



Machine Vision: Automated Visual Inspection and Robot Vision*

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THIS IS A very practical book in which Dr Vernon sets out to address the field of Machine Vision from the point of view of operations which can be implemented on an assembly line with the minimum of hardware investment. The book develops the theme of Machine Vision in a logical order beginning with a brief overview of the field then proceeding to describe the typical equipment associated with the area. The chapters then gradually increase in complexity from those operations which manipulate images, through those which analyze images and eventually finishing with those which interpret or attempt to understand images. For those not familiar with the field of machine vision the differences here may be very subtle. Essentially these techniques vary in the form which the output processing takes, the more complex the operation the higher is the level of the output. In image manipulation the output is usually another image suitably enhanced or filtered. In image analysis the output is some symbolic representation of the image such as a region or an edge token. In image interpretation and image understanding the output is in the form of a specific shape or three-dimensional object such as a chair or cup. It is worth noting here that sometimes the term image processing is used for the earlier operation, which I have called image manipulation. This, however, would be only the narrowest definition of image processing and would be disputed by many who work in the field.

Looking briefly at each chapter the first Chapter provides an in-depth introduction to computer vision putting it in context. Chapters 2 and 3 describe sensors and image acquisition. Tables of commercially available cameras and frame-grabber hardware are given. This data is likely to get out of date very quickly, though the author quite sensibly omits to include prices. The frame-grabbers relate mainly to PC and VME based platforms which makes sense in the design of a cost effective industrial system. Unix workstations such as the Sun Sparc and HP are not considered though these are the principal workhorses for academic vision research. The image acquisition includes a brief description of the Fourier Transform and sampling considerations which readers from a non-engineering background should find useful.

Chapters 4-7 provide a readable description of low level image processing techniques in a logical order adopted in several other texts. Basic operations are described both in words and backed up by many pictorial examples. In addition to this a pseudo-code description is provided for many operations, which would conveniently translate to the reader's own favoured programming language (usually C) and answer many of the 'nitty gritty' problems of practical implementation.

The basic image to image operations such as enhancement and thinning are covered in Chapter 4. The operations are put into four categories: (i) point processing operations such as histogram techniques, (ii) region processing operations such as convolution, and (iii) geometric operations such as warping. The fourth topic mathematical morphology, which is an area of nonlinear image processing usually associated with shape analysis, is tagged on here for want of a better place to put it. I would have liked to see it in a chapter of its own, but that is just my prejudice.

Chapter 5 covers image segmentation which is the process of partitioning images into regions. The definition of segmentation here is very broad and incorporates edge detection and edge tracking methods. Segmentation and edge detection are essentially dual operations. Images are said to consist entirely of non overlapping sets of edges and regions. Segmentation is the process of identifying the regions and edge detection is the process of identifying the boundaries between the regions. They are thus opposite approaches to the same end and hence duals. The region finding methods described are the more simple and practical methods based mainly on histogram techniques. They are fast and perfectly adequate in a machine vision environment where the conditions, especially the lighting may be controlled.

Chapter 6 which is entitled "Image analysis" deals mainly with methods of identifying shapes within images. It is a pot-pouri of methods including template matching, the Hough transform and some pattern recognition theory. The techniques are restricted to those dealing with two-dimensional shapes and objects.

Chapter 7 provides an overview of Shape Description techniques in which the author describes various methods of coding object boundaries for storage and recognition. My main criticism of the chapter is that the most recent survey referenced is by Pavlidis published in 1980. I might say, a little 'tongue in cheek', that I would have felt more disposed towards this chapter if the author had included a reference to a more recent review of these techniques, such as Marshall, S., "Review of Shape Coding Techniques", in the *Journal of Image and Vision Computing*, Vol 7, No 4, 1989.

Chapter 8 deals with robot programming and robot vision. It is the chapter which most separates this book from others in this field. It is a case study demonstrating the use of vision as a feedback mechanism to close the control loop. Three-dimensional models of the robots are presented as is a camera model. An example of a generic program to control a robot using visual feedback is given. Then consistent with the very practical theme of the book a structured lighting system is described for the recovery of depth information. Structured lighting is an active technique whereby the distance to an object and its shape are determined by projecting a pattern of light onto it. This contrasts with more complex but less practical methods found in other books.

Finally Chapter 9 provides an introduction to the more complex three-dimensional methods used in image understanding. It looks at visual processes and passive stereo and should convince the reader that the problems are far from solved. Hopefully it will encourage them to read further into this the difficult subject.

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Machine vision is a very hard task. The many problems such as variations in lighting, texture and the three-dimensional nature of the world put the generalized all-purpose vision system beyond current capabilities. This book deals with the tasks which are possible. When these are too difficult it looks at how the problems may be limited and simplified by controlling the environment in which the problem is carried out. In an assembly line or workbench situation this is entirely reasonable and this is where the book is aimed. If the problem was say to monitor cars travelling along a motorway from an overhead camera then it would not be so easy to control the lighting and a more sophisticated processing strategy would be required.

I would see this book as being of the most value to someone setting up an Industrial Vision system rather than a person engaged in vision research. It would make a good first text for an undergraduate course especially one leading onto project work. I enjoyed reading it and I must admit that I will consider it for the final year and M Sc Vision courses which I teach. It would also be useful as a support text for a

short course to industry.

About the reviewer

Stephen Marshall is a lecturer in the department of Electronic and Electrical Engineering at University of Strathclyde, Glasgow. He was born in Sunderland in 1958 and obtained a B Sc Hons (First Class) from the University of Nottingham in 1979. After a brief period at Plessey Office Systems in Beeston he moved to University of Paisley in 1981, where he was a lecturer in the department of Electrical and Electronic Engineering. In 1984 he spent a sabbatical period with the University of Rhode Island, U S A. He has been with the University of Strathclyde since 1986 where he was awarded a Ph D in Image Processing. He has worked in Computer Vision and Image Processing for over 10 years. His main interests are nonlinear image analysis, stereo vision and medical image processing. He is currently chairman of the British Machine Vision Association (Scottish Chapter) and a member of the IEE Professional Group E4 on Image Processing and Vision.