Faculty of Engineering and Information Technology
University of Technology Sydney

Single Image Super-Resolution via Deep Dense Network

A thesis submitted in partial fulfillment of
the requirements for the degree of
Master of Engineering

by

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November 2019

CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I, Jialiang Shen declare that the thesis, is submitted in fulfilment of the requirements for the award of Master of Engineering, in the Faculty of Engineering and Information Technology at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

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Date: 6/11/2019

Acknowledgments

Foremost, I would like to express my sincere gratitude to my supervisor Associate Prof. Jian Zhang and my senior fellow Yucheng Wang in Baidu for the continuous support of my master study and research, for their patience, motivation, enthusiasm, and immense knowledge. Their guidance helped me in all the time of research and writing of this thesis. I could not have imagined having better advisors and mentors for my master study.

I also would like to appreciate my co-supervisor Dr. JingSong Xu for his expert and sincere help in the project and providing me with continuous support throughout my master study and research.

I thank my fellow labmates in Global Big Data and Technology Center: Zhibin Li, Xiaoshui Huang and Muming Zhao for the stimulating discussions, and supportive helps in the research periods and thesis writing.

Last but not the least, I would like to thank my parents, for their unconditional support, both financially and emotionally throughout the whole master studying.

Jialiang Shen
June 2019 @ UTS

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Journals

- Yucheng Wang, **Jialiang Shen**, Jian Zhang (2019), ASDN: One Deep Convolutional Network for Any-Scale Image Super-Resolution. *submitted to* 'Transactions on Multimedia (**TMM**)'. IEEE.

Conferences

- **Jialiang Shen**, Yucheng Wang, Jian Zhang (2018), Memory-Optimized Deep Dense Network for Super-Resolution. *in* 'International Conference on Digital Image Computing: Techniques and Applications (**DICTA**)'. IEEE.

- Yucheng Wang, **Jialiang Shen**, Jian Zhang (2018), Deep Bi-Dense Network for Image Super-Resolution. *in* 'International Conference on Digital Image Computing: Techniques and Applications (**DICTA**)'. IEEE.

Abstract

Image Super-Resolution (SR) is a research field of computer vision, which enhances the resolution of an imaging system. The need for high resolution is common in computer vision applications for better performance in pattern recognition and analysis of images. However, recovering of the HR image from LR image is a highly ill-posed problem. In this thesis, the image SR problem is solved from three aspects with deep dense network models, including improving reconstruction accuracy, optimizing model training-time memory consumption, and extending effective SR scale ranges. Chapter 1 introduces the importance of image SR reconstruction and summarizes the challenges of image SR problem. Chapter 2 reviews the existing image SR methods, analyses their limitations and explains some related fundamental theories. Chapter 3 proposes a bi-dense model to improve image SR performance based on the dense connections for feature reuse. The bi-dense network does not only reuse local feature layers in the dense block, but also reuses the block information in the network to archive excellent performance with a moderate number of parameters. Chapter 4 evaluates the memory consumption of the vanilla dense model for image SR. For solving this problem, we introduce shared memory strategy into image SR by proposing a memory-optimized deep dense network. Chapter 5 discovers most of the deep SR methods are inefficient or impractical for generating SR of any scale factor, and proposes a novel Any-Scale Deep Network (ASDN), which requires few training scales to achieve one unified network for any-scale SR. In order to design such a powerful network architecture, we propose Laplacian

Frequency Representation to predict SR results of the small ratio range and Recursive Deployment for SR of any larger scale. In this way, the required training data and update periods are substantially decreased to optimize the any-scale SR network. All these algorithms are aimed to solve the single image SR problem. These algorithms are tested on many public datasets and the results on those datasets demonstrate superior performance of our approach over the state-of-the-art methods and validate the effectiveness and correctness of our methods.