

THE ROLE OF MACHINE VISION SUBJECTS IN ELECTRICAL ENGINEERING COURSES.

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ABSTRACT

Machine vision for industrial purposes refers to processing of one or more frames of image data using computer techniques to enable decisions to be made on the basis of this data. As expertise and applications of this technology increase it will become more and more important that undergraduate education include the basics of this area.

GENERAL

The science of image processing started with the deep space program in the sixties. The Jet propulsion Laboratories (JPL) were given the task of enhancing images sent back at low bit rates by scanning cameras from space missions. Up to the advent of the PC, Image Processing work was only carried out by heavily funded research labs such as MIT AI lab and JPL. Now with cheap frame stores, CCD cameras and PCs Image Processing can be carried out in any properly equipped lab. Machine vision is an important area for Electrical Engineering, and also for other fields of Engineering, such as Manufacturing. It may be incorporated as a subject in its own right or as a part of Instrumentation subjects. A knowledge of Computer programming, C or Pascal is required. Image processing is a heavy user of advanced computing architecture as data arrays are large and many computationally expensive operations, such as the Fourier Transform are used in image processing. This paper outlines application areas, lab requirements and future developments in the area of machine vision.

APPLICATION AREAS

Image processing or machine vision is used in Industrial, Military and Medical applications.

INDUSTRIAL

The applications of Image Processing to Industry are many but they may be grouped under the following application areas.

1. Image enhancement and restoration.
2. Inspection
3. Movement Analysis
4. Security Applications
5. Object recognition

INSPECTION

Inspection refers to the imaging of manufactured goods for quality control purposes and processing of those images to extract inspection data.

MILITARY APPLICATIONS

Image processing is used in all branches of the armed forces.

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Images are produced by infra-red sensors for night observation of shipping, or of intrusion of ground forces. Also Sonar and Radar images are processed by imaging techniques.

Traffic analysis is an increasing field of application of machine vision techniques. Applications are in the main in the research phase but reading of number plates at toll gates is an established procedure. Other possible applications are in the speed camera program both for speed measurement and reading of the speeding vehicles number plate.

The analysis of movement of robot systems and slurries may be made by image processing techniques. Techniques for the detection of slurry movement have been simulated and found to work successfully. Industrial applications of this technique are in the process industries.

In Security applications, two images are taken and by comparing images any movement can be detected and appropriate action taken.

Object recognition is a requirement of Robotic Assembly and requires that the variables of object size, position, rotation and grey level be taken into account.

MEDICAL APPLICATIONS

Image enhancement is used to enhance medical images eg X ray pictures to enable tumors to be more easily identified. Image restoration refers to the regeneration of degraded images. Three dimensional views of body organs may be generated using image processing methods using tomographic data.

LABORATORY PROGRAM

Students need to be able to capture and process images. Lab equipment consists therefore of CCD cameras, frame stores and computer equipment to process the image data. A reasonable set of lab experiments would include

1. Use of camera and frame store to capture an image.
2. Image enhancement using filtering techniques.
3. Object recognition exercise.
4. Principles of Inspection of manufactured objects.

LABORATORY EQUIPMENT

To equip a lab for image processing but not research essentially requires that a set of 386 PCs be fitted with frame stores for holding images and that a number of black and white and at least one colour camera are provided for image capture. One colour frame store as a minimum is needed.

There are a number of American, Japanese and English companies who are producing imaging equipment. These include

Cameras	Canon Javelin Electronics
	Hitachi
Frame Stores	Data Translation
	Boston Technology
	PC Vision
Image processing Boards	Hitachi
	Datacube

Software for use with the above boards is available from the vendors. In addition, image processing software is available from specialised suppliers to run on PC's or Work Stations, eg Sun, Silicon Graphics or Apollo. A software package "Z" is available from the CSIRO also.

New equipment should be colour although not all as long as



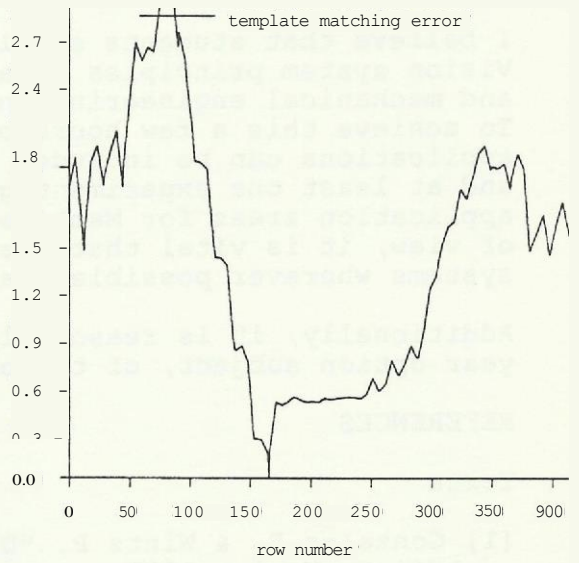
Linah corrupted by noise



Linah rehabilitated by rank filter



Speeding Car Photo



Number Plate Matching Error

some colour equipment is available. Proper lighting equipment is also needed.

Australian agents are Dindema, Data Translation and Matrox for some of the above equipment.

PREREQUISITE SKILLS

Students need a knowledge of a programming language. C is most commonly used but Pascal is satisfactory. A knowledge of Digital Signal Processing is useful for advanced applications.

THE FUTURE

Applications of image processing will increase as expertise to apply this technology is increased and now that image processing equipment is relatively cheap.

The trend is towards colour *imaging rather than* black and white. The ability to synthesise realistic images (Lucas Films, Star Wars) is bridging the gap between computer aided design and image synthesis.

It is no exaggeration to say that Image Processing is a strong world research area. In Australia, BHP, CSIRO and DSTO are active in image research and applications.

PROFESSIONAL BODIES

World professional bodies are mainly under the umbrella of the IEEE. Last year an Australian offshoot of the International Association of Pattern Recognition (IAPR) was formed. (AIAPR) Also in 1989 the first Australian conference devoted entirely to Image processing was run in Canberra.

CONCLUSION

We believe that students should have some knowledge of Vision system principles in all electrical engineering majors and mechanical engineering and manufacturing as well.

To achieve this a few hours of image processing principles and applications can be included in a subject such as Instrumentation and at least one experiment given to alert students to possible application areas for Machine Vision. From an Industrial point of view, it is vital that Australian Industry use Machine Vision systems wherever possible, particularly in manufacturing.

Additionally, it is reasonable to make image processing a final year option subject, of the order of 26-30 hours for one semester.

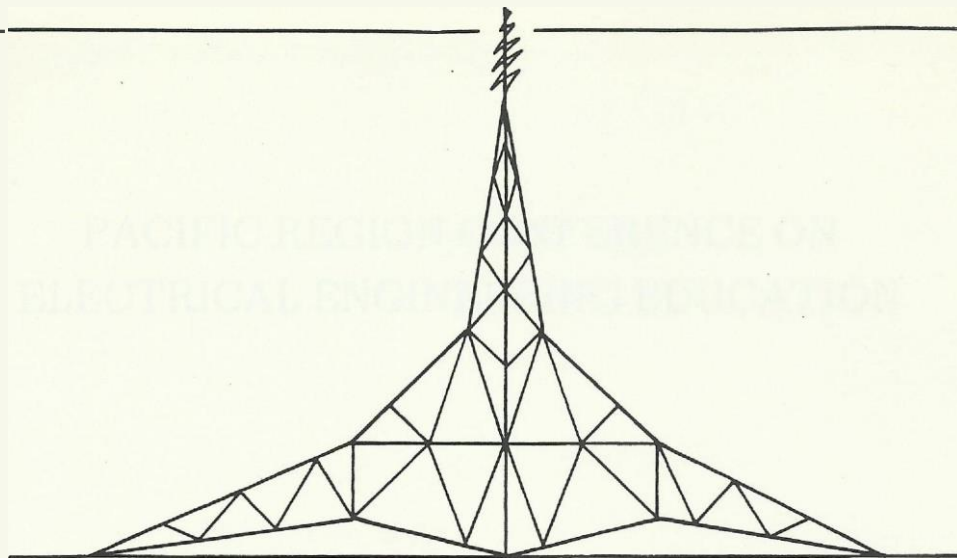
REFERENCES

Texts

- [1] Gonzalez R. & Wintz P. "Digital Image Processing" Reading, MA Addison-Wesley 1977.
- [2] Hall E. "Computer Image Processing & Recognition" New York NY Academic Press 1981.
- [3] Horn B.K.P. "Computer Vision" MIT Press & McGraw Hill 1986.
- [4] Pratt W.K. "Digital Image Processing" Wiley International
- [5] Boyle R.D. Thomas R.C. Computer Vision Blackwell Scientific

Recent Australian Research

- [6] Cooper J. Kitchen L. "Region Based Object Tracker"
Computer Vision Conference pp154-164
- [7] Harvey A.L Phung B. "Image Interference Removal Using
FFT Transform IREE Image Processing Conference
Canberra December 18-21 1989. pp215-218
- [8] Harvey A.L. Cohen H.A. "Image Optical Flow Techniques
for Speed Measurement." International
Symposium on Signal Processing and
Applications Queensland (ISSPA) 27-31 August
1990. pp563-566.
- [9] Kaesler M. "Robotics in Prawn Handling" ARA'90
Melbourne Conference 3-6 June 1990 pp243-248
- [10] Harvey A.L. Cohen H.A. "Speed Up Techniques For Image
Object Recognition" International Conference on
Automation, Robotics and Computer Vision (ICARCV)
Sept18-21 1990. pp965-968
- [11] Harvey A.L. Cohen H.A. "Coarse Fine Template Stretching
for Character Recognition" Symposium, Image
Analysis Society of Australia University of
Melbourne" September 24-26 p30.
- [12] Jarvis R.A. "Eye In-Hand Robot Vision" Robots In
Australia's Future. pp150-161. 13-16 September
1986.



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