Preface to the Fifth Edition

The first edition of this book came out in 1990, and was welcomed by many researchers and practitioners. However, in the subsequent two decades the subject moved on at a rapidly accelerating rate, and many topics that hardly deserved a mention in the first edition had to be solidly incorporated into subsequent editions. For example, it seemed particularly important to bring in significant amounts of new material on feature detection, mathematical morphology, texture analysis, inspection, artificial neural networks, 3D vision, invariance, motion analysis, object tracking, and robust statistics. And in the fourth edition, cognizance had to be taken of the widening range of applications of the subject: in particular, two chapters had to be added on surveillance and in-vehicle vision systems. Since then, the subject has not stood still. In fact, the past four or five years have seen the onset of an explosive growth in research on deep neural networks, and the practical achievements resulting from this have been little short of staggering. It soon became abundantly clear that the fifth edition would have to reflect this radical departure—both in fundamental explanation and in practical coverage. Indeed, it necessitated a new part in the book—Part 3, *Machine Learning and Deep Learning Networks*—a heading which affirms that the new content reflects not only "Deep Learning" (a huge enhancement over the older "Artificial Neural Networks") but also an approach to pattern recognition that is based on rigorous probabilistic methodology.

All this is not achieved without presentation problems: for probabilistic methodology can only be managed properly within a rather severe mathematical environment. Too little maths, and the subject could be so watered down as to be virtually content-free: too much maths, and many readers might not be able to follow the explanations. Clearly, one should not protect readers from the (mathematical) reality of the situation. Hence, Chapter 14 had to be written in such a way as to demonstrate in full what type of methodology is involved, while providing paths that would take readers past some of the mathematical complexities—at least, on first encounter. Once past the relatively taxing Chapter 14, Chapters 15 and 21 take the reader through two accounts consisting largely of case studies, the former through a crucial development period (2012−2015) for deep learning networks, and the latter through a similar period (2013−2016) during which deep learning was targeted strongly at face detection and recognition, enabling remarkable advances to be made. It should not go unnoticed that these additions have so influenced the content of the book that the title had to be modified to reflect them. Interestingly, the organization of the book was further modified by collecting three applications chapters into the new Part 5, *Putting Computer Vision to Work*.

It is worth remarking that, at this point in time, computer vision has attained a level of maturity that has made it substantially more rigorous, reliable, generic, and—in the light of the improved hardware facilities now available for its

implementation (in particular, extremely powerful GPUs)—capable of real-time performance. This means that workers are more than ever before using it in serious applications, and with fewer practical difficulties. It is intended that this edition of the book will reflect this radically new and exciting state of affairs at a fundamental level.

A typical final-year undergraduate course on vision for Electronic Engineering and Computer Science students might include much of the work of Chapters 1−13 and Chapter 16, plus a selection of sections from other chapters, according to requirements. For MSc or PhD research students, a suitable lecture course might go on to cover Parts 3 or 4 in depth, and several of the chapters in Part 5, with many practical exercises being undertaken on image analysis systems. (The importance of the appendix on robust statistics should not be underestimated once one gets onto serious work, though this will probably be outside the restrictive environment of an undergraduate syllabus.) Here much will depend on the research programme being undertaken by each individual student. At this stage the text may have to be used more as a handbook for research, and indeed, one of the prime aims of the volume is to act as a handbook for the researcher and practitioner in this important area.

As mentioned in the original Preface, this book leans heavily on experience I have gained from working with postgraduate students: in particular, I would like to express my gratitude to Mark Edmonds, Simon Barker, Daniel Celano, Darrel Greenhill, Derek Charles, Mark Sugrue, and Georgios Mastorakis, all of whom have in their own ways helped to shape my view of the subject. In addition, it is a pleasure to recall very many rewarding discussions with my colleagues Barry Cook, Zahid Hussain, Ian Hannah, Dev Patel, David Mason, Mark Bateman, Tieying Lu, Adrian Johnstone, and Piers Plummer, the last two of whom were particularly prolific in generating hardware systems for implementing my research group's vision algorithms. Next, I would like to record my thanks to my British Machine Vision Association colleagues for many wide-ranging discussions on the nature of the subject: in particular, I am hugely grateful to Majid Mirmehdi, Adrian Clark, Neil Thacker, and Mark Nixon, who, over time, have strongly influenced the development of the book and left a permanent mark on it. Next, I would like to thank the anonymous reviewers for making insightful comments and what have turned out to be extremely valuable suggestions. Finally, I am indebted to Tim Pitts of Elsevier Science for his help and encouragement, without which this fifth edition might never have been completed.

Supporting materials:

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