FUNDAMENTALS OF MACHINE VISION

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To my mother, Anna,
my wife, Nancy, and
my daughter, Krifka

SERIES INTRODUCTION

The Tutorial Texts series was begun in response to requests for copies of SPIE short course notes by those who were not able to attend a course. By policy the notes are the property of the instructors and are not available for sale. Since short course notes are intended only to guide the discussion, supplement the presentation, and relieve the lecturer of generating complicated graphics on the spot, they cannot substitute for a text. As one who has evaluated many sets of course notes for possible use in this series, I have found that material unsupported by the lecture is not very useful. The notes provide more frustration than illumination.

What the Tutorial Texts series does is to fill in the gaps, establish the continuity, and clarify the arguments that can only be glimpsed in the notes. When topics are evaluated for this series, the paramount concern in determining whether to proceed with the project is whether it effectively addresses the basic concepts of the topic. Each manuscript is reviewed at the initial state when the material is in the form of notes and then later at the final draft. Always, the text is evaluated to ensure that it presents sufficient theory to build a basic understanding and then uses this understanding to give the reader a practical working knowledge of the topic. References are included as an essential part of each text for the reader requiring more in-depth study.

One advantage of the Tutorial Texts series is our ability to cover new fields as they are developing. In fields such as sensor fusion, morphological image processing, and digital compression techniques, the textbooks on these topics were limited or unavailable. Since 1989 the Tutorial Texts have provided an introduction to those seeking to understand these and other equally exciting technologies. We have expanded the series beyond topics covered by the short course program to encompass contributions from experts in their field who can write with authority and clarity at an introductory level. The emphasis is always on the tutorial nature of the text. It is my hope that over the next few years there will be as many additional titles with the quality and breadth of the first ten years.

Donald C. O'Shea
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CONTENTS

PREFACE xiii

1 VISION IN HUMANS AND MACHINES 1

1.1 Visual System Mechanics 1
1.2 Visual Perception 4
1.3 Color Perception 14
1.4 Motion Perception 16

2 IMAGE PROCESSING 19

2.1 Image Characterization 19
2.2 Sampling and Quantization 20
2.3 Spatial Frequency Processes 23
2.4 Neighborhood Processes 24
2.5 Point Processes 28
2.6 Image Processing and Machine Vision 30

3 COMPUTER GRAPHICS 33

3.1 Definition 33
3.2 Graphic Objects and Procedures 34
3.3 Usefulness to Machine Vision 36

4 MACHINE VISION 39

4.1 Goals 39
4.2 Finite Image Spaces 41
4.3 Applications 43
4.3.1 Identification and Sorting of Fish 44
4.3.2 Object Counting 45
4.3.3 Vehicle License Plate Number Sensing 46

5 OBJECTS AND REGIONS 49

5.1 Thresholding 49

5.1.1 Optimum Thresholding 51

5.1.2 Class Variance Thresholding 53

5.2 Segmentation 56

5.3 Mensuration 58

6 RECOGNITION 63

6.1 Representation 63

6.1.1 Boundary Descriptor: Chain Coding 63

6.1.2 Boundary Descriptor: Boundary Splitting 66

6.1.3 Boundary Descriptor: Curve Fitting 67

6.1.4 Boundary Descriptor: Signatures 69

6.1.5 Region Descriptor: Topology 70

6.1.6 Region Descriptor: Texture 71

6.1.7 Volume Descriptors 73

6.2 Pattern and Feature Analysis 75

7 IMAGE SEQUENCES 81

7.1 Frame-to-Frame Analysis 81

7.2 Imaging Trackers 83

7.2.1 Differencing Trackers 84

7.2.2 Correlation Trackers 84

7.2.3 Centroid Trackers 87

7.2.4 Gated Video Trackers 88

7.3 Data Management 91

8 VISION SYSTEMS 95

8.1 Survey 95

8.2 Knowledge-Based Vision: VISIONS, ACRONYM, and SCERPO 97

8.3 Model-Based Vision: VITREO and PARVO 100
8.4 Building a Machine Vision System 101

APPENDICES

A Software 105
B Hardware 113
C Ten Common Misconceptions of Machine Vision 121

ANNOTATED BIBLIOGRAPHY 127

INDEX 131

PREFACE

Machine vision has many definitions and is called by various names, often depending on the discipline that one practices. *Computer vision*, *image understanding*, *scene analysis*, and *robot vision* are some of the terms encountered. These terms are derived from computer science, signal processing, pattern recognition, and robotics studies, respectively. In this text, machine vision is explicitly defined as the study and implementation of systems that allow machines to recognize objects from acquired image data and perform useful tasks from that recognition. The term *systems* in this definition includes both hardware and software, with the restrictions that the hardware is constrained to acquisition and processing equipment and that the algorithms perform recognition and reasoning only. This eliminates issues of robots or vehicles, which are best left to other studies. The concept of a *useful task* helps confine the definition to a manageable level, yet be expandable to include large-scale general purpose vision systems.

Although intended as a supplement to a classroom short-course, the book stands alone as a useful self-study guide and is certainly usable as a primary text or supplement for a more extensive course offering. The organization is novel in that machine vision has essentially come of age and we may now view it (no pun intended) as an established and respected field of research and application with a strong theoretical foundation. Without foundation we simply cannot predict outcomes. Fortunately, it is now possible to engage in machine vision design with high probability of success. Because of this, the text takes the reader from fundamentals drawn from image processing and computer graphics to the methods of applied machine vision techniques. This background is then applied to the largely theoretical basis of human vision, which is, of course, the ultimate measure against which a machine vision system is compared.

There is a tendency for writers to feel that "more is better" and to burden a book with excessive coverage to the extent that the reader is overwhelmed. Since the literature on machine vision is so extensive, including a large number of texts, I have restricted the content to include only what is necessary to allow the reader to understand and construct machine vision systems that perform, once again, useful tasks based on the current state of the art. Additionally, I have prepared an Annotated Bibliography as an assist in navigating a sampling of this vast literature.

To fail to include open-ended discussion would expose the book to speedy decline with respect to a rapidly evolving area, so I have endeavored to leave some discussion without closure so as to stimulate new and creative work in this fascinating and dynamic field. As life-long learners we must strive to advance and grow, and it is my sincere hope that this book assists you in that process.

H. R. Myler
August 1998