
**THE
MACHINE
VISION
SOURCEBOOK**

Don Braggins and Jack Hollingum

IFS (Publications) Ltd, UK
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The Machine Vision Sourcebook

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and
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FOREWORD

It is particularly pleasing to be able to write a Foreword to a book on Machine Vision intended for those who have yet to enter this new and rapidly developing technology. It has taken approximately two decades to move from the research laboratory with machine vision influenced by visual character recognition to the market place where a bewildering choice of machine vision systems are available commercially. En route, technology of computer vision has created spin-off applications in automated visual inspection and visual sensing for robotic applications. Of course, computer vision has influenced other areas of technological application – notably in medicine and the analysis of visual information whether retrieved from microscope or satellite.

To concentrate our minds on the 'target area' of this book, our attention is directed to industrial applications of visual sensing. Inevitably, a great deal of confusion exists in the interpretation of the parameters identified by manufacturers for their specific projects. Mixed in with this is the need to understand the differing philosophies which visual inspection and robot vision impose on commercial products. To use a vision system specifically designed for automated inspection on a robotic application could prove disastrous in terms of response time and cost. Frequently a more pragmatic approach is much more successful in robotic workcells when just limited information of certain component part pictures (for example, perforations) is all that is needed.

Even in 1986, the availability of commercial sensors for robotic applications is largely limited to proximity devices. Only a few manufacturers offer as a standard feature the option of computer vision in a direct attempt to tackle the problem of environmental sensing of the industrial workplace. Consequently, a reliable but simple and fast vision system capable of detecting a corner or a centre of a hole will be of enormous benefit to the successful operation of certain assembly problems, for example. It cannot be emphasised too strongly that a gulf exists between commercial products available for industrial application and the state-of-the-art of vision research in research laboratories. The secret is not to be too clever but to acquire success using an elegant and thoughtful approach in an early application of machine vision.

For the initiated, the more comprehensive specification of machine vision systems incorporating high resolution and grey-scale picture analysis is being helped enormously at the present time through hardware implementation of local-area operators and pipe-lining techniques in computer architecture. The well-established edge extraction algorithms which previously took several seconds to compute can now be done at frame rates – although at a price. These developments coupled with other dedicated parallel processing architectures are just entering the market place for the next generation of vision applications.

To summarise then, we can identify on the one hand the use of simple vision techniques to support robotics operations and on the other hand a much more comprehensive specification to solve really difficult problems for the very brave. It is important to remember that researchers have been proclaiming for a decade and a half that machine vision for inspection and robotics is 'just around the corner'. I believe that we are now only just entering the corner let alone negotiate its angular analogy. Of course research is not slowing down; advanced robotics is dominated currently by the prospects offered by three-dimensional scene analysis and the integration of sensory information arising from a multiplicity of sensors – known as sensor fusion. Keep an eye on this work but do not ignore the proliferation of simpler applications which can so easily be neglected in the excitement of the technology.

Perhaps the most important ingredients in the successful application of machine vision is the sensor itself coupled with the illumination of the scene. There are very few, if any, vision sensors specifically made for robotic applications. We do have a plentiful supply of solid-state cameras designed primarily for the television industry and it is fashionable to re-build some of these sensors in packages more appropriate to robotic applications. It is so easy to ignore the correct specification required for a vision sensor to operate reliably in a rugged environment. Manufacturers need to pay much more attention to the design of vision systems suitable for robotic applications before the machine vision systems already available can be used successfully. Furthermore, the problems of scene analysis can be simplified enormously by careful consideration to lighting in order to keep control of the visual information extracted from the work area. The need for even lighting of a part for visual inspection is self-evident but its control is difficult to achieve. In robotic applications considerable success has been demonstrated by using structured light (usually as a light stripe) projected on to the work area. This, coupled with the simple expedient of back-lighting, is the way to early success and it cannot be stressed too strongly that pointing a camera at a work area in an uncontrolled environment is the most certain recipe for disaster.

A volume such as this is going to be of enormous benefit to those who are entering the technology for the first time. It is to be hoped that the unanswered questions stimulated by its content will in turn encourage users of the technology to read further and to take a closer interest in crucially important developments associated with environmental sensing. We now have direct access to a new technology which can influence flexible manufacture enormously – indeed it might not be possible without it. Researchers since 1960 have been involved in the development of the techniques and it is now up to industry to profit from the investment in research effort.

*Professor Alan Pugh
September 1986*

PREFACE

The need for this 'Sourcebook' became apparent following the success of Jack Hollingum's book 'Machine Vision – The Eyes of Automation' which was published in 1984 with a largely UK outlook on the machine vision industry. The listing of companies and organisations concerned with vision which it contained has become widely used; what was needed was a more international compilation, and, because of rapid evolution of the industry, an updated version of the text.

Part 1 of the book is therefore based on relevant parts of Jack Hollingum's earlier book but has been thoroughly updated by Don Braggins. The text of Part 2 is wholly new and was produced by Don Braggins; the tabulations are based on the results of a questionnaire designed by him, analysed using computer programs written by Jack Hollingum. None of the analysis would have been possible without the hard work of the book editorial staff of IFS Publications, who had to chase in the responses before entering all the data received from the organisations concerned.

Parts 3 and 4 are very largely the work of the organisations featured in Part 2, though to avoid incredulity and boredom the myriad claims to being 'the leading machine vision company in....' have been removed.

A bibliography and glossary complete the book. In compiling the glossary, it became apparent that usages either side of the Atlantic are already beginning to diverge, so do exercise caution and insist that the suppliers define their terms if you are in any doubt. The term grey-level processing seems particularly susceptible to debasement.

The initial mailing of questionnaires was based on listings from the authors' own files and from various publications, notably the first edition of the Directory of the US based Machine Vision Association of SME. Even this combination of sources left some organisations unlisted, so to those who find themselves omitted we can only offer our apologies, and request that they contact the publishers to ensure inclusion in the next edition.

The tabulation and classification of organisations and products has been made very much with the prospective user in mind. The authors felt it important not to over-classify the products, since any detailed specifications are likely to become outdated well within the life of a single edition. What is more important is to know the broad fields of application within which suppliers operate, and of course to be able to identify those who can provide services on a reasonably local basis.

This book does not attempt to teach you how to become a vision expert – what it does do is provide the basis for you to ensure that you are able to select a competent contractor when you utilise vision.

APPENDIX

1. Sample questionnaire used for this edition
2. Notice of subsequent editions – reader registration and updated information

MACHINE VISION SOURCEBOOK QUESTIONNAIRE

This questionnaire is divided into sections; not all sections apply to every type of organisation.

In addition to the information derived from the questionnaire, which will form the basis of the various tabulations to be contained in the sourcebook, you are invited to submit on a separate sheet of paper a 'pen-portrait' (brief description) of your organisation and, if appropriate, its products, services, and distribution arrangements, and one black and white glossy print of a product, installation, or other item of interest. The 'pen portrait' should not exceed 750 words, preferably less. It should cover the following topics:

The organisation – its form and function.

Expertise – indicating the number and vision experience of relevant staff.

Experience – previous experience in machine vision of the organisation.

Products – an opportunity to expand on the 'standardised' information requested.

World-wide resources – an opportunity to expand on the 'standardised' regional information requested, perhaps by listing contacts in major areas.

The content of the 'pen portrait' will need to be somewhat modified for specialised organisations such as publishers, learned societies, etc. 'Pen portraits' may be edited but the information contained therein will not be independently verified.

Appropriate organisations are also invited to submit for consideration a case study, again not exceeding 750 words, with one or two black and white photographs or line drawings. An edited version of selected contributions will be included in the sourcebook. If possible please supply an endorsement from the end-user for the text concerned, indicating whether the endorsement itself may be published.

Note: The compilers of the sourcebook cannot take responsibility for verifying that distribution arrangements indicated by manufacturers and distributors correspond. It is suggested that each should ensure that the other has received, and appropriately completes, a copy of this questionnaire, which may be freely copied. In this context the term 'distributor' is used to cover any form of representation, such as overseas sales offices, agents, appointed systems integrators, etc.

Section 1 – Name and address (applies to all types of organisation)

Organisation's name

Address

Country of location

Telephone

Telex

Electronic mail address (or Telefax) – specify

Contact person and/or job title

(b) Industrial sectors served

- M** – Mechanical engineering
- E** – Electronic and electrical engineering
- V** – Vehicle manufacture
- I** – Instrument engineering
- C** – Chemical industry
- L** – Metal manufacture
- F** – Food, drink and tobacco
- T** – Textiles and clothing
- S** – Service industries and commerce
- O** – Other (specify)

Section 4 – Experience (applies only to organisations identified as ‘M’, ‘S’, ‘B’, ‘D’, ‘I’ and ‘C’, i.e. primary manufacturers, subsidiaries, custom system builders, distributors, systems integrators and consultants).

(a) Years established (organisation need not have been active in vision during whole of period specified).

- A – under 1 year
- B – 1-2 years
- C – 2-4 years
- D – 4-8 years
- E – over 8 years

(b) Number of vision systems installed worldwide as at end of 1985

- A – under 10 systems
- B – 10-20 systems
- C – 20-40 systems
- D – 40-80 systems
- E – over 80 systems

Please indicate precise number on a confidential basis: []

Section 5 – Principals (applies only to organisations identified as ‘S’, ‘D’, ‘I’ and ‘C’, i.e. subsidiaries, distributors, and some systems integrators and consultants).

If appropriate, please indicate names of your principals who manufacture complete vision systems. (Note that, for reasons of space, this information is limited to a maximum of three principals, and does not apply to principals who supply components of systems).

Principal 1 name

Principal 2 name

Principal 3 name

Section 6 – Component suppliers (applies only to organisations identified as ‘P’, i.e. suppliers of component parts for vision systems).

Type(s) of product supplied

(Circle upper case letter if you are a manufacturer, lower case if you are a distributor)

- I** **i** – Illumination equipment
- O** **o** – Optics
- C** **c** – Cameras
- F** **f** – Framestores
- P** **p** – Image processing hardware (including non-industrial image analysis systems)
- S** **s** – Image processing software
- X** **x** – Other (specify).....

Section 7 – Product information (to be completed only by primary vision system manufacturers and system builders).

This section may be photocopied to cover additional models, but the editors may exclude repetitious entries.

Product name

Please circle all letters which apply to the named product (major or minor importance indicated by upper case or lower case, respectively).

(a) Intended application areas

- G g** – Guidance (robots and general)
- W w** – Weld (and other) seam guidance for robots
- C c** – Character recognition
- P p** – Part recognition
- L l** – Linear (one-dimensional measurement)
- M m** – Measurement (two-dimensional, low to medium accuracy)
- A a** – Accurate measurement (CMM type systems)
- F f** – Flaw detection
- S s** – Shape conformity checking
- D d** – Development of applications
- O o** – Other (specify)

(b) Main characteristics of product

Input

- L l** – Linear array camera input
- A a** – Area array camera input
- T t** – Thermionic camera input
- O o** – Other inputs (specify)

Processing

- B b** – Binary image processing (including simple thresholding of a digitised grey scale image)
- G g** – Grey scale processing (arithmetic or edge finding)
- C c** – Colour processing and discrimination

Speed (assume square scenes for linear camera systems)

- V** – Very high speed (> 60 scenes analysed per second)
- H** – High speed (10-60 scenes/second)
- M** – Medium speed (1-10 scenes/second)
- S** – Slow speed (under 1 scene/second)

Cost range of a typical system (excluding custom work and handling equipment), US dollars.

- A** – under \$5,000
- B** – \$5,000 to \$10,000
- C** – \$10,000 to \$20,000
- D** – \$20,000 to \$40,000
- E** – \$40,000 to \$80,000
- F** – over \$80,000

Section 8 – Research centres

Services offered

- P** – Post graduate courses
- S** – Short courses
- I** – Projects with industrial partners
- C** – Consultancy
- L** – Licensing of products or processes
- D** – Contract development
- R** – Contract research
- O** – Other (specify)

Section 9 – Other organisations concerned with vision

Type of organisation

- G – Government department
- L – Learned society
- T – Trade association
- B – Book publisher
- J – Journal (or other periodical) publisher
- F – Trade Fair or Exhibition organiser
- C – Conference organiser
- O – Other (specify)

Section 10 – Additional information (applies to all organisations)

- (a) Have you included a *'pen-portrait'*? Yes/No.
Have you included a photograph? Yes/No.
- (b) Have you included a *case study*? Yes/No.
have you included an endorsement by the end-user? Yes/No.
May the endorsement be quoted? Yes/No.
Have you included photos or drawings as part of the case study? Yes/No.

Section 11 – Pen portrait

Please use this available space below to give a brief description of your organisation and, if appropriate, its products, services, and distribution arrangements. If possible please supply one black and white glossy print of a product, installation, or other item of interest. Ideally this should be approximately 750 words, therefore if necessary continue on a separate sheet.

Section 12 – Case study

Please use the available space below to commence typing your case study. Again this should be approximately 750 words in length, therefore if necessary continue on a separate sheet of paper.

READER REGISTRATION AND UPDATED INFORMATION

Machine vision is a fast-moving area of technology and it is anticipated that demand for regularly updated editions of *'The Machine Vision Sourcebook'* will quickly arise.

If you wish to be advised of new editions prior to publication, please fill in the attached card, and send it to:

IFS (Publications) Ltd
35-39 High Street
Kempston
Bedford MK42 7BT
England

If the card has already been used, a copy of this page attached to your letterhead, giving your name and position within the company, will be sufficient.

All organisations mentioned in this edition will be contacted for updated information for subsequent editions. If you know of, or are a member of, an organisation which you think should be in the book but is not mentioned, please fill in the address of the organisation in the space provided, or advise the authors at the above address.

Please let me know of future editions of *'The Machine Vision Sourcebook'* prior to publication

Name

Position

Company

Address

.....

.....

Tel.

I would like you to include details of the following organisation in your next edition:

Organisation

Address

.....

Contact

Tel.

CONTENTS

1 – Introducing Machine Vision	1
1.1 What is machine vision? 3	
1.2 Why use vision? 17	
1.3 Getting started? 27	
1.4 Working with a supplier 33	
1.5 Future trends 37	
2 – The Sources	43
2.1 Manufacturers and builders of vision systems 45	
2.2 Component part suppliers 89	
2.3 Local sources 97	
2.4 Research and information sources 107	
2.5 Address list 113	
3 – Company Profiles	151
4 – Case Studies	285
5 – Bibliography and Further Reading	345
6 – Glossary of Terms	351
Appendix	359
Sample questionnaire used for this edition	
Notice of subsequent editions	

1

INTRODUCING MACHINE VISION

THIS part of the book introduces the technology and applications of machine vision making no assumptions about prior knowledge of the subject. It does not set out to make the reader an expert in the application of machine vision, but it does indicate some general guidelines for the selection of systems, and tells the prospective user how to get started. It concludes with a brief look at the future trends which can be expected in the field.

