

# Computer Vision

A unified, biologically-inspired approach

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The work was performed while the author was with  
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# Preface

Since first becoming involved in research into the factors which control thresholds of human visual performance over 25 years ago, I have become more and more fascinated by the possibilities of computer vision based on human vision. In those early days it was difficult to confirm how human vision worked or, indeed, how such things as display characteristics influenced it. Image quality measurement was still largely subjective, visual physiology and neurophysiology of primates, as opposed to lower animal vision, was in relative infancy, colour vision was open to wide speculation and modern electronic computers, particular digital computers, were also in their infancy. In the 1960's and 1970's I considered myself fortunate, therefore, to have direct and deep involvement in the development of objective image quality measurement, plus wide ranging explorations of thresholds of visual performance. At the same time I was privileged to have close contact with some of the workers involved in the more important work on visual physiology and neurophysiology, whilst being kept aware through colleagues of the developments and advances in electronic computing. As a result, by the mid 1970's I felt that, although the subject was (and still is) highly controversial, I had a fairly clear idea of how at least the early stages of human vision worked and how they interacted with such environmental factors as image quality and display noise. Over the years I have been acutely aware that *my* views on, and interpretations of, human visual function were opposed to those of many others, and often with those of the 'Establishment'. As the studies have progressed I have, therefore, endeavoured to justify at least the *adequacy* of my views by practical demonstration. Over the same period, and up to the present day, I have been delighted to find many new facts and figures concerning visual function emerging which, by and large, are supportive of my approach. However, full justification and demonstration of mechanisms of *human* vision is *not* the purpose of this book, and will not be presented, other than in summary and by inference in *computer* vision demonstrations.

In the mid 1970's I was invited to develop a matrix computer model of the early visual processes based on my interpretation of early human vision, in order to be in a position to model the effects of *specific* local image structure on visual performance thresholds. This activity inevitably drew me closer to digital computing and, in particular, to computer image processing.

As I became more aware of the diverse activities going on in the fields of computer image processing, I felt more and more strongly that many of the techniques and approaches were clumsy, computer intensive and/or imprecise. Added to this, most of the approaches were aimed at one particular facet of the

multidimensional problem of vision. At the same time I became more conscious of the quite amazing speed and fidelity of virtually every facet of *human* visual performance, together with the fact that *all* visual functions develop from a pair of simple optical systems and matrices of detectors. This led me to believe that the detail mechanisms of human vision *had* to be basically simple – in fact *much* simpler than a lot of the computer image processing of which I had become aware. I therefore took on the task of attempting to develop *wide-ranging* and *self-consistent* computer image processing which was itself simple and of high fidelity, by basing it on what I thought I knew, or could infer, about the mechanisms of human vision. The results of these endeavours have, to me, been highly rewarding and have led to a rather comprehensive approach to low level and intermediate computer vision which is the main topic of this book. As with my studies on human visual performance, I am all too conscious that some aspects of my approach are at variance with those of other and established workers in the field. I have therefore, over the last several years, put a lot of effort into justifying and demonstrating facets of the approach. Results and findings have been written up in a large number of British Aerospace PLC Company Reports, with a condensation being published in a smaller number of scientific papers. One main purpose of this book, therefore, is to present the entire subject in one open publication which does not, in general, need reference back to Company Reports. Since the research has been in progress for nearly 15 years, some aspects reported are already several years old, but are included for completeness. Inevitably, *because* some aspects of my approach are ‘unusual’, readers with some previous knowledge in depth of aspects of computer vision may find a number of things to disturb them, particularly in the early chapters. I ask them to bear with me, read the whole book with an open mind, and only then form judgement. I firmly believe that the results *in toto* amply confirm the approach.

The book is considered to be a rather comprehensive, self-consistent coverage of *one* approach to computer vision, with many direct or implied links to human vision. As such, its potential readership should include both established workers in computer vision, the more *practically* biased visual scientists and newcomers to the field (although the latter will need to supplement their reading substantially with more classical texts).

I am highly indebted to my employer, Sowerby Research Centre of British Aerospace PLC, both for continued support over many years in my research and, more specifically, for giving permission for the publication of this book and in practical support towards its preparation. I am also indebted to a small group of colleagues who have greatly assisted me in the practical aspects of computer programming, a discipline in which I am a comparative novice, but with which I have had to become deeply involved in order to explore successfully the many avenues of image processing covered in my studies. My thanks are also due to my colleague John Ackroyd, both for his assistance in administrative matters and for many helpful suggestions concerning the manuscript. Finally, I am indebted to my wife, Dorothy, for passive support during all the time that I have had to shut myself away to prepare the book and for much active help in editorial activities.

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