Rain Remove for Single Image based on DenseNet

7934

Qiming Li,Luoying Qiu,Likai Wang
Shanghai Maritime University

Introduction

Computer vision systems are susceptible to weather under outdoor conditions. Especially on rainy days, the rain streaks can seriously reduce the quality and clarity of images under the effect of the light scattering so that making the image contrast and visibility reduced, which will seriously interfere with the normal work of the computer vision system, including video surveillance, target detection, and recognition tasks, and ultimately affect the human understanding of the acquired images.So, it is important to remove rain streaks from images and preserve image information meanwhile. For removing rain from a single image, the existing methods, whether based on prior knowledge or neural network, are either excessive or incomplete. In order to effectively remove rain streaks from a single image, the guided filtering is proposed for image pre-processing, the DenseNet is used as the basic network, and the dense blocks with different structures are used to build rain removal network.

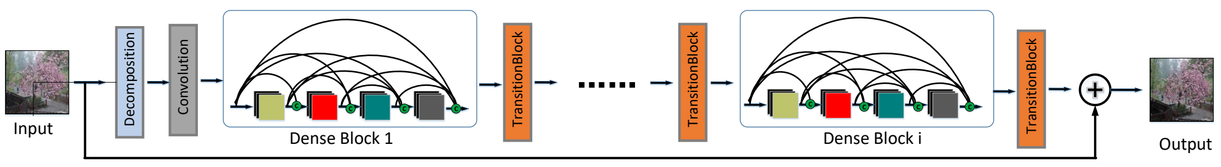
Methods

First, using guided filtering to remove interference from complex background of the image and decompose the image, obtaining a layer of high-frequency detail where rain streaks and image contours co-exist. Then, taking advantage of the parameter sharing and feature reuse of dense neural network, the obtained high-frequency layer is used as input to a dense neural network to generate the residual mapping between images containing rain and rain-free images. Finally, the network uses the rain streak residual information to output rain-removal image with better preservation of the original image texture.

➢ Image processing

Because the high-frequency layer of the image contains the majority of the rain pattern information, a guided filtering algorithm is used to decompose the rain image into basic layer and high-frequency layer. Guided filtering involves adding guided image information to determine pixel values during the filtering process. Image input devices can determine pixel density by guiding the image to generate weights. Either a single image or an input image can be used as a guide image. When the input image is utilized as a guiding image, the guided filtering turn into a denoising filtering, which allows the processed image to retain the image edge contour.

➢ The Network structure



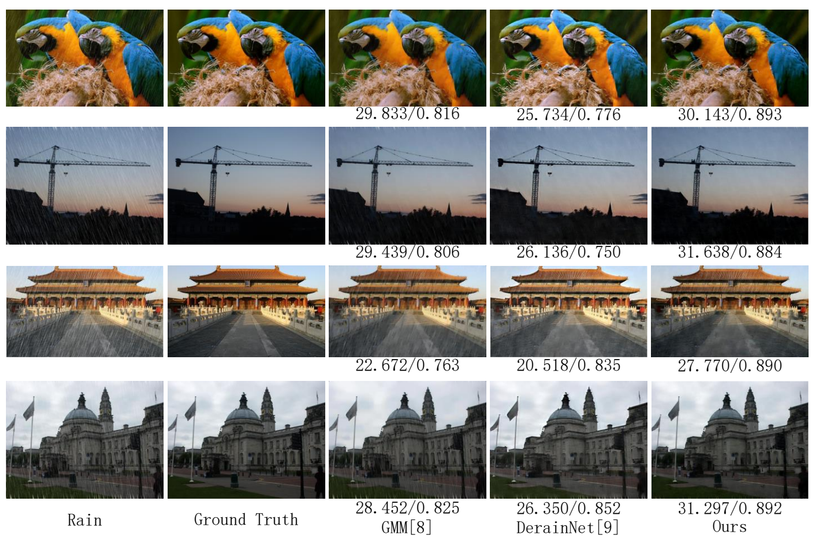
First, the input image is decomposed by guided filtering to obtain high-frequency layers containing rain streaks and image background contours. Then, it passes through convolution with a step size of 1 and a convolutional kernel of 3×3, which is then fed into a dense network of Dense Blocks and Transition Blocks. After a series of feature extraction, the extracted rain bond residual map is superimposed on the input rain image to obtain the output rainfall removal map.

➢ Residual Learning

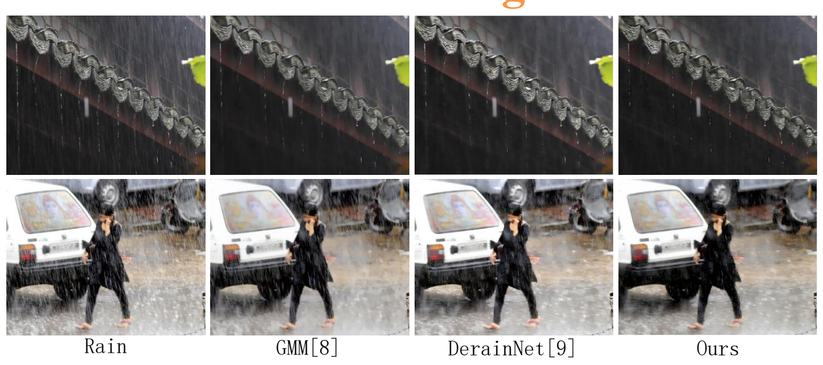
The network is trained on multiple image high-frequency layers to minimize the objective functions to adjust network parameters.Using the trained network model and inputting the rain image, the rain streaks can be extracted. The rain steaks are overlaid with the firsthand rain image to get the final image of removing rain.

Results

➢ Results on synthetic dataset



➢ Results on real-world rain images



➢ Results on real-world snow images

Conclusions

A single image rain removal algorithm based on dense neural network is proposed in this paper. To improve the feature extraction capability of the network, we use guided filtering as the pre-processing step of the network and train the network model at the high-frequency layer obtained by the filter. In order to explore the mapping relationship between the rainfall image and the clean background image, taking advantage of the high feature reuse rate and parameter sharing properties of the dense neural network. The experimental results show that, the algorithm proposed in this paper performs better than other rain removal algorithms in both synthetic data sets and real data sets.