UNIVERSITY OF TECHNOLOGY SYDNEY
Faculty of Engineering and Information Technology

IMAGE SUPER-RESOLUTION BASED ON FRACTAL ANALYSIS

by

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Certificate of Authorship/Originality

I, Xunxiang Yao, declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Faculty of Engineering and Information Technology at the University of Technology Sydney.

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List of Publications

Journal Papers

J-1. **X. Yao**, Q. Wu, P. Zhang and F. Bao, "Weighted Adaptive Image Super-Resolution Scheme based on Local Fractal Feature and Image Roughness," *IEEE Transactions on Multimedia*, vol. 23, pp. 1426-1441, 2021.

J-2. **X. Yao**, Q. Wu, P. Zhang and F. Bao,"Adaptive rational fractal interpolation function for image super-resolution via local fractal analysis," *Image and Vision Computing*, vol. 82, pp. 39-49, 2019.

J-3. F. Bao, **X. Yao**, Q. Sun, Y. Zhang, C. Zhang,"Smooth fractal surfaces derived from bicubic rational fractal interpolation functions," *Science China Information Sciences*, vol. 61, pp. 1-3, 2018.

J-4. Y. Zhang, P. Wang, F. Bao, **X. Yao**, C.Zhang, H. Lin,"A Single-Image Super-Resolution Method Based on Progressive-Iterative Approximation," *IEEE Transactions on Multimedia*, vol. 22, pp. 1407-1422, 2019.

J-5. Y. Zhang, P. Wang, Q. Fan, F. Bao, **X. Yao**, C.Zhang,"Single Image Numerical Iterative Dehazing Method Based on Local Physical Features," *IEEE Transactions on Circuits and Systems for Video Technology*, vol. 30, pp. 3544-3557,2019.

J-6. P. Zhang, Q. Wu, **X. Yao** J. Xu,"Beyond modality alignment: Learning part-level representation for visible-infrared person re-identification", *Image and Vision Computing*, vol. 108, 104118, 2021.

Submitted Papers

J-1. **X. Yao**, Q. Wu, P. Zhang and F. Bao, "Image super-resolution based on multifractals in transfer domain," *Signal Processing: Image Communication*, Under review, 2021.

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ABSTRACT

Image super-resolution is an important problem in the computer vision field. Image super-resolution aims to generate high-resolution images with an "ideal" appearance from low-resolution ones. From traditional interpolation methods (bilinear, bicubic et al.) to CNN methods, the quality of reconstructed HR image is highly improved. However, most of these methods are failing to keep texture details and edge structure, especially in highly complicated texture area.

To tackle such problems, fractal geometry is applied to image super-resolution, which demonstrates its advantages when describing the complicated details in an image. The common fractal-based method does not distinguish the complexity difference of texture across all regions of image regardless of smooth regions or texture-rich regions. Due to such strong presumption, it causes artificial errors while recovering smooth area and texture blurring at the regions with rich texture. This thesis firstly proposes a rational fractal interpolation model with various setting in different regions to adapt to the local texture complexity. Secondly, it should keep the degree of image roughness non-decreasing, which reflects various texture features and appearance during the image super-resolution process. However, this point is not well addressed in the current work. This thesis argues that reducing roughness during image super-resolution is the key reason causing various problems such as artificial texture and/or edge blur. Here, keeping the image roughness non-decreasing during super-resolution is being well investigated for the first time to our best knowledge. Thirdly, fine details are more related to the information in the high-frequency spectrum on the Fourier domain. Most of the existing methods do not have specific modules to handle such high-frequency information adaptively. Thus, they cause edge blur or texture disorder. To tackle the problems, this thesis explores image super-resolution on multiple sub-bands of the corresponding image, which are generated by NonSubsampled Contourlet Transform (NSCT). Different sub-bands

hold the information of different frequency which is then related to the detailedness of information of the given low-resolution image. Our extensive experimental results demonstrate that the proposed method achieves encouraging performance with state-of-the-art super-resolution algorithms.