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Three-Dimensional Computer Vision: A Geometric Viewpoint. MIT Press. 1993. ISBN 0-262-06158-9 £58.50. 663pp. hardbound.

This is an excellent book dealing with computer vision problems involving stereo and motion and is necessary reading for anyone interested in the subject. The book is based largely on actual experience that the author and his group have acquired as part of a five year long project carried out by them for the European Esprit 1 program. The goal of the project was to study machine visual perception in the context of a robot moving in an indoor environment. However, the issues addressed are quite *generic* in the sense that they have much wider applicabilty and are relevant to other mobile robotic systems meant to perform a variety of perception and navigation tasks.

There are two characteristic features of the book which make it unique and also the first of its kind. In the first place, the emphasis is on the use of sound mathematical principles rather than on just providing immediately usable techniques (although the book does also include quite a few ready-to-use algorithms). Mastering these mathematical ideas will not only enable one to understand in-depth many of the existing computer vision techniques, but may also enable the design of new techniques.

A second and more interesting characteristic is the use of geometry in introducing the mathematical ideas. The conventional computer vision paradigm stresses the signal processing approach, primarily based on function theory and algebra. This book on the other hand starts with the observable model that the three-dimensional world around us is where a robot has to move and act.

The author has written the book in the style of a text book with a section in each chapter on how to read the chapter, and a set of problems and exercises with their solutions. However to actually base a course on this text book would require supplementary material for some or all of the following:

- signal processing fundamentals, particularly Fourier and other image transforms,
- image segmentation,
- different representation schemes for 2- and 3-dimensional objects,
- representations of symbolic and relational structures for the highest-level processing of scenes,
- frequently available techniques for 'matching' and 'inference', and
- the treatment of colour.

The book contains eleven main chapters, a twelveth chapter that provides the answers to problems and three short appendices that include the necessary mathematical preliminaries.

The main discourse starts with Chapter 2 on *Projective Geometry*. A camera is viewed as a geometric engine that specifies a mapping between projective spaces of different dimensions. Chapter 3 is on *Modelling and Calibrating Cameras*. Taking a simple pinhole camera, the chapter shows how it can be modelled mathematically using the concepts of projective geometry. The treatment also includes mathematical methods for calibrating cameras.

Chapter 4 on *Edge Detection* contains a good survey. Quite understandably, the author has given more stress to the work in this area from his own group. After describing a number of classical edge operators, the author goes into the more recent approaches of Canny and Deriche, with Deriche's filter, including its recursive implementation, described in great detail. (Rachid Deriche was a member of the author's research group). The chapter would have been more comprehensive if the following were also covered:

- image enhancement by 'point processing', such as histogram modifications, intensity transformations etc.,
- edge detection or similar processing of coloured images, and
- discussion of image restoration under various degradation models.

Chapter 5, *Representing Geometric Primitives and Their Uncertainty*, deals with the problem of representing simple geometric entities such as points, lines, planes, and displacements. Although representations for such geometric primitives are very well-known, the situation gets complicated when the problem of error propagation in the measurement of such primitives has to be taken into account. This is a basic problem in computer vision and can be summarised as follows: suppose $g0$ is a geometric representation derived from another, say $g1$. The problem is to compute the uncertainity of $g0$ given the uncertainity of $g1$. It may be noted that hardly any text on the subject has addressed this topic earlier. The author illustrates his idea by means of a concrete example of computing the uncertainty of a 2-D line.

Chapter 6 on *Stereo Vision* addresses the problem of detecting corresponding tokens in two or more different images of the same object/scene. The next three chapters, *Determining Discrete Motion from Points and Lines* (Chapter 7), *Tracking Tokens over Time* (Chapter 8), and *Motion Fields of Curves* (Chapter 9), describe different aspects of motion estimation. Chapter 7, for example, gives a detailed analysis of the intrinsic mathematical difficulty of the problem of estimating the 3-D displacement of a camera given a number of correspondences between geometric primitives in two or three images. Chapter 8 is relatively more algorithmic and the problem of tracking tokens over time is considered. The methods that are described in this chapter are variations on the theme of recursive least-squares estimation and Kalman filtering. Chapter 9 is basically devoted to the well-known concept of optical flow applied to three-dimensional lines and curves.

While Chapter 5 dealt with the representation of

simple geometric primitives, Chapter 10, *Interpolating and Approximating Three-dimensional Data*, addresses representation of higher level geometric objects. The author selects some relevant topics in higher level shape representations, such as shape topologies, stochastic geometry, Delaunay triangulation, etc. and shows applications of these ideas in extracting or reconstructing higher level geometric objects from the data of some sensory processes. Unfortunately well-established 3-D representation schemes have been completely left out.

Chapter 11, *Recognizing and Locating Objects and Places*, deals with the problems of recognizing and locating objects and places to perform navigational tasks by a robot, from the higher level geometric description of objects. This can be regarded as the highest level representation of a scene to accomplish simple perceptual tasks by a machine. Considering the vast amount of work that has so far been done on this topic, this chapter appears incomplete. Short discussions at least on the following issues would have been of interest to the reader and provide a more comprehensive idea about the topic:

- minimum distance classifiers,
- statistical classifiers,
- some discussion on neural networks, and
- syntactic methods for handling structural recognition problems etc.

The language of the book is simple and the presentation concise and logically sequenced. A large number of figures, diagrams, and photographs help the reader in understanding the mathematical concepts easily. In keeping with the high quality of the contents, the printing and production quality are also excellent.

Overall, this is an excellent book highly recommended to all interested in the field of computer vision.

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DONALD R. YAGER and DIMITAR P. FILEV
Essentials of Fuzzy Modelling and Control. John Wiley, 1994, £41.50, 388pp. hardbound. ISBN 0 471 01761 2

This is a very authoritative book written by two authors, one of whom is an internationally recognised expert in the field and another who is currently working on applications. It covers its subject material comprehensively and can justifiably claim to be a leading text in its discipline.

The reader is introduced to the subject with a very gentle explanation of the concept of a fuzzy set but the introductory chapter soon picks up pace and formalism and sets the tone for the rest of the book.

Chapters 2 and 3 are an exposition of the formal mathematics which underpins fuzzy logic. They are well written and very thorough but the mathematics is general and very formal. They will not make easy reading for people who do not have the necessary mathematical skills. These people could have been accommodated by the provision of more worked examples.

Chapters 4 and 5 discuss, respectively, fuzzy control and fuzzy modelling. These two chapters are still very formal but are not quite as intense as the three which precede them. The former draws comparisons between traditional control methods and those using fuzzy logic so a reader familiar with traditional methods should feel very comfortable with this chapter. The same cannot be said of the chapter on modelling. Traditional mathematical and numerical models such as simulations use very different techniques to those of fuzzy models. A reader who is approaching the subject from this background will soon realise that the two approaches do not have very much in common.

The book then enters its most pragmatic phase and gives the reader some respite from formal mathematics. Chapters 6, 7 and 8 deal with the various stages of constructing both fuzzy models and fuzzy controllers. They discuss the design, the implementation, the tuning and the defuzzification of the result (an essential step to produce an output signal for fuzzy control). These chapters give numerical examples of how various techniques are applied and a practitioner could be forgiven for feeling that these are the only chapters which come close to reality.

The final chapter, far from being a conclusion, looks at how two competing approaches, the Mamdani or constructive method versus the logical or destructive method, which are discussed earlier in the book, can be combined and generalised to provide even greater flexibility. It returns to the very formal style used earlier but proposes a very interesting combination of the afore mentioned methods which should provide a useful technique for solving problems which stretch the earlier methods to the limit.

The publishers quite correctly claim that this book is not 'a loose collection of papers' but one gets the impression that it has drawn heavily on this source for much of its material and at times the joins show. For example, in some places both the style and the mathematical notation change. In general, most chapters start with an easy introduction but quickly adopt a style which is not significantly easier to read than those of papers on the subject. In an attempt to comprehensively cover the field, some chapters finish by covering material so quickly that the reader would have to resort to the papers quoted in order to pursue the topic.

This, however, brings with it two advantages for the average reader. Firstly, the authors have provided a most comprehensive collection of apparently carefully selected references. One could pursue these references confident of finding relevant material. Secondly, and rather strangely, the later chapters repeat themselves initially in referring to earlier work in the book. They then branch