Foreword

By Olivier Faugeras

Making a computer see was something that leading experts in the field of Artificial Intelligence thought to be at the level of difficulty of a summer student's project back in the sixties. Forty years later the task is still unsolved and seems formidable. A whole field, called Computer Vision, has emerged as a discipline in itself with strong connections to mathematics and computer science and looser connections to physics, the psychology of perception and the neuro sciences.

One of the likely reasons for this half-failure is the fact that researchers had overlooked the fact, perhaps because of this plague called naive introspection, that perception in general and visual perception in particular are far more complex in animals and humans than was initially thought. There is of course no reason why we should pattern Computer Vision algorithms after biological ones, but the fact of the matter is that

(i) the way biological vision works is still largely unknown and therefore hard to emulate on computers, and
(ii) attempts to ignore biological vision and reinvent a sort of silicon-based vision have not been so successful as initially expected.

Despite these negative remarks, Computer Vision researchers have obtained some outstanding successes, both practical and theoretical.

On the side of practice, and to single out one example, the possibility of guiding vehicles such as cars and trucks on regular roads or on rough terrain using computer vision technology was demonstrated many years ago in Europe, the USA and Japan. This requires capabilities for real-time three-dimensional dynamic scene analysis which are quite elaborate. Today, car manufacturers are slowly incorporating some of these functions in their products.

On the theoretical side some remarkable progress has been achieved in the area of what one could call geometric Computer Vision. This includes the description of the way the appearance of objects changes when viewed from different viewpoints as a function of the objects' shape and the cameras parameters. This endeavour would not have been achieved without the use of fairly sophisticated mathematical techniques encompassing many areas of geometry, ancient and novel. This book deals in particular with the intricate and beautiful geometric relations that exist between the images of objects in the world. These relations are important to analyze for their own sake because this is one of the goals of science to provide explanations for appearances; they are also important to analyze because of the range of applications their understanding opens up.

The book has been written by two pioneers and leading experts in geometric Computer Vision. They have succeeded in what was something of a challenge, namely to convey in a simple and easily accessible way the mathematics that is necessary for understanding the underlying geometric concepts, to be quite exhaustive in the coverage of the results that have been obtained by them and other researchers worldwide, to analyze the interplay between the geometry and the fact that the image measurements are necessarily noisy, to express many of these theoretical results in algorithmic form so that they can readily be transformed into computer code, and to present many real examples that illustrate the concepts and show the range of applicability of the theory.

Returning to the original holy grail of making a computer see we may wonder whether this kind of work is a step in the right direction. I must leave the readers of the book to answer this question, and be content with saying that no designer of systems using cameras hooked to computers that will be built in the foreseeable future can ignore this work. This is perhaps a step in the direction of defining what it means for a computer to see.