Rain Streaks Removal in Image via Decomposition and Visibility Feature Saturation

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Abstract

The rain like streaks or spots in the gray or colour image may degrade its quality. Several removals techniques are available to remove by using high frequency components which may increase unnecessary intensity. In this paper we are comparing the rain removal algorithm by traditional decomposition methods with visibility features extraction methodology. The frequently used saturation-visibility feature (SVF) rain and removal mainly used orientation filter with digitally controlled high pass filter or HPF. The visual depth guide or VDG may by help of the common morphological features. The high-frequency fragments, histogram of adjusted grades, popular Eigen colour, strength of ground are necessary for extract rain are discussed in this paper. Different experimental results are compared the efficacy of the rain removal algorithms and the result shows that VDG is better than the SVF method but required more computations time.

Keywords

Image decomposition method, Morphological component analysis, Raindrops omitting process, Rain removal methodology, sparse representation process, Saturation feature extraction

I. INTRODUCTION

The image processing techniques are essential tools for film industry as well as in criminal conviction. One of the important analysis is the deduction of rainfall streak removal catching much awareness [1–6]. Basically it is used for the image enhancement. Garg et al worked on dynamics-correlation of rain droplets identification and removal process in videos and many more application [2-3]. Barnum et al. proposed the simplified model rain or snow streak detection for a single image [1]. Bossu et al. [7], extended this work depending on the regulations of photometry and size which are useful for various selection and modify of particularly basic latent rain streaks for high quality video and streaming images. Orientations histogram of the rain streaks may be estimated with the help of traditional geometric analysis. Different studies [8-9] are based on raindrop recognition in both images and

videos considering rain streaks appeared in different detection.

Both non-rain and rain parts of any particular image and the proper detection of this kind of rain streaks erasing is a very difficult task. Here, we mainly compared a single-image along with rain streaks in the random direction removal by morphological component analysis (MCA) methodology [11-12]. In this process, a bilateral filter segregates low-frequency (LF) component and high-frequency components (HF) component. The high frequency component decomposed as rain and without rain component by using sparse coding. An intelligent dictionary learning process may be developed using MCA algorithm [15]. The rest of the work is presented as in Section II Saturation Visibility Feature (SVF) image de-raining system followed by sparse coding methodology. In section IV result analysis and comparison and finally conclusion.

II. METHOD BY PEI

The rain removal of the particular region for the visual quality enhancement is based on the morphological features extraction of bright dots [15]. If V and S represent the visibility and saturation in the HSV colour-picture [8], then Eq (1) will be useful to find the basic probable candidate visibility pixels.

$$R_{ini} = (1 - S) * V \quad (1)$$

The power spectral distribution function (PSD) of the rain and snow streaks general 2D frequency region is elliptical nature and directional, but rain drop is unpredictable random in nature and not orientated to any particular directions. Due to this purposed it required to enhance signal strength (Fig.1)

A. The Rain Heightening & Detection Methodology

The basic properties of rain drop in any image have low dispersion and visibility and also affect the pixels. Based on this a simple flow chart is prepared as Fig. 1. The visibility and saturation are merged together by using high pass filter.

Orientation filtrations process: The direction of the rain drops is flow top to bottom which provides the enhanced gray image.

The threshold determination: the threshold is decided by different experimental processes generally 10 to 15

percent intensity, the better results are 13 percent on an average.

Fig. 1. Illustration of saturation feature rain removal methodology.

B. Rain Removal

The identification process of any rain streak in any particular pixels is done by various methods. These pixels need to modify inpainting process [6]. Figure 2 [16] illustrates the general procedure to control the intensity of any picture by using the image inpainting process and the red-region is rainy pixels and represented by “1” and the background region by using yellow colour.

Tofilled by the rain region by manipulation surrounding background with an average value. The simulation of improvedresult is presented in Fig. 3 by the rain elimination.

III. RAINSTREAKS REMOVAL AND ENHANCEMENT TECHNIQUES USING DECOMPOSITION

The basic image component extraction of an image is objective is rain removal. The HF and LF components identify as strain [14]. The MCA image decomposition algorithm is performed into to the HF part decomposed into rain and non-rain component. The rain removal of the particular region for the visual quality enhancement is based on the morphological features extraction. The experimental results shows that VDG decomposition algorithm is provide best result than the SVF method but required more computational time due to geometric component analysis.

0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	1	1	0	0	0
0	0	0	1	0	0	0
0	0	0	0	1	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

(a)

0.2	0.2	0.3	0.3	0.3	0.2	0.4
0.23	0.3	0.2	0.3	0.3	0.2	0.2
0.34	0.4	0.9	0.95	0.1	0.4	0.3
0.12	0.3	0.2	0.93	0.2	0.2	0.5
0.2	0.3	0.4	0.3	0.89	0.3	0.3
0.5	0.6	0.6	0.3	0.3	0.4	0.2
0.7	0.5	0.4	0.2	0.1	0.1	0.2

(b)

0.2	0.2	0.3	0.3	0.3	0.2	0.4
0.23	0.3	0.2	0.3	0.3	0.2	0.2
0.34	0.4	0.281	0.281	0.1	0.4	0.3
0.12	0.3	0.2	0.281	0.2	0.2	0.5
0.2	0.3	0.4	0.3	0.281	0.3	0.3
0.5	0.6	0.6	0.3	0.3	0.4	0.2
0.7	0.5	0.4	0.2	0.1	0.1	0.2

(c)

Fig. 2. Representation of image pixels, (a) the rain streaks, (b) inpainting, and (c) visibility after inpainting.

A. Pre-processing

Bilateral filtering process in the original figure I to separate current component I_{LF} and I_{HF} i.e. based on current frequency component $I = I_{LF} + I_{HF}$ in the pre-processing segment. This filter also provides smoother output image. A rule can be proposed based on the D_{HF} dictionary along with the two sub-dictionaries, D_{HF_G} where

$$D_{HF_R}(D_{HF} = [D_{HF_G} D_{HF_R}])$$

Geometric and rain parts I_{HF} and optimized by Eq.(2),

$$\theta_{HF}^k \in R^m \min \|b_{HF}^k - D_{HF} \theta_{HF}^k\|_2^2 \text{ s.t. } \|\theta_{HF}^k\|_0 \leq L \quad (2)$$

Where $b_{HF}^k \in R^n$ and

$$I_{HF}, k = 1, 2, \dots, P, \theta_{HF}^k \in R^m$$

for the sparse coefficients of b_{HF}^k for $D_{HF} \in R^{n \times m}$, $n \leq m$, and L

The highest degree of the existing nonzero coefficients of b_{HF}^k . The sparse coefficients are θ_{HF}^k maximum nonzero elements of I_0 are consider for this process [13]. Therefore, solving such problem Eq. (3) is more useful.

$$(\theta_{HF}^k)^* = \arg \min_{\theta_{HF}^k} \left(\frac{1}{2} \|b_{HF}^k - D_{HF} \theta_{HF}^k\|_2^2 + \lambda \|\theta_{HF}^k\|_1 \right) \quad (3)$$

where $(\theta_{HF}^k)^*$ represent the regularization extreme limit. All patch b_{HF}^k used for reconstruct and rain high frequency component depending on nonzero coefficients of θ_{HF}^k for D_{HF-G} or D_{HF-R} .

B. General Algorithm for Rain Streak Removal Methodology

Input: Image along with rain streak and output: the rain streak removed from the output.

Step 1: Extract the low frequency current component (I_{LF}) and high frequency current component (I_{HF}), for $I = I_{LF} + I_{HF}$ by using bilateral filter.

Step 2: Extract the image patches $y^k \in R^n$ from I_{HF} , where k is integer use for online dictionary learning which is used for sparse coding for

$$D_{HF} = \arg \min_{D_{HF}} \sum_{k=1}^p \left(\frac{1}{2} \|y^k - D_{HF} \theta^k\|_2^2 + \lambda \|\theta^k\|_1 \right)$$

Step 3: Dictionary D_{HF} can be used for sparsely represent y^k , where k is positive integer.

Step 4: Extract HOG features for D_{HF} . to classify all of the atoms formules into The K-means algorithms used two distinct clusters depending HOG features.

Step 5: Detect the proper clusters in the “rain and also geometric sub-dictionary,” D_{HF-R} & D_{HF-G} . with the help of MCA algorithm for input-output transformation time.

$$\theta_{HF}^k \in R^n \quad \min_{\theta_{HF}^k} \|b_{HF}^k - D_{HF} \theta_{HF}^k\|_2^2 \text{ s.t. } \|\theta_{HF}^k\|_0 \leq L$$

For each patch $b_{HF}^k \in R^n, k = 1, 2, \dots, p$,
in I_{HF} with respected to
 $D_{HF} = [D_{HF-G} | D_{HF-R}]$

Step 6. Each patch b_{HF}^k may be used for reconstruct by using either I_{HF}^G and I_{HF}^R of I_{HF} on the sparse coefficient by the rain removed scheme by using $I^{Non-Rain} = I_{LF} + I_{HF}^G$ expression.

C. Removal of Rain Streaks Methodology

Depending on reference dictionaries D_{HF-R} and D_{HF-G} , [15] MCA algorithms dictionary learning process is complete easily. The sparse coding necessary for patch b_{HF}^k with for $D_{HF} = [D_{HF-R} + D_{HF-G}]$. The actual geometric component noted as I_{HF}^G or component due to rain strikes I_{HF}^R of I_{HF} is depending parameter θ_{HF}^k and it coefficient tense to zero D_{HF-G} to $\tilde{\theta}_{HF}^k$ for minimum. All type of patch generally b_{HF}^k or

$$\tilde{b}_{HF-R}^k = D_{HF-R} \times \tilde{\theta}_{HF-R}^k \text{ or } b_{HF-G}^k = D_{HF-G} \times \tilde{\theta}_{HF-G}^k,$$

which recover I_{HF}^R or I_{HF}^G . Finally, the subject image is obtained

$$I^{Non-Rain} = I_{LF} + I_{HF}^G.$$

IV. RESULTS AND DISCUSSION

Fig. 3. Different image extraction process left images are gray image and right images are for colour image (a) original image, rain strikes are visible (b) feature based strikes (c) result by using decomposition method.

Rain streaks removal process easily execute in MATLAB (Intel Core i5-540M processor) with minimum 4-GB memory. The computational time for the bilateral filtering time, dictionary learning process & partition methodology, and sparse coding methodology etc. The implemented and execute process MATLAB (Intel Core i5-540M processor) environment each test images is shown in Fig. 3.

The feature based extraction technology provide near optimum result with decomposition methods. The decomposition method provide more clearer image quality but more computational process cost in terms of executions time and input-output transformation time.

V. CONCLUSION

The rain removal method based on feature extraction process works good for simple and small

rain drop omitting but it is a single-image-based rain streak removal process. The visual depth guide or VDG may by help of the common morphological features. The high-frequency fragments, histogram of adjusted grades, popular Eigen colour, strength of ground are necessary for extract rain are discussed in this paper. Different experimental results are compared the efficacy of the rain removal algorithms and the result shows that VDG is better than the SVF method but required more computations time. From the complexity point of view SVF is suitable techniques for single image removal process.

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