I_r$$

Where $\beta = 0.8$ in rain removal and $\beta = 0.5$ in snow removal in this method.

4. EXPERIMENTAL RESULTS

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.

In this section we compare different filters results of Rain and Snow Detection and Removal of Single color images in MATLAB Filtering Concepts. Here we compare,

- Bilateral Filter
- Guided Filter and
- Multi-guided Filter

Bilateral and guided filters are existing filters, and multi guided filter is a proposed one filter. Above three filters are compared with proposed method in order to prove the accuracy of multi guided algorithm.

Bilateral Filter

The bilateral filter is a non-linear technique that can blur an image while respecting strong edges. Its ability to decompose an image into different scales without causing haloes after modification has made it ubiquitous in computational photography applications such as tone mapping, style transfer, relighting, and de-noising.

The bilateral filter is also defined as a weighted average of nearby pixels, in a manner very similar to Gaussian convolution. The difference is that the bilateral filter takes into account the difference in value with the neighbors to preserve edges while smoothing.

$$BF[I]_{\mathbf{p}} = \frac{1}{W_{\mathbf{p}}} \sum_{\mathbf{q} \in \mathcal{S}} G_{\sigma_s}(\|\mathbf{p} - \mathbf{q}\|)\, G_{\sigma_r}(|I_{\mathbf{p}} - I_{\mathbf{q}}|)\, I_{\mathbf{q}},$$

$$W_{\mathbf{p}} = \sum_{\mathbf{q} \in \mathcal{S}} G_{\sigma_s}(\|\mathbf{p} - \mathbf{q}\|)\, G_{\sigma_r}(|I_{\mathbf{p}} - I_{\mathbf{q}}|).$$

Guided Filter

The guided image filter is based on a local linear model. The guided filter delivers the filtering output by considering a reference image. The reference image is said as the guidance image which can be the input image itself or another different image. The guided filter has better edge preserving smoothing and gradient preserving property.

1. Firstly read the guidance image and the input image.
2. Enter the values of r and ε where r is the local window radius and ε is the blur degree of the filter.
3. Calculate the values: Mean of I, Variance of I, Mean of P, Average cross product of I and P.
4. Compute the value of linear coefficients. a = (cross_IP – mean_I.*mean_P)./ (var_ I+ ε) b = mean_ P - a. * mean _I

5. Compute the mean of a and b
6. Obtain the filtered output image Q using mean of a and b, Q = mean_ a. * I + mean _b

The performance of the Multi-Guided Filtering is measured based on the speed, similarity and time consuming. Experiments were carried out to compare the performances of existing Bilateral, Guided filtering and clear recovered image obtained using Proposed Multi-Guided Filtering by varying the number of images.

Accuracy: The accuracy of a test is its ability to differentiate the rain portion and normal portion correctly. To estimate the accuracy of a test, have to calculate the proportion of true positive and true negative in all evaluated cases. Mathematically, this can be stated as:

$$\text{Accuracy} = \frac{(TP+TN)}{(TP+TN+FP+FN)}$$

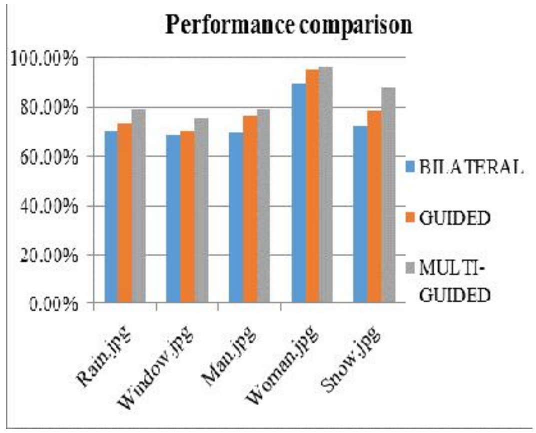
True positive (TP) = the number of cases correctly identified as rain
False positive (FP) = the number of cases incorrectly identified as rain
True negative (TN) = the number of cases correctly identified as not rain
False negative (FN) = the number of cases incorrectly identified as not rain

Dataset	Bilateral Filter	Guided Filter	Multi guided Filter
Rain.jpg	70.25 %	73.45 %	78.89 %
Window.jpg	68.21 %	70.654 %	75.343 %
Man.jpg	69.6691%	76.4926%	79.0441%
Woman.jpg	90.0%	95.5%	96.3889%
Snow.jpg	72.564 %	78.78 %	88.45 %

Table1. Results comparison with Accuracy

COMPARISON GRAPH

Compared to the accuracy result of three filters provided the best accuracy rate. Whether the single image accuracy or the overall accuracy is high in Multi Guided Filter compared to those prior approaches as shown below.



5. CONCLUSION

The Research work attempted to solve the problem in raindrop/snow removal in single image. The input image is preprocessed and then the multi guided filters is used to acquire the low and high frequency parts. The high frequency contains the rain/snow parts. Therefore to obtain an accurate result the high frequency is further decomposed into low and high frequency by applying the guided filter. The obtained low frequency will contain the non dynamic components of high frequency. Finally add the low frequency to get the restored image, the clear recovered image is obtained by applying the Multi-Guided Filtering. This proposed approach reduces the execution time and increase the accuracy compared to the previous approach.

6. FUTURE WORK

For future work, the performance of the research method can be further improved in terms of visual quality and computational complexity by employing the dictionary learning technique. Particularly dictionary learning consume most of execution time, in order to solve this problem effective pruning technique has to designed that improves the convergence speed of decomposition process and performance. The visual quality can also be affected by fog and mist. Therefore to improve the accuracy of the proposed research, it is necessary to check whether the fog and mist characteristics are present in the input image.

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