Preface

The main purpose of this book is to provide a comprehensive state-of-the-art survey of the newly emerging area of physically correct visual texture modeling. Multidimensional visual texture is the appropriate paradigm for physically correct representation of material visual properties. The book presents recent advance in the texture modeling methodology used in computer vision, pattern recognition, computer graphics, and virtual and augmented reality applications.

While texture analysis is a well-established research field, it is still predominantly restricted to the simplest and most approximate texture representation—either grayscale or color textures. Several books devoted to such simple static texture analysis have been published, but there is no book dedicated to either the area of more general texture modeling or recent state-of-the-art textural representations.

Several features set our book apart from the few other visual texture books published.

- The only book with comprehensive treatment of texture synthesis.
- The only book covering all known aspects of the most advanced visual surface representation which can be recently applied—the Bidirectional Texture Function (BTF).
- The right timing. This book arrives at a time of advanced computing and graphics hardware which can process and store enormous amounts of data needed for physically correct material modeling and recognition; likewise, recent GPU programming progress allows users to utilize relatively intuitive and economical programming. This allows for fast implementation, thereby enabling real industrial applications of the presented methods.
- A complete reference. This self-contained book covers the entire pipeline from material appearance representation, measurement, analysis, and compression, to modeling, editing, visualization, and perceptual evaluation.

Recent progress in computing and acquisition technology of advanced visual data, together with advances in theories of mathematical modeling, provide us with timely opportunity to achieve new breakthroughs beyond the current state of computer vision art. Finally, it is possible to measure not only the ordinary static color

textures, but also the far more complicated and accurate high-dimensional visual texture representations.

Natural visual textures provide ample information about local lighting field structure as well as the surface relief, accounting for such effects as self-occlusions, self-shadowing, inter-reflection or subsurface scattering. Moreover, the appearance of real materials dramatically changes with, for example, illumination and viewing variations. The prevailing computer vision methodology uses only a small fraction of this readily available and potentially rich information source, but we believe that this emerging research area will soon have significant impacts on further progress in artificial visual cognition and related applications. Our aim is thus to offer the first book with this focus, in order to foster this development.

The book builds on the authors' work in this field over two decades and was inspired by positive feedback to several of our tutorials: *Bidirectional Texture Function Modelling* at CVPR 2010, San Francisco, *Accurate Material Appearance Modelling* at SCIA 2011, Ystad, *Advanced Textural Representation of Materials Appearance* at SIGGRAPH 2011, Hong Kong, and *Advanced Nature Exteriors Modelling* at ICPR 2012, Tsukuba.

The book starts from the basic principles and builds on the fundamentals and basic visual texture taxonomy introduced as a foundation for using the latest techniques in texture modeling. The reader is expected to possess graduate level knowledge in statistics and probability theory as well as competence in basic computer graphics principles. However, it is also suitable for newcomers to the field of computer graphics and computer vision, as well as for practitioners who wish to be brought up to date on the state-of-the-art methodology of texture modeling. This survey book will provide a useful reference and textbook for researchers, lecturers, industry practitioners, and students interested in this new and progressive research area.

We tried to keep the book as concise as possible to maintain its scope at an acceptable level. Rather than explaining mathematical and implementation details of all methods, we refer to the original publications. Our ambition was to provide the reader with general knowledge about state-of-the-art visual texture modeling. Attempting to rigorously explain, for example, the Markovian or mixture models used in this book would require at least twice as many pages.

Prague, Czech Republic

Michal Haindl
Jiří Filip

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