

# Fast Deep Multi-patch Hierarchical Network for Nonhomogeneous Image Dehazing

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## Abstract

*Recently, CNN based end-to-end deep learning methods achieve superiority in Image Dehazing but they tend to fail drastically in Non-homogeneous dehazing. Apart from that, existing popular Multi-scale approaches are runtime intensive and memory inefficient. In this context, we proposed a fast Deep Multi-patch Hierarchical Network to restore Non-homogeneous hazed images by aggregating features from multiple image patches from different spatial sections of the hazed image with fewer number of network parameters. Our proposed method is quite robust for different environments with various density of the haze or fog in the scene and very lightweight as the total size of the model is around 21.7 MB. It also provides faster runtime compared to current multi-scale methods with an average runtime of 0.0145s to process  $1200 \times 1600$  HD quality image. Finally, we show the superiority of this network on Dense Haze Removal to other state-of-the-art models.*

## 1. Introduction

Outdoor images are often deteriorated due to the extreme weather, such as fog and haze, which influences visibility issues in the scene because of the degradation of color, contrast and textures for different distant objects, selective attenuation of the light spectrum. Restoring such hazed images has become an important problem in many computer vision applications like visual surveillance, remote sensing, and Autonomous transportation etc. Most of early methods proposed for image dehazing are based on the classic atmospheric scattering model which is shown as the following equation. 1.

$$I(x) = J(x)t(x) + A(1 - t(x)) \quad (1)$$

where,  $x$  represents pixel locations,  $I(x)$  is the observed hazy image,  $J(x)$  is the dehazed image,  $t(x)$  is called

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Equal contribution.

medium transmission function and  $A$  is the global atmospheric light. Recently, Deep learning based methods have shown remarkable improvements though those methods suffer from degradation of colour, texture in image, halo artifacts, haze residuals and distortions. In our problem statement, Non-homogeneous haze in the scene can be seen in the real world situation where different spatial domains of the image can be affected by different levels of haze. The degradation level also vary a lot for objects at different scene depth due to non-uniform haze distribution in the image. Few example images of such Non-homogeneous haze are shown in figure 4. Dehazing model should put more effort to handle non-uniform haze and different degradation between different scene depth jointly. Multi-scale and scale-recurrent models can be a viable solution in this type of problem because of its coarse-to-fine learning scheme by hierarchical integration of features from different spatial scale of the image. This type of methods is inefficient because of high runtime and large model size due to a lot of convolution and Deconvolution layers. Apart from that, increasing depth of layers at fine scale levels may not always improve the perceptual quality of the output dehazed image. On the contrary, main goal of our model is to aggregate features multiple image patches from different spatial sections of the image for better performance. The parameters of our encoder and decoder are very less due to residual links in our model which helps in fast dehazing inference. The main intuition behind our idea is to make the lower level network portion focus on local information by extracting local features from the finer grid to produce residual information for the upper level part of the network to get more global information from both finer and coarser grid which is achieved by concatenating convolutional features.

## 2. Related Work

Most early work of image dehazing methods is developed on atmosphere scattering model as it's physical model. In that respect, previous works on image dehazing can be













