Preface

Quite a few books in computer vision and graphics have been written about faces. Ours focuses on geometric and appearance face modeling from color and depth imagery. It explores various applications in computer vision and computer graphics as well as other areas such as multimedia and human-computer interaction.

We started working on geometric face modeling fifteen years ago. Since then, we have looked at many other related analysis and synthesis problems ourselves and have closely followed work by other engineers. It has been a delight to witness such rapid development in the field. Not surprisingly, a large and sophisticated body of literature has developed. We hope our systematic treatment will provide a good guide for students and a useful reference for experts.

Three factors have contributed to this rapid progress: sensors, computational resources, and new algorithms.

First, imaging sensors have come a long way. Digital cameras are now ubiquitous among general consumers, with almost all laptops and smart phones having built-in cameras. There has been tremendous progress on depth sensors as well. Structured light systems can capture good-quality depth maps in real time. A recent example is the Kinect sensor developed by Microsoft for their XBOX 360 console. These new sensor technologies enable many applications not feasible before, and continue to drive demand for new applications and better image processing algorithms.

Second, many image processing algorithms previously considered expensive are now practical on nearly all computing devices: desktops, laptops, game consoles, and even phones. Faster computers also make it easier to develop and test more sophisticated techniques.

Third, new representations and techniques have developed. For example, linear space representations for shape, albedo, and shading dramatically reduce the number of degrees of freedom needed for recovering face geometry and appearance. Example-based approaches effectively synthesize realistic facial expressions and enhance the appearance of faces.

This book focuses on algorithms for face image analysis and synthesis. Sensors and computational resources are described when needed. Our goal is to present the basic tools and underlying mathematics and physics for studying face geometry and appearance, as well as comprehensively describe state-of-the-art technologies. Work in this area has been spurred by many potential applications, and we present some of them including face anima-

tion, appearance editing, head pose tracking, eye-gaze correction, conversational agent, and human interactive proof.

Acknowledgements: We would like to thank our colleagues and collaborators who have contributed to the book: Dennis Adler, P. Anandan, Dan Bohus, Qin Cai, Michael Cohen, Alex Colburn, Baining Guo, Erik Hanson, Eric Horvitz, Gang Hua, Chuck Jacobs, James Mahoney, Ko Nishino, Jingyu Qiu, Yong Rui, Mingli Song, Dimitris Samaras, Aswin Sankaranarayanan, Ying Shan, Heung-Yeung Shum, Mike Sinclair, Mingxuan Sun, Demetri Terzopoulos, Yang Wang, Zhen Wen, Ruigang Yang, Cha Zhang, Lei Zhang, Qing Zhang, and Qingshan Zhang.

We are grateful to those who provided figures: Lijun Yin, Ko Nishino, Steve Marschner, Duane Molitor, and others who are acknowledged in the figure captions.

We would like to thank John Snyder for proofreading some parts of the book.

We would like to thank Phil Chou and Alex Acero for their encouragement and support and Microsoft Research for providing a stimulating research environment.