PREFACE

"That we see the world as well as we do is something of a miracle. What seems so direct and effortless turns out, on close consideration, to involve many rapid and complex processes the details of which we are only beginning to glimpse."

Francis H.C. Crick, David C. Marr
and Tomaso Poggio, 1980

Writing a book about human vision is difficult to motivate, because the process seems so obvious and simple. After all, we simply open our eyes and see. While an understanding of the goals of the human visual pathway is straightforward, determining the specific computations is often difficult.

Part of the difficulty lies in providing an appropriate framework within which to study the visual system. Neurophysiology has served as a framework for the study of the internal components of the visual system. Similarly, psychophysics has provided the framework for the study of the external behavior of the visual system. In this book, we consider a computational framework that may provide the bridge between the data on external and internal behavior. This computational paradigm provides a framework within which research goals may be framed and studied, and critical questions concerning the structure of the computations involved can be isolated and investigated.

This book documents one such computational study of the human early visual system. It is based upon a Ph.D. thesis, which I wrote at the Artificial Intelligence Laboratory of the Massachusetts Institute of Technology under the supervision of David C. Marr, with the financial support of the Advanced Research Projects Agency of the Department of Defense and the National Science Foundation.

Throughout the development of this book, we will have two goals in mind. The first is to take one more step in an iterative and evolving process of understanding the computations of the human visual system. Although some of the details are not yet completely determined, most of the basic concepts involved in solving the computational problem of surface reconstruction are clearly stated. Our second goal is to illustrate the computational paradigm in which those basic concepts can be elucidated. We will see the importance of the paradigm in allowing us to isolate different levels of description of a computational theory, to determine appropriate questions to be addressed at each level, and to illuminate the interactions of the different levels.

Although there are still many details left to be completed, I hope that the basis for the transformation of image irradiances into descriptions of surfaces has been sufficiently well developed to allow the reader to appreciate both the computational approach to vision and the specific models for stereopsis and visual surface interpolation. For readers interested in a more detailed description of the computational approach, and a much broader discussion of the human early visual system, I highly recommend David Marr's book *VISION: A Computational Investigation into the Human Representation and Processing of Visual Information.*

Ellen Hildreth, who read (almost) more drafts of this manuscript than I did, who provided many valuable comments, and who helped me keep my sanity throughout it all;

and my parents, who taught me long ago that few things are more valuable and lasting than a thirst for knowledge.