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A ROBUST DEFECT DETECTION METHOD FOR RAIN OR SNOW REMOVING IN IMAGE USING HYBRID FILTERS

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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. A method of image analysis is proposed for detection of rain and snow defects in single image. In this paper, we detect rain and snow in images, for this detection we used two different methods namely Gabor filter method and Hybrid filters. The hybrid filters is a combination of three shaper filters are called as saturation filter, differential filter and white filter. Finally, experiments show that the performances of proposed different multiple filters are influenced by its parameters such as central frequencies and mask size.

Keywords: [Image Disintegration, Gabor filter, Hybrid filters.]

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 considerably 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 are used 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. 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 paper, 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 sparse coding and dictionary learning.

2. LITERATURE SURVEY

In this section we compare more previous works. The combination of rain/snow detection and a guided filter is used to decompose the input image into a complementary pair: (1) the low-frequency part that is free of rain or snow almost completely and (2) the high-frequency part that contains not only the rain/snow component but also some or even many details of the image. Then, we focus on the extraction of image's details from the high-frequency part. To this end, we design a 3-layer hierarchical scheme Though belonging to the dynamic weather category, rain and snow still have some differences when appearing in the image or video. First, rain is semi-transparent. Because of this, the objects will not be occluded completely but some blurring may appear. Second, pixels with different intensities will be affected by rain differently. When the pixel's primary intensity is relatively low, rain will enhance its intensity. When a high intensity pixel is affected by rain, its intensity will become lower. This is to say that rain-affected pixels tend to have the same intensity because the reflection by rain is dominating under this scenario. On the other hand, snow is un-transparent and can largely occlude the object behind it. In addition, son has bright and white color, and snow's reflection is strong. Consequently, snow often possesses high intensity values in an image, which is hardly affected by the background. Rain/snow removal from a video or a single image has been an active research topic over the past decade. Today, it continues to draw attentions in outdoor vision systems (e.g., surveillance) where the ultimate goal is to produce a clear and clean image or video. Here, the most critical task is to separate rain/snow components from the other part. To this end, a low-pass filtering is often used. However, the low-frequency part produced by the low-pass filter would still contain some rain streaks or snowflakes if the filter is not strong enough. To avoid this, the low-pass filtering needs to be rather strong. Nevertheless, such a strong filtering will unavoidably remove some or even many details of the image at the same time. This implies that the high-frequency part (the residual) contains not only rain/snow components but also some or even many details of the image. Then, some learning-based methods can be designed to further classify rain/snow components in the high-frequency part. We have some limitations are Low accuracy, Less Reliability, Bad human vision, Degrade effectiveness

3. PROPOSED METHODOLOGY

An efficient algorithm to remove rain or snow from a single color image. Our algorithm takes advantage of two popular techniques employed in image processing, namely, image decomposition and dictionary learning. It acquires the low and high frequency parts by implementing a rain/snow.

A method of image analysis is proposed for detection of rain and snow defects in single image. In this paper, we detect rain and snow in images, for this detection we used two different methods namely Gabor filter method and Hybrid filters. The hybrid filters is a combination of three shaper filters are called as saturation filter, differential filter and white filter. Finally, experiments show that the performances of proposed different multiple filters are influenced by its parameters such as central frequencies and mask size.

In this work, a novel method is proposed based on the difference between clear background edges and rain streaks or snow streaks. The method mainly uses the hybrid filter to remove rain streaks or snowflakes. Suggests that the rain streaks or snowflakes are different from other textures. Introduce the algorithm of removing the rain streaks or snowflakes. And shows the experimental results and compares with other methods.

3.1 GABOR FILTER AND HYBRID FILTER

We detect rain and snow in images, for this detection we used two different methods namely Gabor filter method and Hybrid filters detection.

The hybrid filter is a combination of three shaper filters are called as saturation filter, differential filter and white filter.

Gabor Filter - Firstly, in the pre-processing, input images are cropped according to luminance characteristic, meanwhile, geometric operations and gray interpolation are carried out to pick-up the target normal direction area. Secondly, a group of real Gabor filters are used to the pre-processed images to suppress backgrounds and emphasize defects. And, the noises are separated using a threshold. Hybrid Filters- We expand our algorithm in the image, so we can detect the intensity change between neighbor frames and achieve an accurate detection algorithm. Our detection algorithm is based on many linear filter, so it is very efficient.

3.2 METHODOLOGIES

A. Preprocessing

We have done some preprocessing task on input images for detection. The main problem of image analysis is noise or irrelevant information.We have to make sure that source images are noise free to a maximum extent and images should content high frequency information.

To remove the rain and snow, we need to enhance the signal of raindrops and snowflakes for the purpose of raindrops and snowflakes detection.Considering structure of rain stripes which are usually placed in one direction and have a texture like structure, we use set of Gabor filters for detecting themWe subtract the low frequency part from the image to get high frequency part.

B. Gabor Filter

Gabor filter is used as a linear filter for extracting features from images. One of these features is extraction of directional lines which we consider here. In Gabor filters bank, a similar set of continuous and interrelated family is produced by changing delay and rotation angle.

In rain detection application, rain lines are identified by introducing special direction to filter and mentioning the related mathematical relations with acceptable accuracy. Of course, a threshold limit is defined for increasing accuracy to express Gabor filter and its different values change accuracy of result.

To achieve this goal, the rainy image is partitioned to multiple sub images. Then, all directions of Gabor filter banks are applied to each sub image and the direction which maximizes the energy of the filtered sub image is selected as the predominant direction of that region.A Gabor filter can be viewed as a sinusoidal plane of particular frequency and orientation, modulated by a Gaussian envelope. It can be written as:

$$h(x,y) = s(x,y)g(x,y)$$

where s(x,y) is a complex sinusoid, known as a carrier, and g(x,y) is a 2-D Gaussian shaped function, known as envelope.

The complex sinusoid is defined as follows,

$$s(x,y) = e^{-j2\pi(u_0x+v_0y)}$$

The 2-D Gaussian function is defined as follows,

$$g(x,y) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}\right)}$$

Thus the 2-D Gabor filter can be written as:

$$h(x,y) = e^{-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}\right)} e^{-j2\pi(u_0x+v_0y)}$$

Whereβ = 0.8 in rain removal and β = 0.5 in snow removal.

C. Hybrid Filter

We expand our algorithm in the image, so we can detect the intensity change between neighbor frames and achieve an accurate detection algorithm. Our detection algorithm is based on many linear filter, so it is very efficient.

Feature 1. Snow is always white and brighter than background.

Feature 2. The saturation is low in the center of snow particle and high in the edge of snow particle.

Feature 3. The directional derivative of saturation in snow particle is positive in the left edge of snow particle and negative in the right edge of the snow particle on x-direction, it is positive in the top edge of snow particle and negative in the bottom edge of the snow particle only-direction. We define three indicators that detect the features of snow. For a given pixel in an image, I_{sat} is the saturation of pixel, I_w is the distance from color of pixel to pure white color, $I_{diffsat}$ reflects the differential feature of saturation.

I_{sat} = min (I_R,I_G,I_B)

I_w = max (I_R,I_G,I_B) − min (I_R,I_G,I_B)

$I_{diffsat}$ = I'_{sat}

We use three shaper filters to recognize the snow particle: saturation filter, differential filter and white filter.

- Saturation Filter
- Differential filter
- White filter

The saturation filter is composed of many rectangle features which calculate the sum of saturation in the rectangle. White rectangle feature responses positive value while black rectangle feature responses negative value. The saturation filter responses large value when the saturation of pixel is larger than that in the around area.

Differential filter $\psi^{diffsat}_n$ estimates differential feature of snow particle. Differential filter responses arge value when differential feature of the region is like that of snow particle.

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

White filter ψ^{w}_n calculates the sum of Iw in a rectangle feature around the pixel. We perform the white balance before the snow detection algorithm, so the center of snow is pure white. White filter responses large value in snow particle.

D. Recovering

A classifier applied to the n th pixel takes the form h (n) i =D (ψ I n >θ). D(s) is a decision stump, it responses 1 when s is true, responses 0 when s is false. A pixel is in snow particle only all the classifiers response the positive value.

In this section, we extract the rain and snow from image. In each frame, we label the foreground region in detected rain and snow region and label the background region.With the labeled background regions, we can extract the rain and snow particle by above three filters.

We get the foreground color by finding the brightest color F_{rain} in rain regions and F_{snow} in snow regions, and estimate the ˆ α value of pixels with the highest confidence. We also reconstruct the background by our proposed method.

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

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

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,

Guided Filter and

Multi-guided Filter

Gabor Filter

Guided filters and Multi guided filters are existing filters, and Gabor filter is a proposed one filter. Above three filters compared by rain and snow detection and removal process in s single color image using Accuracy Results.

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. Enter the values of r and ε where r is the local window radius and ε is the blur degree of the filter.

2. Calculate the values: Mean of I, Variance of I, Mean of P, Average cross product of I and P.

3. Compute the value of linear coefficients. a = (cross_IP – mean_I.*mean_P)./ (var_ I+ ε) b = mean_ P - a. * mean _I

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

Multi Guided Filter

Using Multi guided filter, edges of the image is getting smoothed very much. So the low frequency part contains only these smoothed edges.

We use 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.

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

After using guided filter, high-frequency part remains the non-rain or non-snow component.

On the other hand, using guided filter also makes recovered image blurred. So we change it to make recovered image clear as follow:

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

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.

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

RESULTS

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

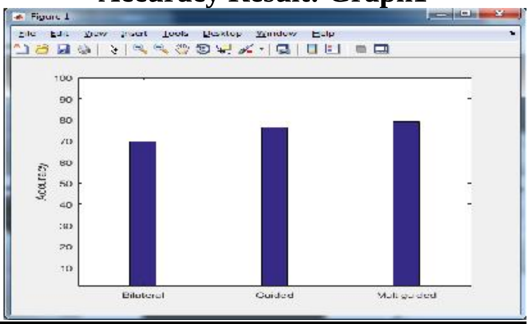
Accuracy: The accuracy of a test is its ability to differentiate the rain portion and normal portion correctly. To estimate the accuracy of a test, we should calculate the proportion of true positive and true negative in all evaluated cases. Mathematically, this can be stated as:

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

Result: 1

Input: 1

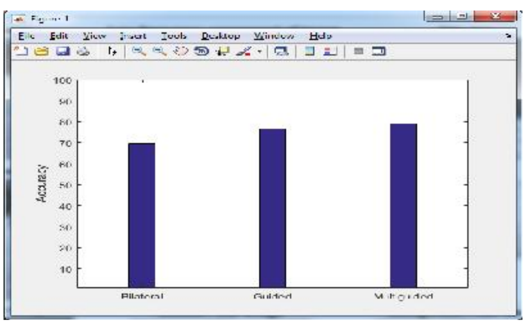
Accuracy Result: Graph1



Result: 2

Input: 2

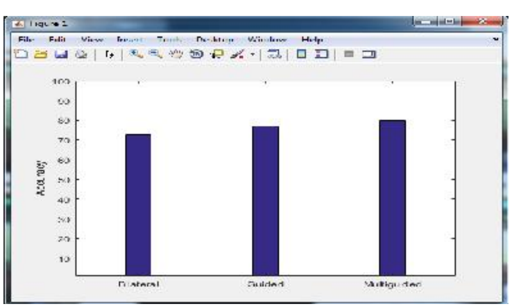
Accuracy Result: Graph 2



Result: 3

Input: 3

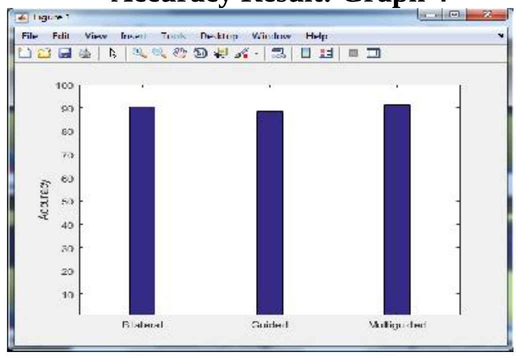
Accuracy Result: Graph 3



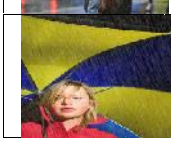
Result: 4

Input: 4

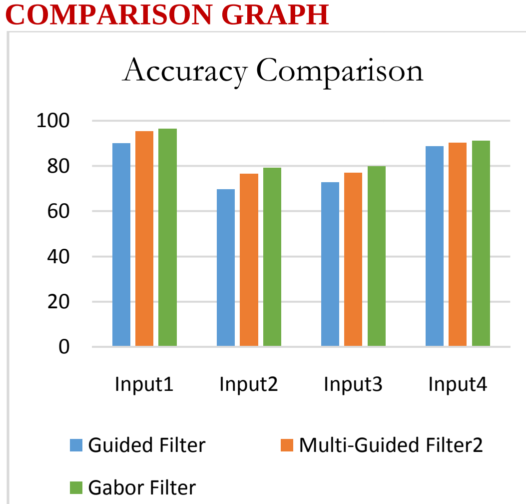
Accuracy Result: Graph 4



RESULTS COMPARISON

Input / Filters	Guided Filter	Multi guided Filter	Gabor Filter
	90.0	95.5	96.3889
	69.6691	76.4926	79.0441
	72.7876	76.9823	79.8673
	88.6526	90.2998	91.2698

COMPARISON GRAPH



CONCLUSION

A novel and efficient rain and snow removal method using Gabor Filter. We detect rain and snow in images, for this detection we used two different methods namely Gabor filter method and Hybrid filters detection.The hybrid filters is a combination of three shaper filters are called as saturation filter, differential filter and white filter. We expand our algorithm in the image, so we can detect the intensity change between neighbor frames and achieve an accurate detection algorithm. We further make it more clearly based on the properties of clear background edges. Our results show that it has good performance in rain removal and snow removal.

Experimental results section we compare different filters results of Rain and Snow Detection and Removal of Single color images in MATLAB Filtering Concepts. Guided and Multi guided filters are existing filters, and Gabor filter is a proposed one filter. These three filters compared by rain and snow detection and removal process in s single color image using Accuracy Results.

We show that three filters accuracy value in results section. And also show comparison graphs for filters. In this results we achieve best accuracy value for all inputs. Our Gabor filterhave high accuracy value comparing to other existing filters.

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