CAPSULE NETWORK BASED SUPER RESOLUTION METHOD FOR MEDICAL IMAGE ENHANCEMENT

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Declaration

I declare that this dissertation does not incorporate, without acknowledgment, any material previously submitted for a Degree or a Diploma in any University and to the best of my knowledge and belief, it does not contain any material previously published or written by another person or myself except where due reference is made in the text. I also hereby give consent for my dissertation, if accepted, to be made available for photocopying and for interlibrary loans, and for the title and summary to be made available to outside organization.

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The above candidate has carried out research for the Masters/MPhil/PhD thesis/ Dissertation under my supervision.

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Abstract

Medical imaging has been one of the most attentive research and development areas since the 1950s, particularly due to the contribution to disease diagnosis. Despite the fact that imaging technologies have been advanced in multiple ways, yet resolution limitations can be observed. To overcome the resolution limitations, various image enhancement techniques have been used. Image Super-Resolution (SR) is the latest technique in the list to achieve higher resolution with much lower resolution images. Earlier, frequency based and interpolation based SR techniques were used for SR. The afterward achievements in SR techniques are obtained via Convolution Neural Network (SRCNN) based methods and have several flaws.

Capsule net (Caps Net) is the state of the art alternative methodology for the problems which were previously solved by CNN. One recent attempt was made to assess the Caps Net for SR task. This new area has a lot to be explored. Especially the time inefficiencies of this approach should be addressed along with accuracy improvements.

In this research several capsule network routing mechanisms have been investigated for Super Resolution pipeline with a medical image dataset. Standard Dynamic Routing and Expectation Maximization Routing methods are re-configured to improve the accuracy. Above all, a novel integration of state of the art routing mechanism, Inverted Dot Product based Attention Routing mechanism is introduced for Super Resolution task.

With 300,000 medical image training pairs and 2,500 evaluation pairs, every model was evaluated. Along with different image quality indexes, it was shown that the Dynamic Routing based method outperformed all methods and the newest Attention Routing based approach has shown similar image quality performance to that of the state of the art method FSRCNN and less time complexity to that of the existing Caps Net based approaches. This implies that clinicians can use this system effectively in a clinical setting.

Dedication

I dedicate this thesis to my parents, my grandmother and my wife who are always withstand in my successes and failures.

Acknowledgment

Throughout the completion of this dissertation I have received great deal of helping hand from many people around me.

I would first like to thank my supervisor, Dr. Subha Fernando for her effort, patient, commitment and guidance for the success of this project. Her expertise was invaluable in formulating the research question and the methodology. Your exceptional support and feedback always helped me to bring my work to a higher level.

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LIST OF ABBREVIATIONS

Abbreviation	Description
SR	Super Resolution
SFSR	Single Frame Super Resolution
DR	Dynamic Routing
EM	Expectation Maximization
Conv	Convolution
Net	Network
Caps	Capsule
GPU	Graphical Processing Unit
FSRCNN	Fast Super Resolution using Convolutional Neural Network
SRCNN	Super Resolution using Convolutional Neural Network
GAN	Generative Adversarial Network
(A)NN	(Artificial)Neural Network
GUI	Graphical User Interface
PSNR	Peak Signal to Noise Ratio
LR	Low Resolution
HR	High Resolution
SSIM	Structural Similarity Index
MSSSIM	Multi Scale Structural Similarity Index
MRI	Magnetic Resonance Imaging
CT	Computed Topography

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