

A VISION TO ENHANCE IMAGE



A Vision to Enhance Image Quality and Analysis

Being open and embracing new techniques are crucial to scientific research.

The high-quality images and videos on our smartphones and digital devices nowadays are the product of scientists' scrupulous research on innovative solutions. Prof. Lei ZHANG, Chair Professor of Computer Vision and Image at The Hong Kong Polytechnic University (PolyU), has contributed to this field of study with a vision of enhancing image resolution and quality for our daily life applications.

Prof. Lei ZHANG

Chair Professor of Computer Vision and Image Analysis

Professor of Department of Computing

Highly Cited Researcher:

2015-2022

Clarivate Analytics



“Every time new techniques emerge, the field is greatly impacted. If you cannot catch up, you will lag behind your peers and lose the opportunity.”

Highly Cited Research on Image Enhancement

With research interests focused in computer vision and image processing, Prof. ZHANG's studies have profoundly benefited ubiquitous applications on smartphone and digital cameras. Over the decade, research outputs have contributed to enhancing the quality of photographs on cameras, image editing software and biomedical image analysis.

Prof. ZHANG said, “Being open and embracing new techniques are important to scientific research. The honour to be a highly cited researcher has driven me to a more valuable contribution in this field, with impactful research to generate sustainable influence and value to the society.”

Better picture quality is an end result of image enhancement and analysis, which are increasingly helpful for diverse digital and computer products. Prof. ZHANG's research has substantially influenced the field of image restoration, enhancement and quality assessment.

Image restoration and enhancement aim to reproduce a high-quality image from a low-quality input that is noisy, blurred or low-resolution, while quality assessment seeks to predict the perceptual quality of a given image. Prof. ZHANG's works in these areas are frequently cited by academics and industry professionals for useful and novel ideas and references.

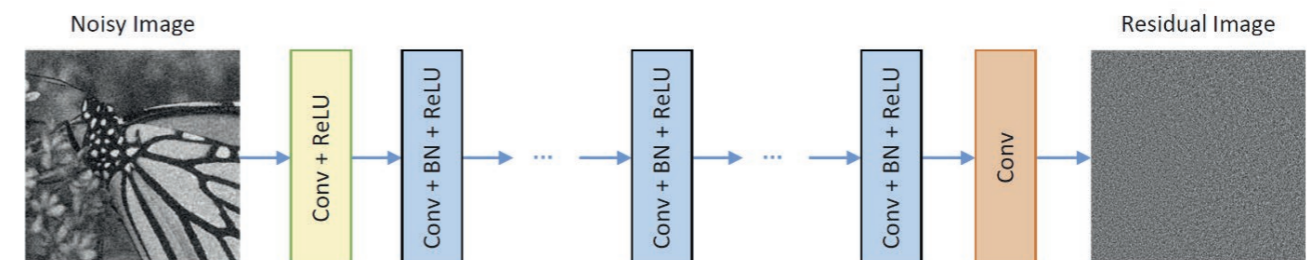


Figure 1. The network architecture of DnCNN.

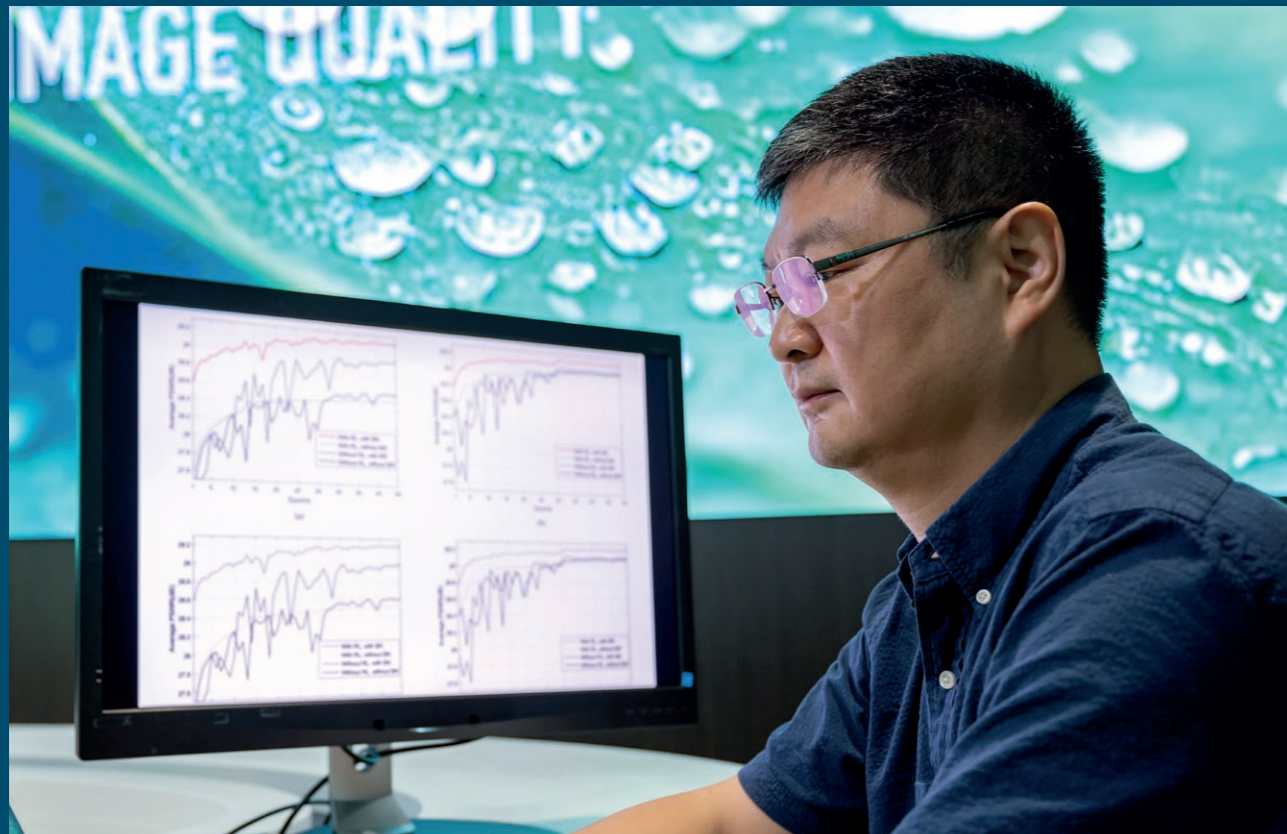
Enhancing Images

Prof. ZHANG's research "Weighted Nuclear Norm Minimization with Application to Image Denoising" showed that the weighted nuclear norm minimization (WNNM) algorithm outperforms many previous state-of-the-art denoising algorithms such as block-matching and 3D filtering (BM3D) for noise reduction in terms of both quantitative measure and visual perception quality. WNNM has become one of the most representative denoising algorithms before the deep learning era.

One of Prof. ZHANG's highly cited papers, titled "Beyond a Gaussian Denoiser: Residual Learning of Deep CNN for Image Denoising" on *IEEE Transactions on Image Processing*, presented one of the first denoising convolutional neural network (DnCNN) models. This research finding not only produces favourable image-denoising

performance quantitatively and qualitatively but also delivers promising run time by GPU implementation. Significantly, it paves the way to investigate proper CNN models for denoising images with complex noise and image restoration tasks.

With the rapid proliferation of digital imaging and communication technologies, image quality assessment (IQA) is crucial for numerous applications such as image acquisition, transmission, compression, restoration and enhancement. A novel feature similarity (FSIM) index for full reference IQA was introduced in the paper named "FSIM: A Feature Similarity Index for Image Quality Assessment". It is proven that FSIM can achieve much higher consistency with subjective evaluations than state-of-the-art IQA metrics.



Open to Change

Technology, particularly in the field of computer science, moves incredibly fast. However, research does not necessarily move at the same speed. In the past 20 years, the dominant technologies in image processing, computer vision and pattern recognition, which are of Prof. ZHANG's research interests, have significantly changed and evolved. From 2006 to 2016, sparse representation, dictionary learning and low-rank analysis dominated the area of image restoration and enhancement. Currently, the focus is on deep learning.

Prof. ZHANG said, "Every time new techniques emerge, the field is greatly impacted. If you cannot catch up, you will lag



Figure 2. Left: an input noisy image. Right: the denoised image by DnCNN.

Research Interests

Computer Vision, Image/Video Processing, Pattern Recognition

Selected Highly Cited Publications

1. K. Zhang, W. Zuo, Y. Chen, D. Meng, L. Zhang, Beyond a Gaussian Denoiser: Residual Learning of Deep CNN for Image Denoising, *IEEE Trans. on Image Processing*, vol 26, July 2017.
2. S. Gu, L. Zhang, W. Zuo, and X. Feng, Weighted Nuclear Norm Minimization with Application to Image Denoising, *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pp. 2862-2869, 2014.
3. Lin Zhang, Lei Zhang, X. Mou, and D. Zhang, FSIM: A Feature Similarity Index for Image Quality Assessment, *IEEE Trans. on Image Processing*, vol. 20, no. 8, 2011.

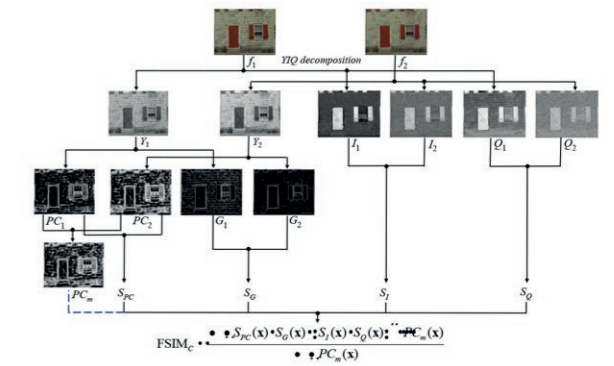


Figure 3. Illustration of the computing process of FSIM index.

behind your peers and lose the opportunity. Therefore, being open to new techniques and keeping exploration for them are key drivers to produce impactful research outputs."

Looking ahead, the computing resources required for artificial intelligence (AI) research also bring many challenges. Nevertheless, Prof. ZHANG added the honour of being a highly cited researcher is a driver to think more and explore deeper to create innovative solutions and excel in technological development.