Preface

The main purpose of this book is to bring together a collection of defining works that span the breadth of knowledge in texture analysis - from 2D to 3D, from feature extraction to synthesis, from texture image acquisition to classification, and much more. The works presented in this book are from some of the most prominent international researchers in the field. The reader will find each chapter a defining testament to the state of the art in the area of texture analysis describe therein, as well as a springboard for further investigation into it.

Chapter 1 provides an introduction to texture analysis, reviewing some of the fundamental techniques, amongst them more traditional methods such as co-occurrence matrices and Laws energy measures, and pointers to some of the more recent techniques based on Markov Random Fields (MRFs) and Fractals.

Chapter 2 sees an exposition of the concepts engaging researchers today in modelling and synthesising textures, as well as a comprehensive review of some of the key works in this area in recent years.

The topic of texture classification is arguably one of the most popular areas of computer vision. In Chapter 3, a novel texton based representation suited to modelling the distribution of intensity values over extremely compact neighbourhoods for MRFs is presented. There is also a comparative study of this texton based model against filter bank approaches to texture classification.

Not all textures exhibit a regular structure and therefore some researchers have focused on the analysis of randomly formed textures, such as random patterns printed on a variety of materials. In Chapter 4 a statistical model to represent random textures is outlined which is used for novelty detection in a quality inspection task, and further developed for general image segmentation.

In Chapter 5, a colour image segmentation technique is presented which is a prime example of how texture can be combined adaptively with other

key image information, i.e. colour. Several application areas, including medical imaging, are shown to benefit from using such a combination as a compound image descriptor.

There has been significant advance recently in the practical implementation and investigation of theoretical methods in the area of 3D texture analysis, mainly fuelled by the amazing growth in the computational power of desktop machines. This in turn has permitted further advances in the theoretical study of 3D texture analysis. To reflect the extent of these advances, there are three chapters on 3D texture analysis in this book.

In Chapter 6, the theory of a surface-to-image function is developed to show that sidelighting acts as a directional filter of the surface height function. A simplified version of this theory is then exploited via a classifier that estimates the illumination direction of various textures. Chapter 7 deals with physics based 3D texture models in computer vision and psychophysics, for example showing how the spatial structure of 3D texture provides cues about the material properties and the light field. In Chapter 8, topics in modelling texture with the bidirectional reflectance distribution function (BRDF) and the bidirectional texture function (BTF) are presented. Two particular methods for recognition described in detail are bidirectional feature histograms and symbolic primitives that are more useful for recognising subtle differences in texture.

In Chapter 9, dynamic textures, such as smoke, talking faces, or flowers blowing in the winds, are investigated for which the global statistics of the image signal are modelled, learned, and synthesised to create video sequences that exhibit statistical regularity properties, using tools from time series analysis, system identification theory, and finite element methods.

Chapter 10 returns to the problem of texture synthesis. The method presented considers a hierarchical approach where textures are regarded as composites of simpler subtextures. These subtextures are studied in terms of their own statistics, interactions, and layout to generate highly realistic synthesised scenes such as landscapes.

In Chapter 11, a detailed case study of the Trace transform is presented which not only describes the general concept of the technique, but outlines its implementation in the digital domain, such that the desirable and invariant properties of the features (triple functionals) of the image or texture data are preserved.

Local Binary Patterns have recently become an extremely useful texture analysis tool in a variety of applications, and the second case study of the book in Chapter 12, they are shown in action for a variety of face analysis applications.

Chapter 13 presents a plethora, or what the authors like to call a galaxy, of texture features. This however should be regarded an inexhaustive list of the multitude of texture features available in the literature. Apologies in advance to anyone wondering why his or her favourite feature has not made it into this chapter!

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Majid Mirmehdi
Xianghua Xie
Jasjit Suri