Image Texture Analysis

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Foundations, Models and Algorithms

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Preface

Hello darkness, my old friend
I've come to talk with you again
because a vision softly creeping
left its seeds while I was sleeping
and the vision that was planted in my brain
still remains
within the sound of silence

—Simon and Garfunkel

Research on image texture analysis has made significant progress in the past few decades. However, image texture classification (and segmentation) is still an elusive goal despite a tremendous effort devoted to work in this area. This is perhaps analogous to what Alan Turing proved, "there are many things that computers cannot do" although he also showed us that there are many things that computers can do [1]. Traditional image texture classification usually consists of texture feature extraction and texture classification. This scheme is flexible as many image and pattern classification, segmentation, and clustering algorithms in literature can be used for texture classification once texture features are available. The separation of features and classification has a limitation that texture features extractors must be well designed to provide a representative set of texture features for the classification algorithm. In the past few years, convolutional neural networks (CNN) have emerged as a popular approach for the advancement of image texture classification. The CNNs are being used in not only image classification but also other applications such as machine vision and language translation. It is quite astounding for the CNN algorithm to extract features automatically without human interactions. Unlike traditional artificial neural networks, CNNs can extract features from the spatial image domain. The concept of receptive field used in CNNs is very similar to the spatial filter in the digital image processing.

Our goal in writing this book is to introduce the basics of image texture analysis to a beginner who is interested in pursuing research in this field. Simultaneously, we wish to present the basic K-views models and algorithms for extracting and classifying image textures, which were developed in our research laboratory and collaborations with other research scientists. We also include the fundamentals of popular textural feature extraction methods and classification algorithms to serve as

a solid foundation in this book. The algorithms selected as the basis are carefully decided through our research findings and reformation from the many years of teaching in image texture analysis. Specifically, we divide the book into three parts; Part I consists of Chaps. 1–4 describing the existing models and algorithms. Part II includes Chaps. 5–8 introducing the K-views models and algorithms. Part II is based on the foundation of the papers on the K-views models published in conferences and journals. Part III introduces deep machine learning models for image texture analysis in Chaps. 9 and 10. In order to have complete coverage on image texture analysis in deep machine learning, we present those popular models and algorithms already well developed by many eminent researchers.

If we have learned something from this research area, it is that we are more like the metaphor of "dwarfs standing on the shoulders of giants". We are very grateful to learn so much from the many pioneers who have devoted their time and life to research in this fascinating area. This book is intended for building a foundation and learning the basics of image texture analysis. The recommended audience is senior undergraduate students and first-year of graduate students. Therefore, we have provided examples for the clarification of concepts in the book. We have tried our best to sift through the manuscript. If there are still any errors or typos in this book, it is our responsibility. Please kindly inform us for the correction.

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Reference

1. Harel D (2012) Standing on the Shoulders of a Giant: One Persons Experience of Turings Impact (Summary of the Alan M. Turing Lecture), The Weizmann Institute of Science, Rehovot, Israel

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The skies proclaim the work of his hands;
Day after day they pour forth speech;
Night after night they display knowledge. (Psalm 19: 1, 2)

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