Computer Vision Story

Mubarak Shah

Computer Vision

- Computer Vision deals with recovery and use of information about objects present in a scene from images of the scene.

Computer Vision

- Computer Vision emerged from:
  - Image Processing
  - Pattern Recognition

Fairy Tale

- Once upon a time there were two neighboring farmers, Jed and Ned. Each owned a horse, and the horses both liked to jump the fence between the two farms. Clearly the farmers needed some means to tell whose horse was whose.
- So Jed and Ned got together and agreed on a scheme for discriminating between horses. Jed would cut a small notch in one ear of his horse. Not a big, painful notch, but just big enough to be seen. Well, wouldn't you know it, the day after Jed cut the notch in horse's ear, Ned's horse caught on the barbed wire fence and tore his ear the exact same way!
- Something else had to be devised, so Jed tied a big blue bow on the tail of his horse. But the next day, Jed's horse jumped the fence, ran into the field where Ned's horse was grazing, and chewed the bow right off the other horse's tail. Ate the whole bow!

Fairy Tale

- Finally, Jed suggested, and Ned concurred, that they should pick a feature that was less apt to change. Height seemed like a good feature to use. But were the heights different? Well, each farmer went and measured his horse, and do you know what? The brown horse was a full two inches taller than the white one!

- When you have difficulty in classification, do not look for ever more esoteric mathematical tricks; instead, find better features!
- It is “features” stupid!!

Computer Vision

- Computer Vision started as an AI problem.

AI

- Artificial Intelligence is the study of mental faculties through the use of computational models.
  - Search
  - NLU
  - Speech Recognition
  - Games
  - Computer Vision
  - Expert Systems

Image Understanding

- To understand a single image of a scene, locate and identify objects, their structure, and spatial arrangements, and relationships with other objects.

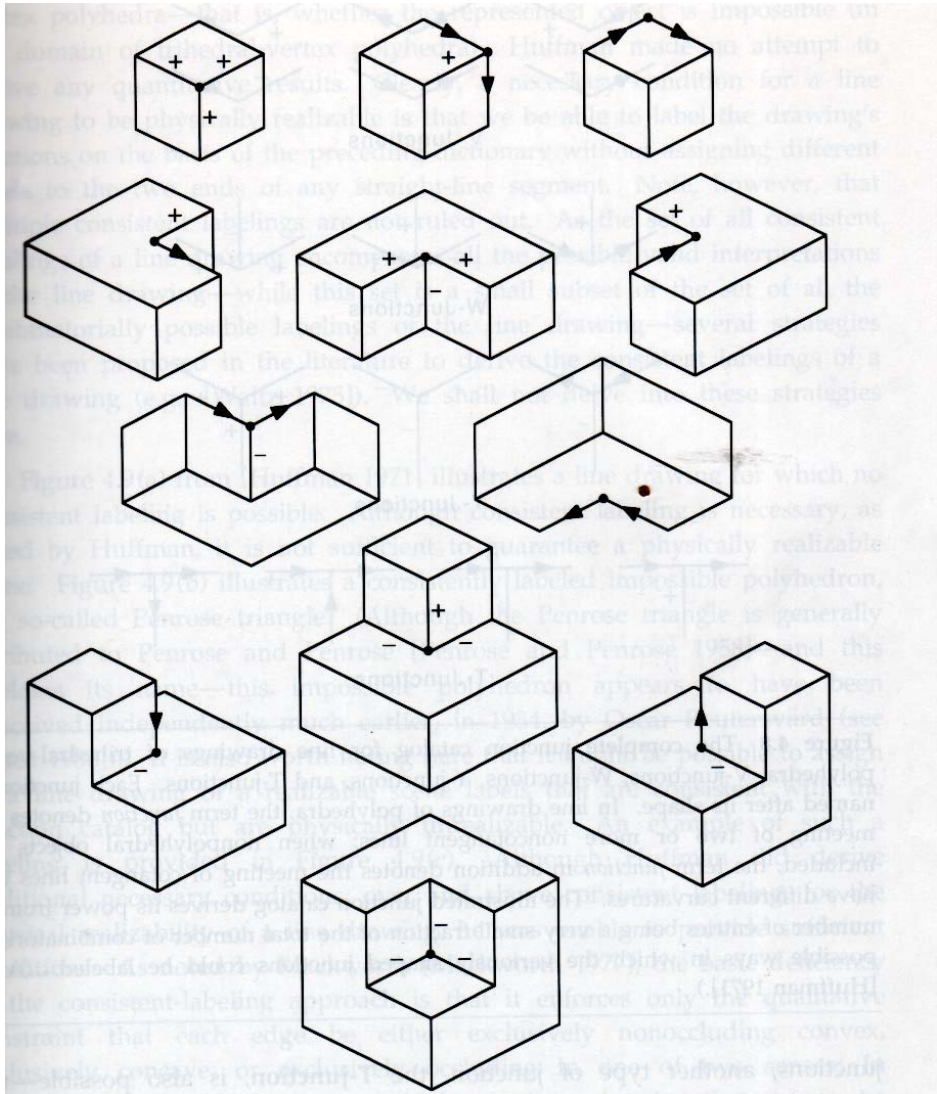
Different Levels

- Low Level: Extraction of symbolic information
- Intermediate Level
- High Level: Interpretation

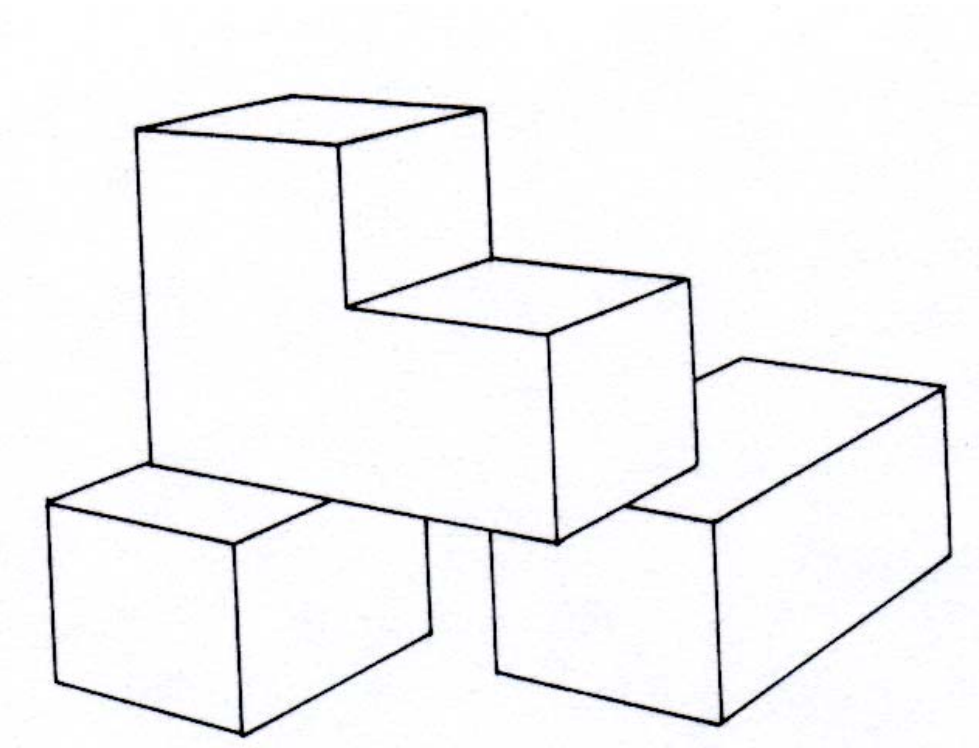
High Level Vision

- Image Understanding
- Scene Interpretation
- Line Drawings

Interpretation of Line Drawing



MIT Copy Demo

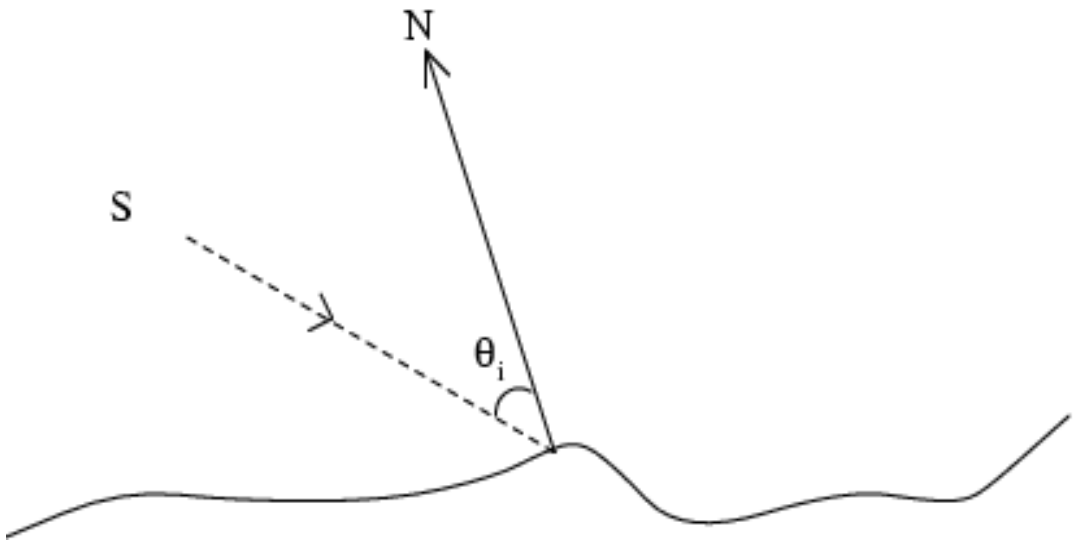


What happened?

- In order to do line interpretation, need to extract lines from images
  - Horn-Binford line finder
  - Solve low level problems before high level problems can be solved.

Horn: Physics Based Vision

- Optics
- Reflectance
- Illumination



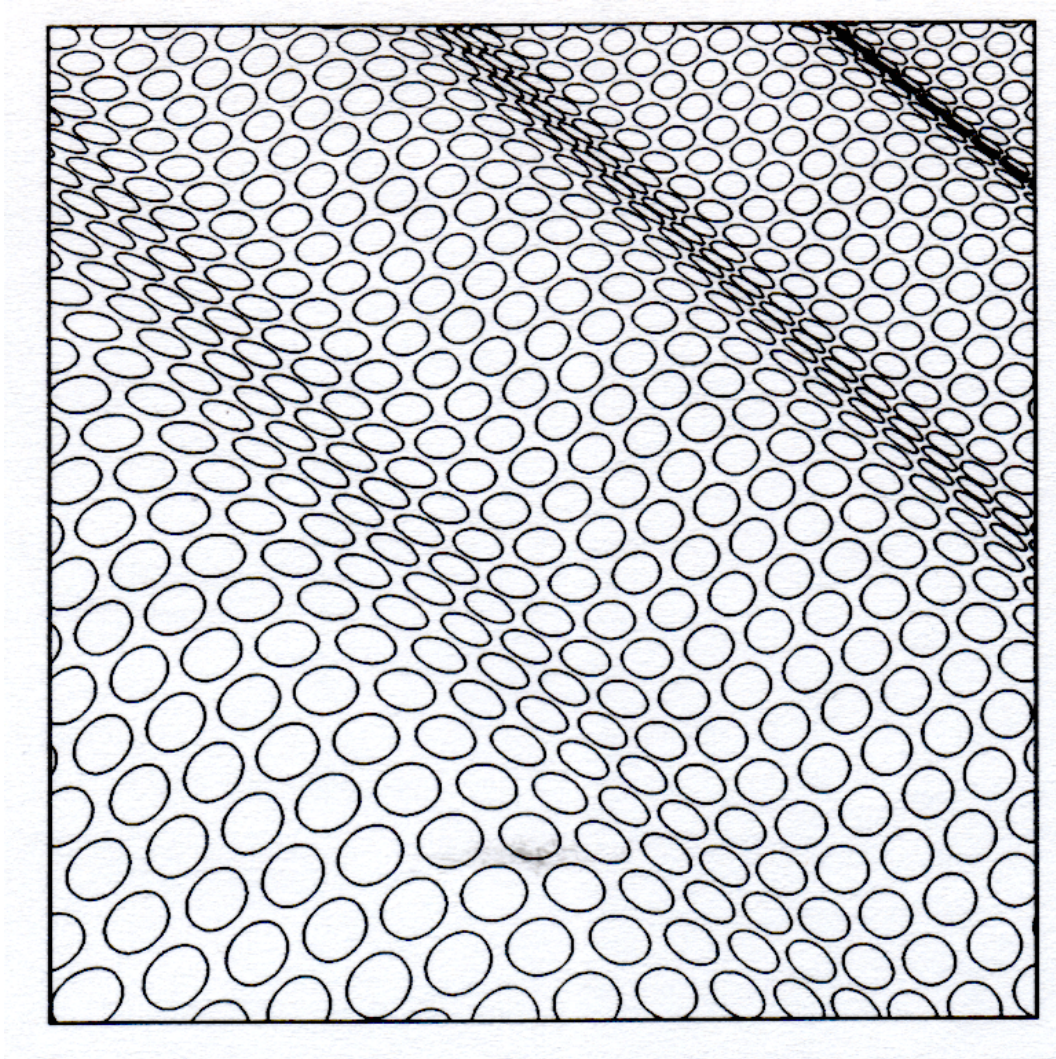
Marr Approach

- **Human vision system**
- **Shape from X: Recover 3-D from 2-D**
- **Quantitative vs Qualitative**

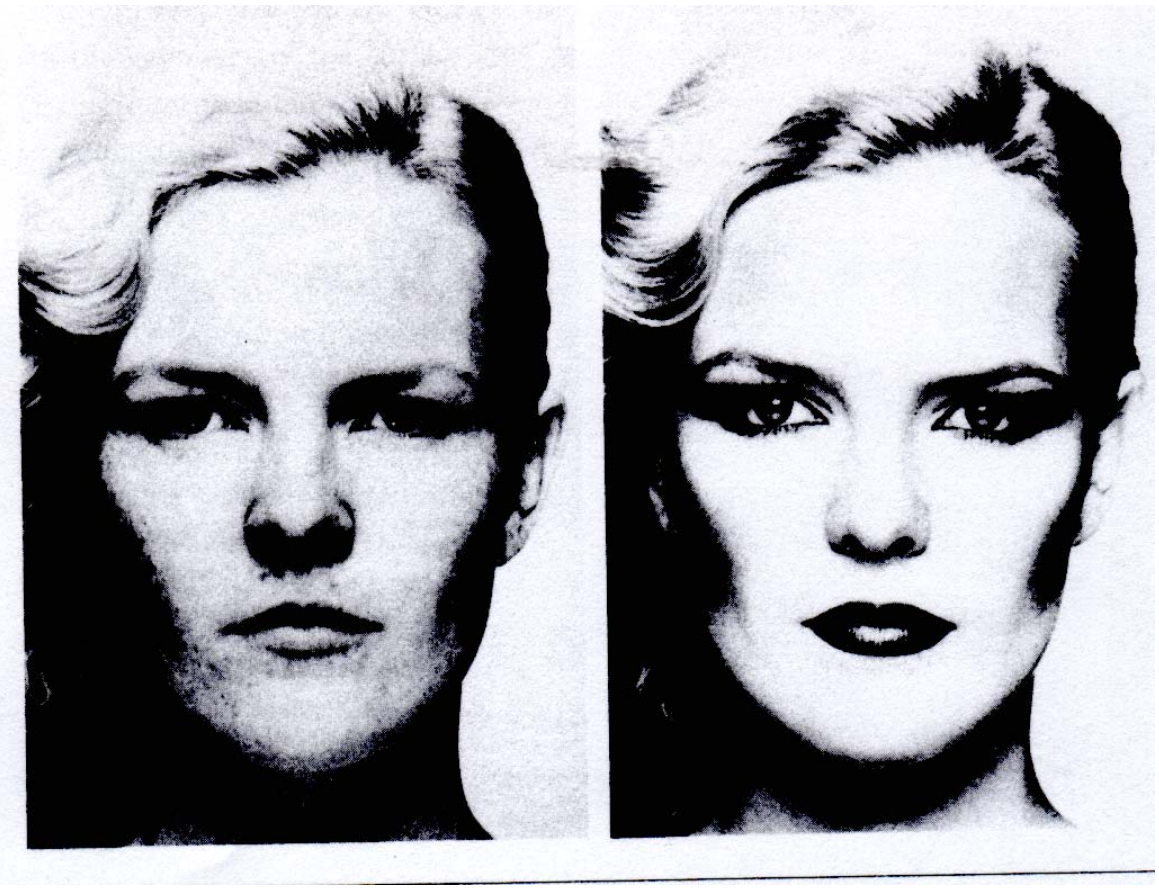
Shape from X

- Shading
- Stereo
- Texture
- Motion
- Contours

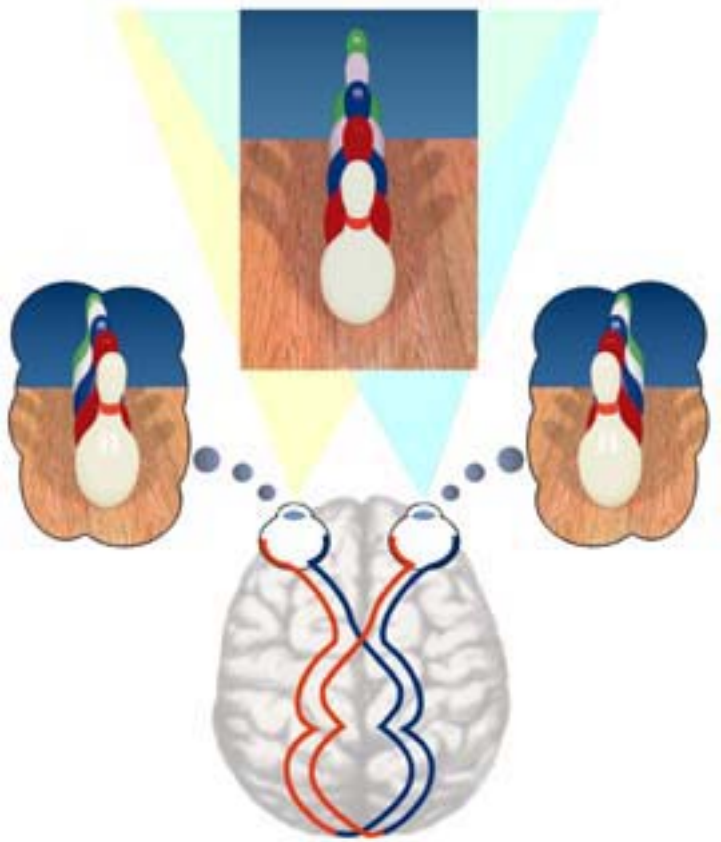
Shape from Texture



Shape from Shading



Shape from Stereo



Marr's Three Levels

- Primal Sketch
  - Marr-Hildreth edge detector
- 2.5 Sketch
  - Marr-Poggio stereo algorithm
  - Grimson's stereo algorithm
  - Ullman's structure from motion
  - Pentland, Witkin, Kass,
  - Terzopoulos: surface reconstruction
- 3-D
  - Generalized Cylinders: Nishihara

After 30 Years of Research

- Stereo is almost a solved problem
- Structure from motion is very hard
- Shape from shading is not interesting/applicable
- Range images did not help much
- Not much progress in understanding/recognition/interpretation

Motion-Based Recognition

- A longer sequence leads to recognition of higher level motions, like walking or running,which consist of a complex and coordinated series of events that cannot be understood by looking at only a few frames.
  - 3-D is not necessary for recognition
  - Use motion directly for recognition vs
    - Recognition followed by reconstruction

Video Understanding

- Gestures
- Activities
- Facial expressions
- Visual Speech

- Applications
  - Video Surveillance and Monitoring
  - Perceptual User Interface
  - Model-based Video Compression
  - Augmented Reality and Video Games
  - Synthesis of Video Sequences

Copy Demo Using A Video Sequence:

Making a Sandwich

[bread, lettuce, ham, bread]

A picture is worth a thousand words.

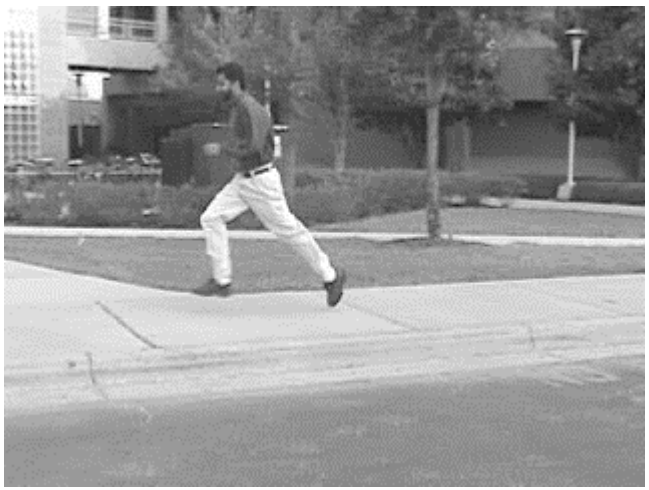
A word is worth a thousand pictures.

A H UNT

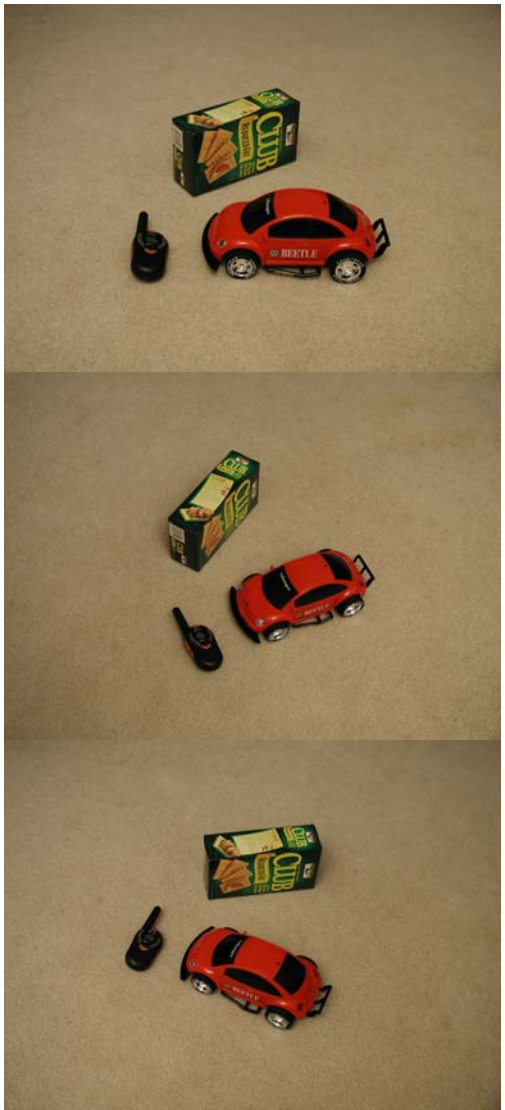
Computer Vision: Outlook

- Video Understanding
- Video Registration
- Video Synthesis
- Video Categorization

Video Registration



Tri-view Morphing: Car-Radio-Box



Scene Representation (Terminator II)

Obtained from the DVD

Chapter 21: Syringe Point


Detected by our algorithm

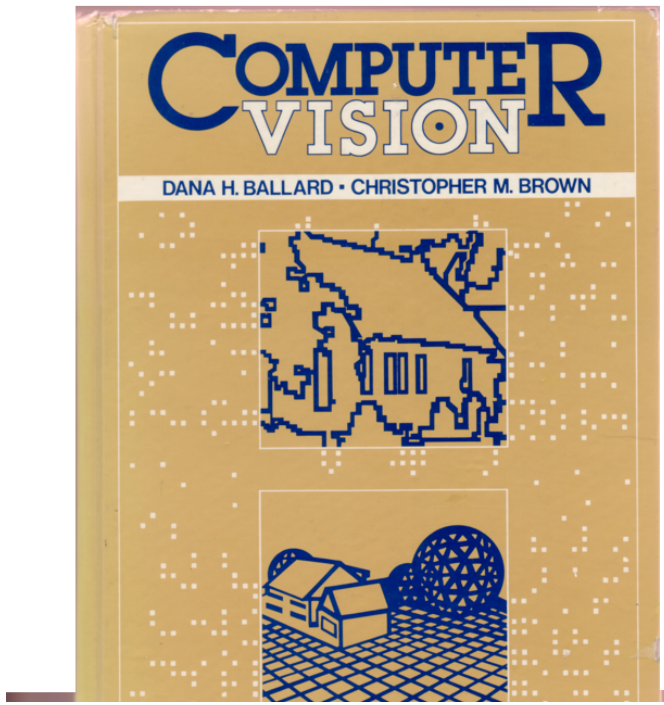
Chapter 26: Night Repairs


Chapter 29: Detailed Files


Chapter 30: Scalcedas Camp


Computer Vision Text Books

History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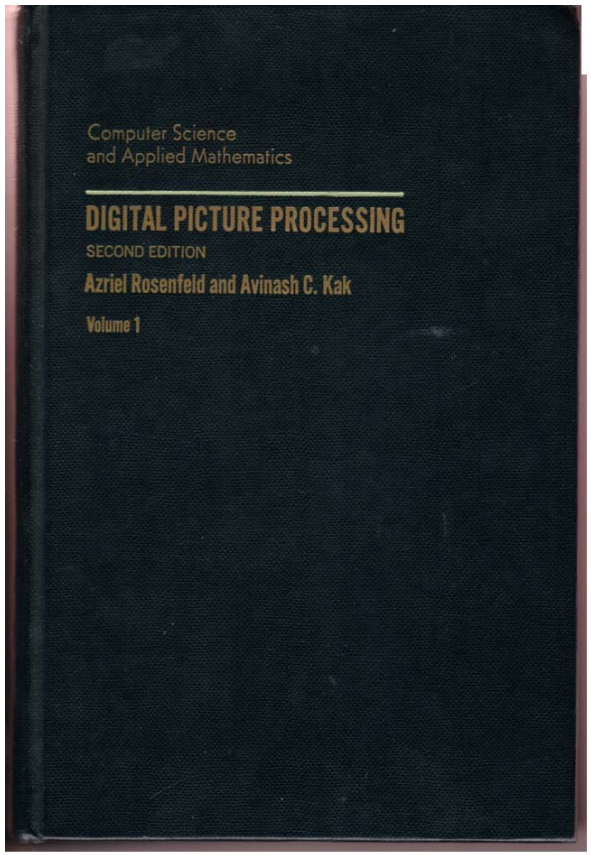
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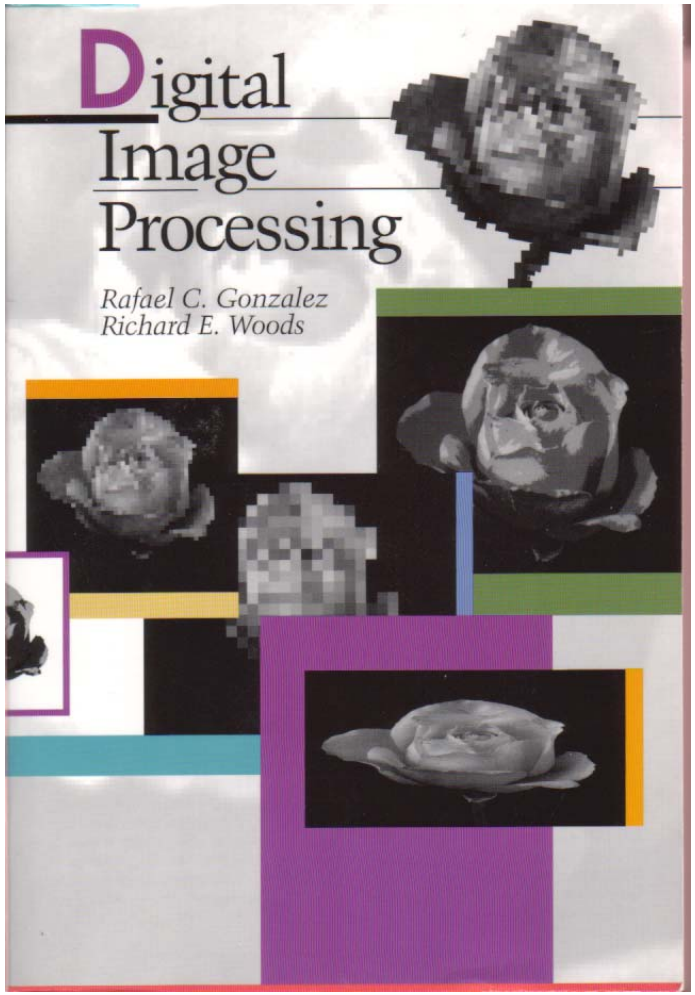
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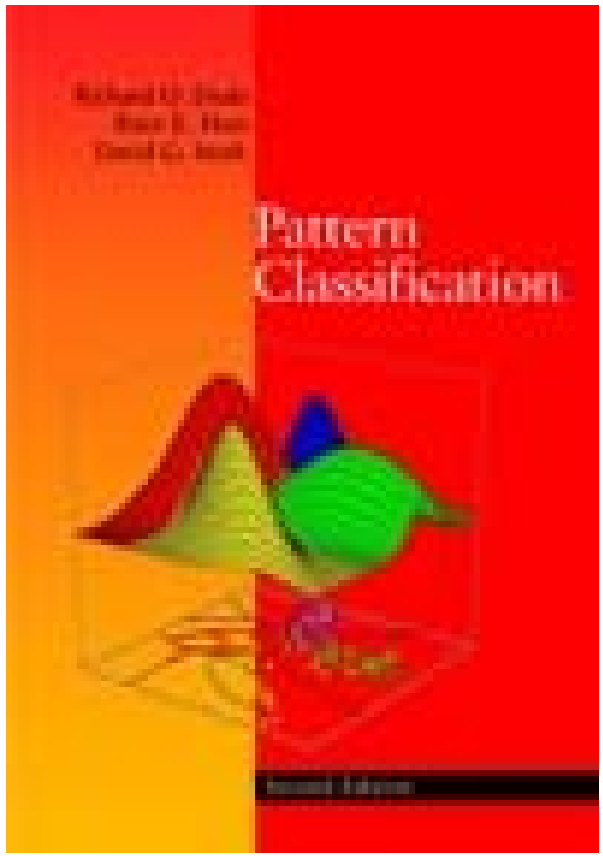
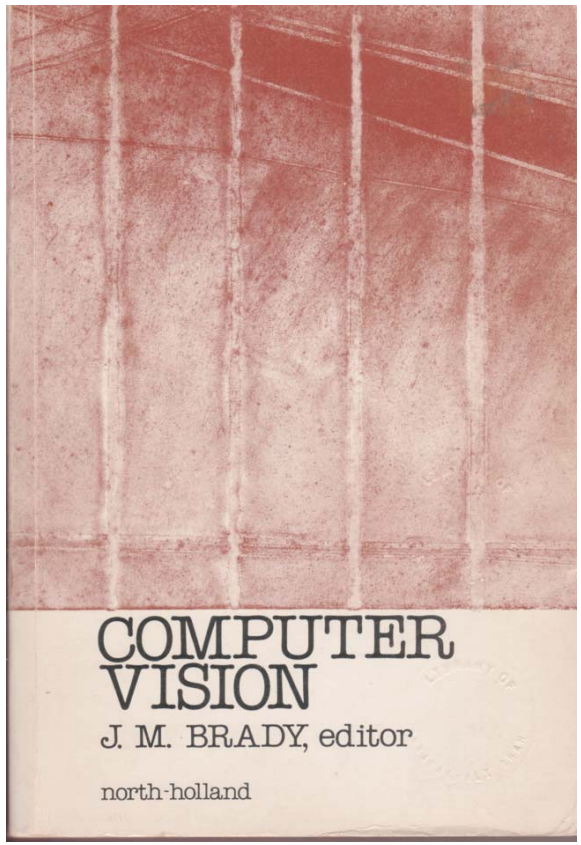

Pattern
Classification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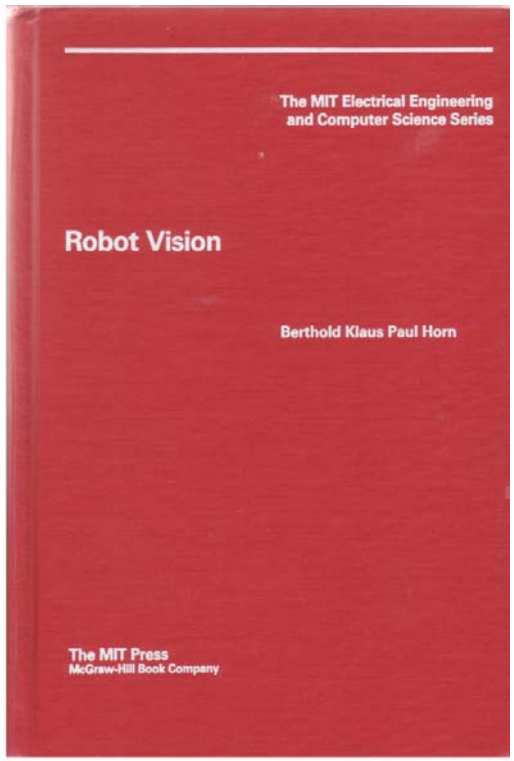
The MIT Electrical Engineering
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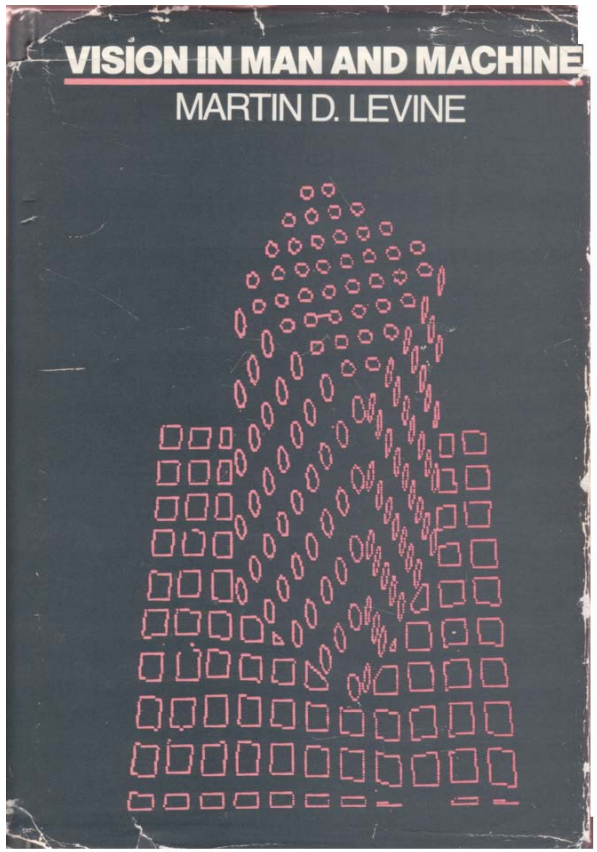
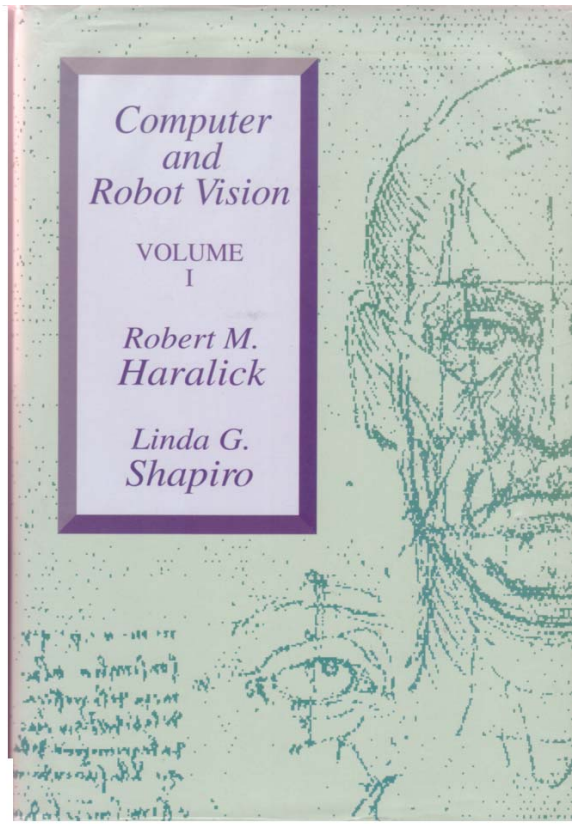
Robot Vision
Berthold Klaus Paul Horn
The MIT Press
McGraw-Hill Book Company

VISION IN MAN AND MACHINE

MARTIN D. LEVINE

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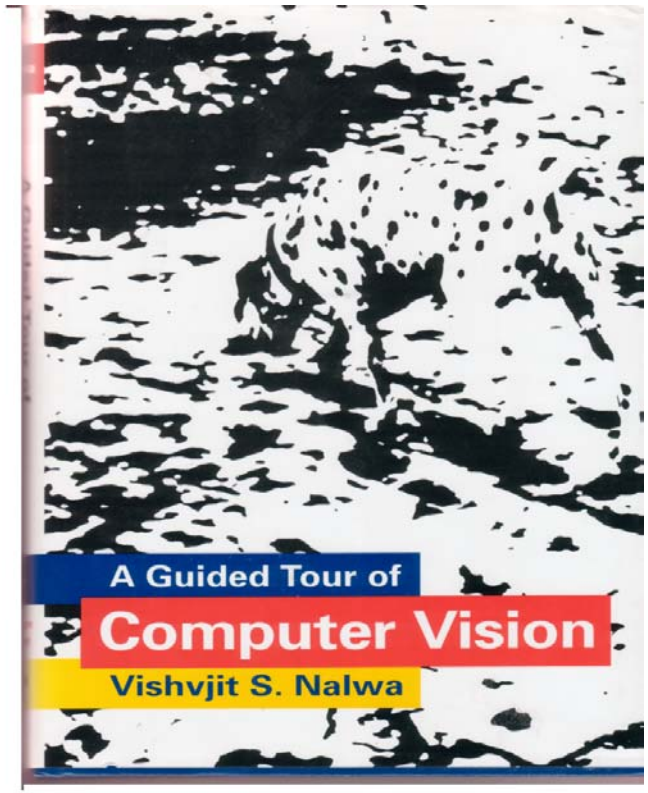
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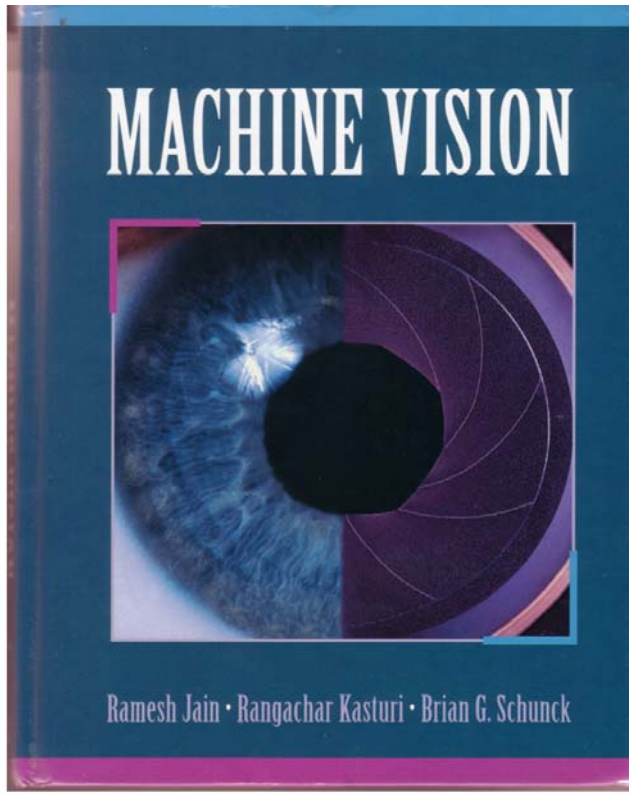
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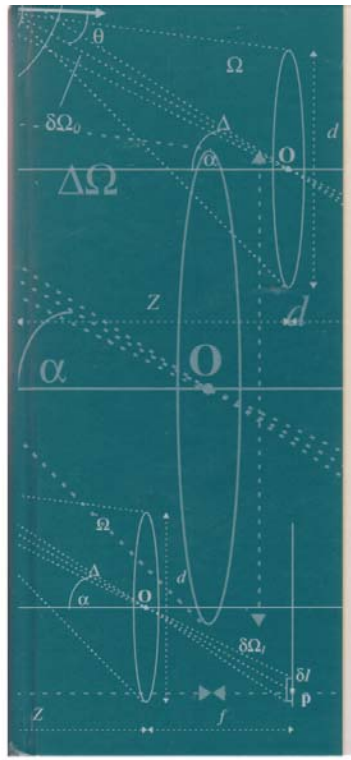

INTRODUCTORY TECHNIQUES *for* 3-D COMPUTER VISION

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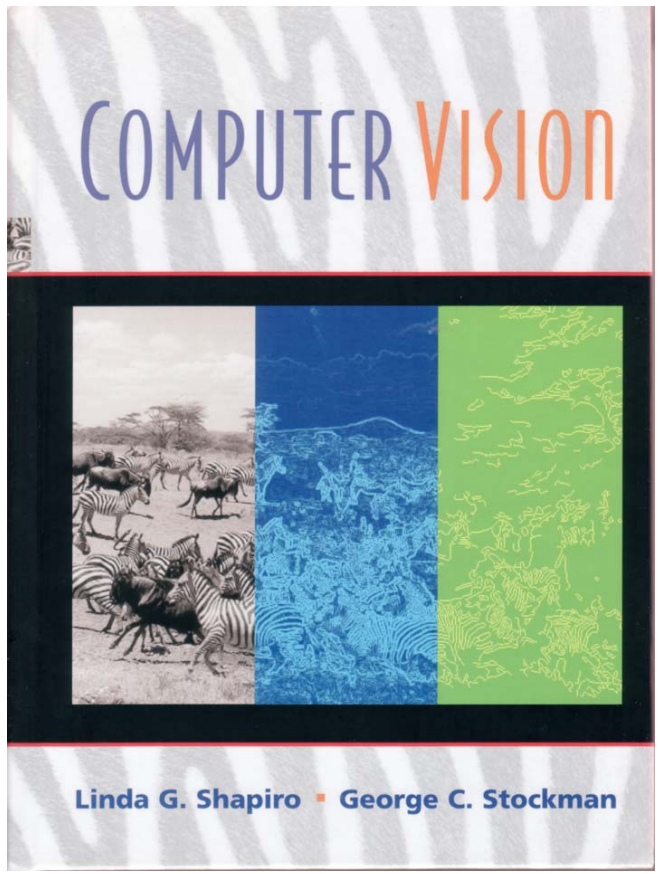
Alessandro Verri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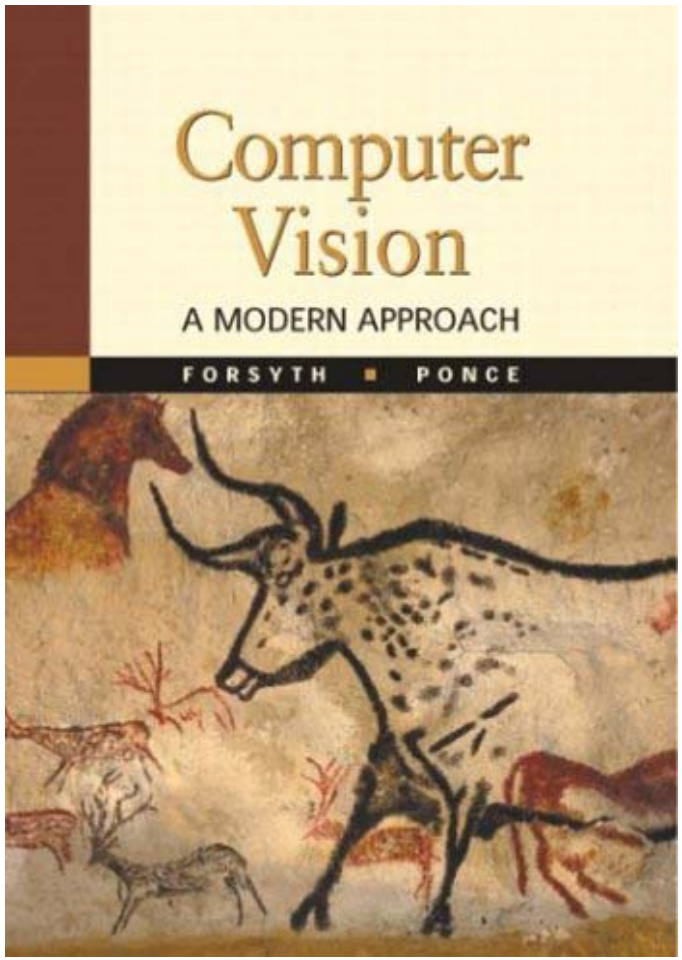
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A MODERN APPROACH
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Computer Vision Researchers

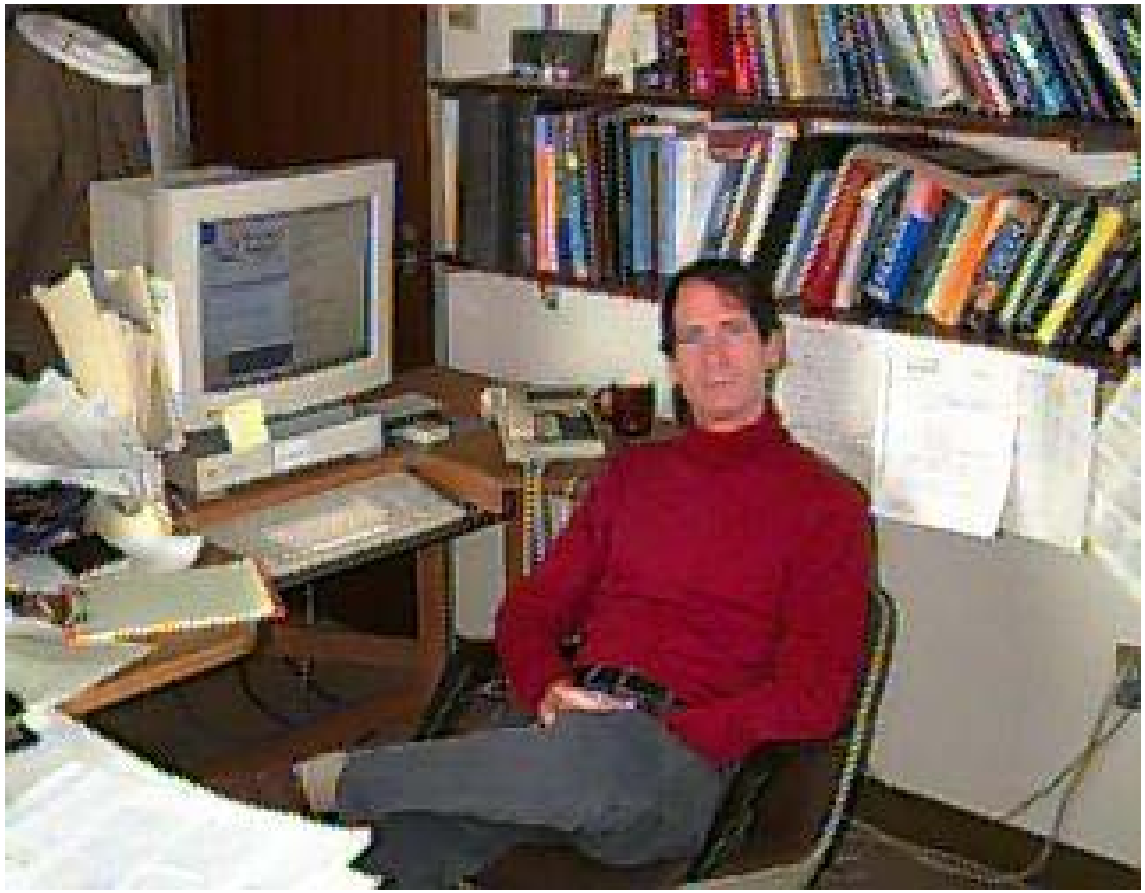
Azriel Rosenfeld

Berthold Horn

Thomas Huang

Jake Aggarwal

Chris Brown



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Olivier Faugeras

Takeo Kanade

Sandy Pentland

Shree Nayar

John Canny

Demetri Terzopoulos

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Computer Vision Journals

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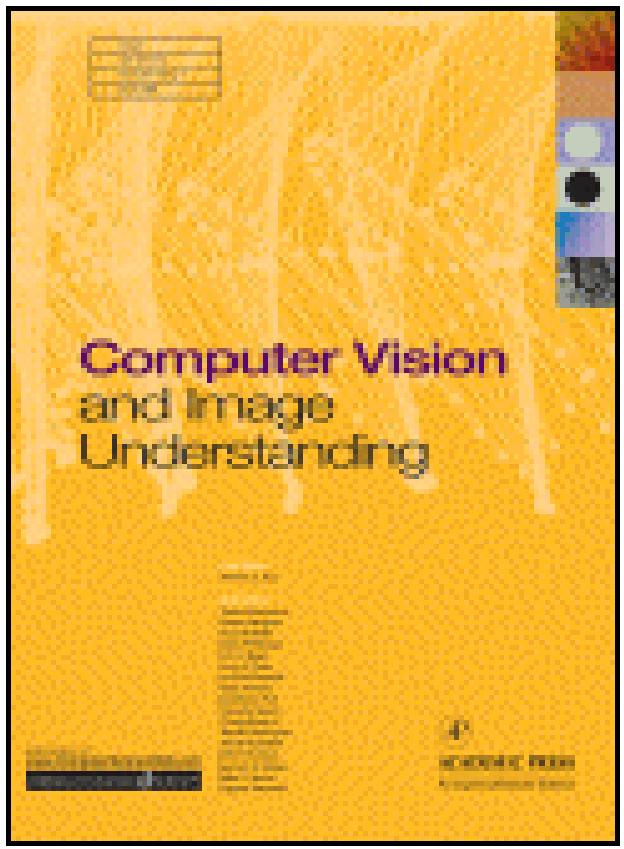
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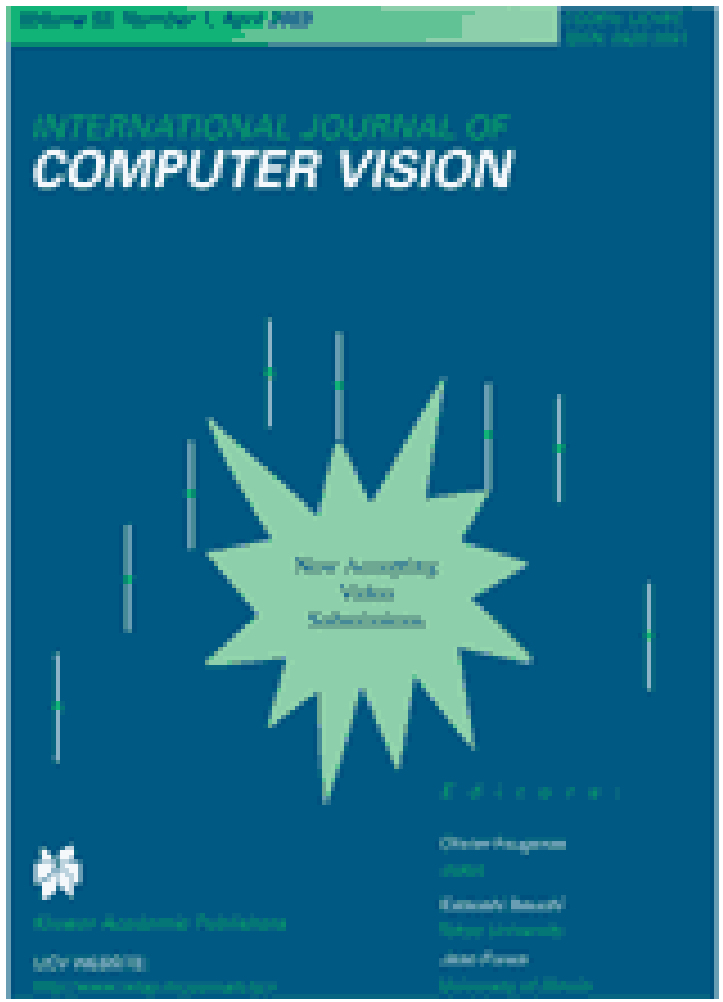
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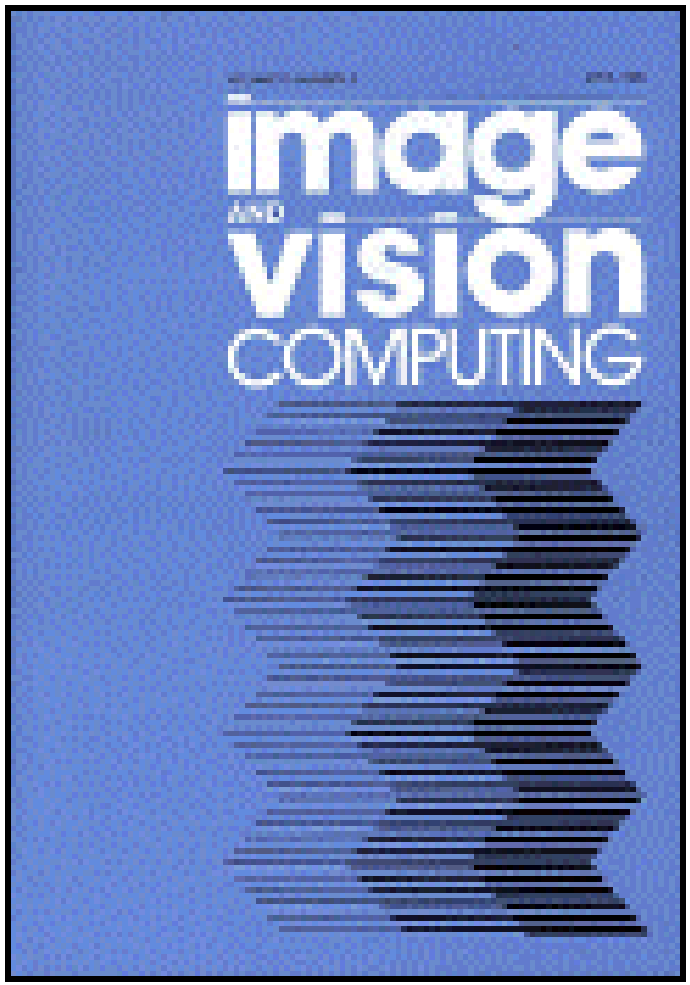
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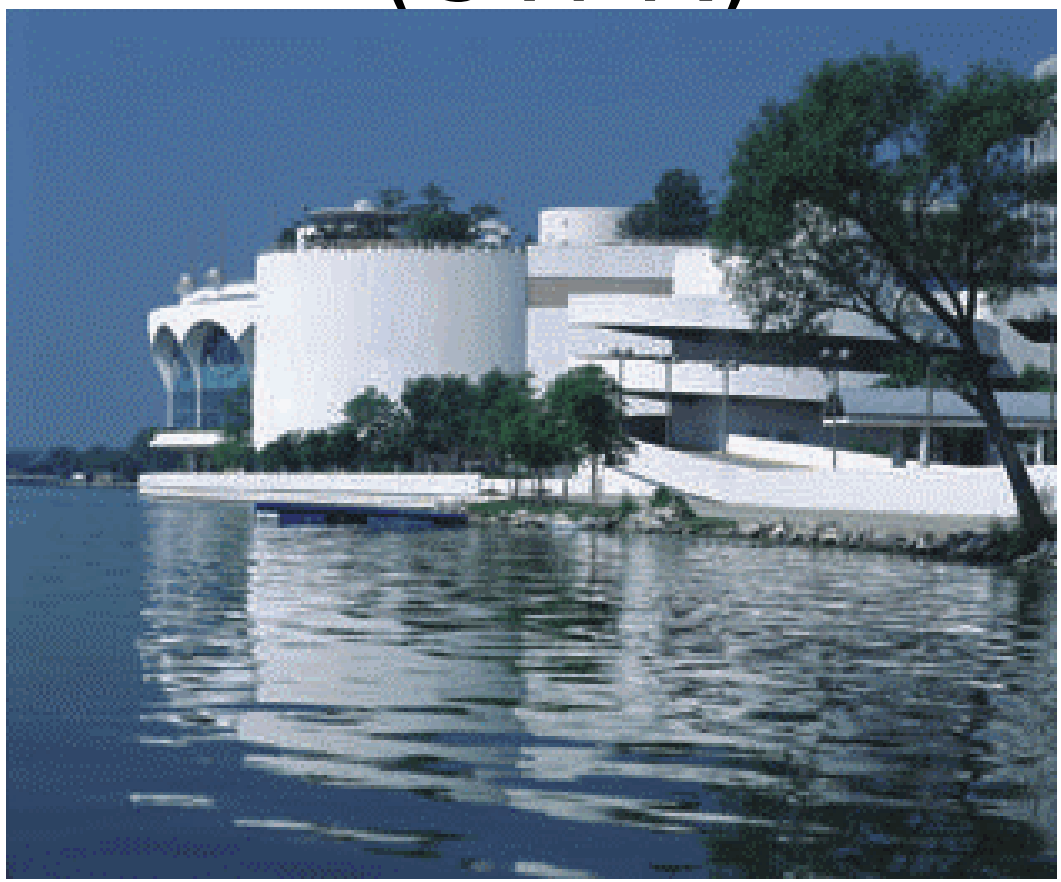
Computer Vision Conferences

International Conference on Computer Vision (ICCV)

IEEE Conference on Computer Vision and Pattern Recognition (CVPR)



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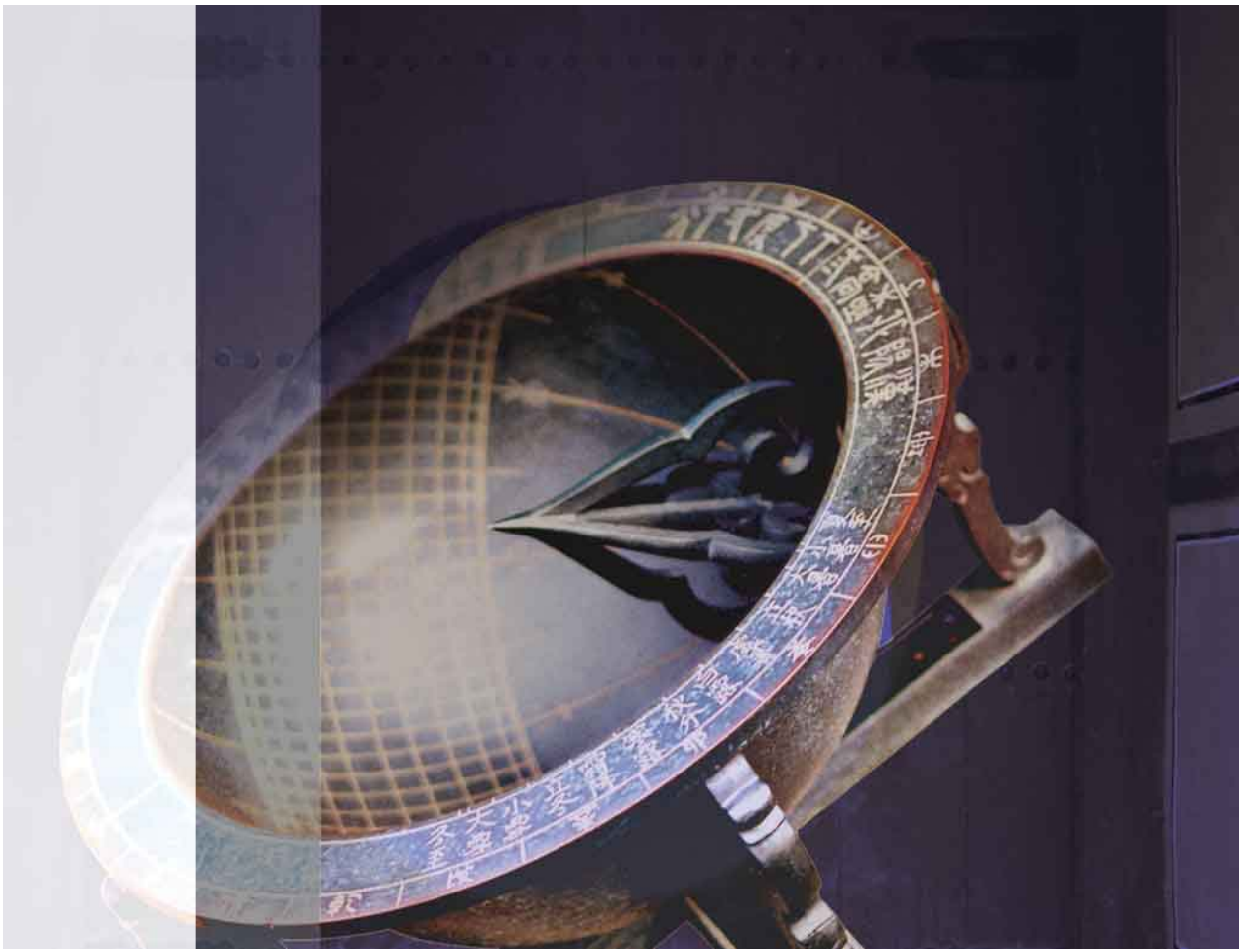


Computer Vision at UCF

- Started in August 1986
- Developed four courses
  - Intro to Robot Vision
  - Computer Vision
  - Computer Vision Systems
  - Advanced Computer Vision

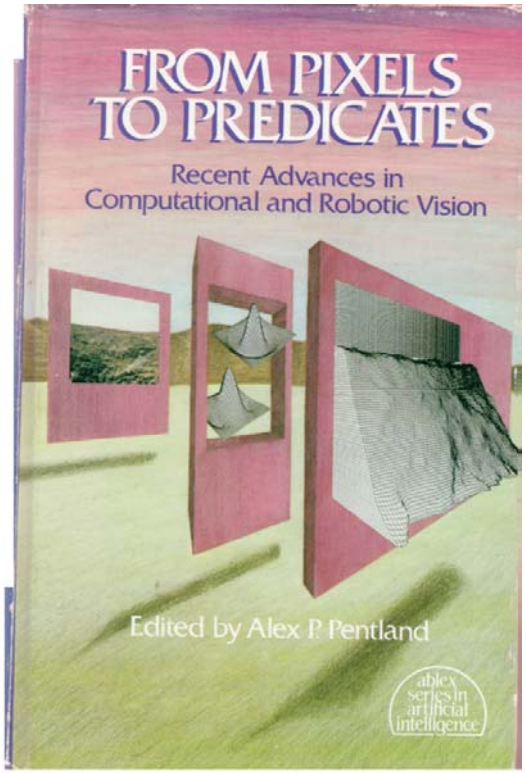
- Graduated first Ph.D. student in 1989
- Dr. Lobo joined in 1992
- Dr. Foroosh joined in 2002

Vision Books Used at UCF

FUNDAMENTALS OF COMPUTER VISION[1]

Mubarak Shah
Computer Science Department
University of Central Florida
Orlando, FL 32816

December 7, 1997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ablex series in artificial intelligence

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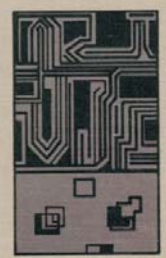
DAVID MARR

Model-Based Computer Vision

Rodney Allen Brooks

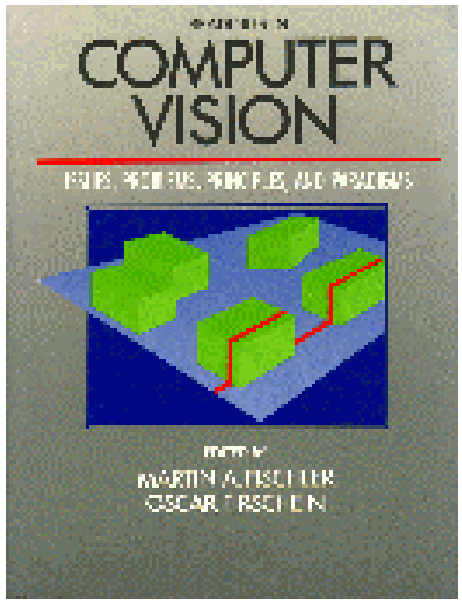


UMI Research Press
Computer Science: Artificial Intelligence

Perceptual Organization and Visual Recognition

David Lowe

Kluwer Academic Publishers, 1985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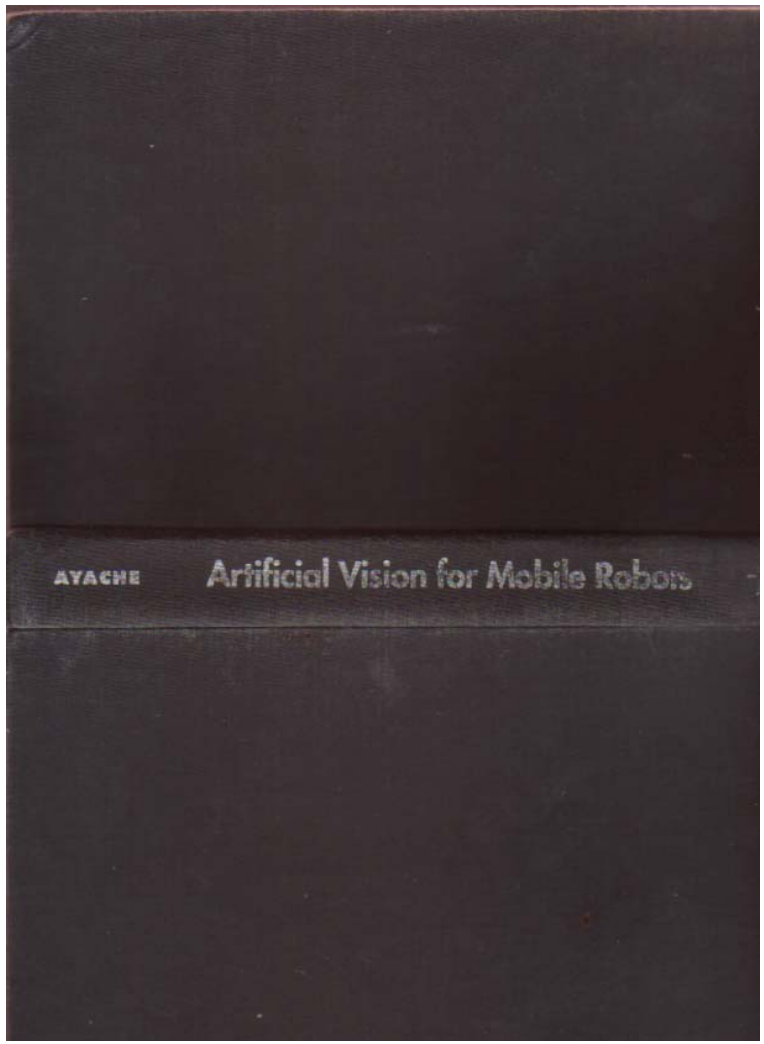
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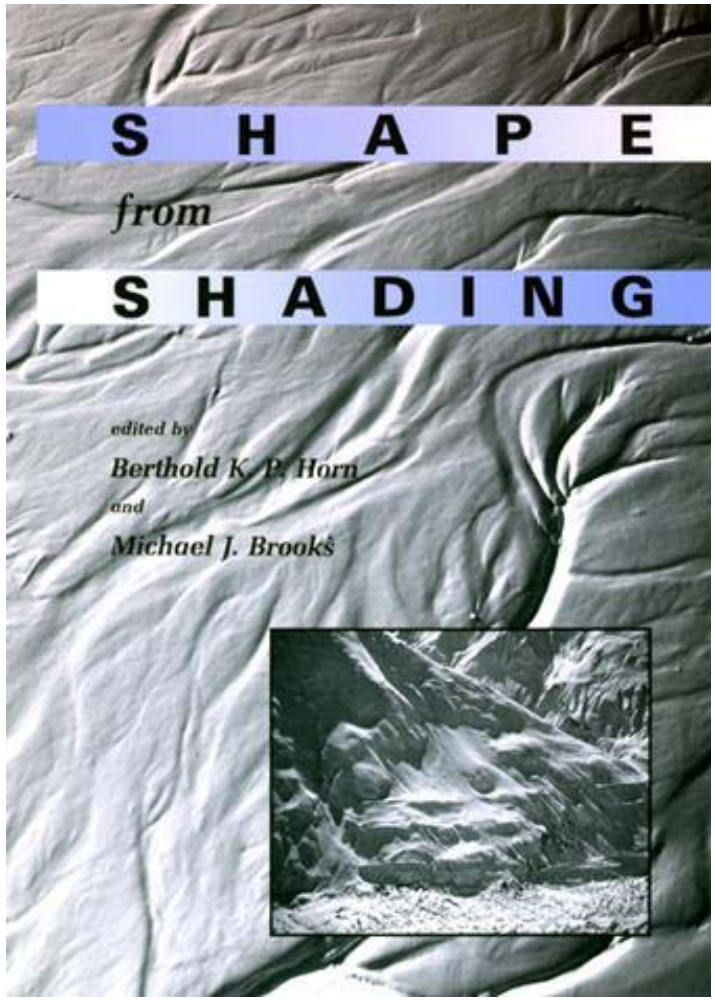
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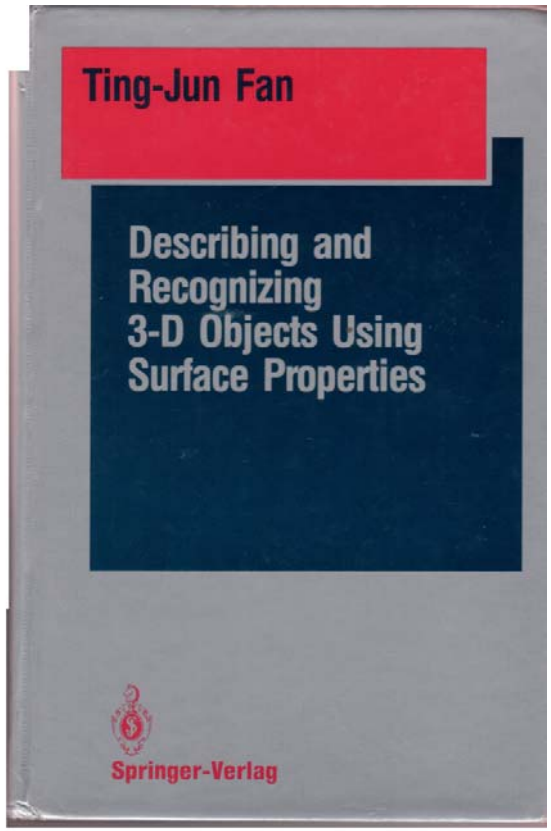
Michael J. Brooks


Ting-Jun Fan
Describing and Recognizing 3-D Objects Using Surface Properties
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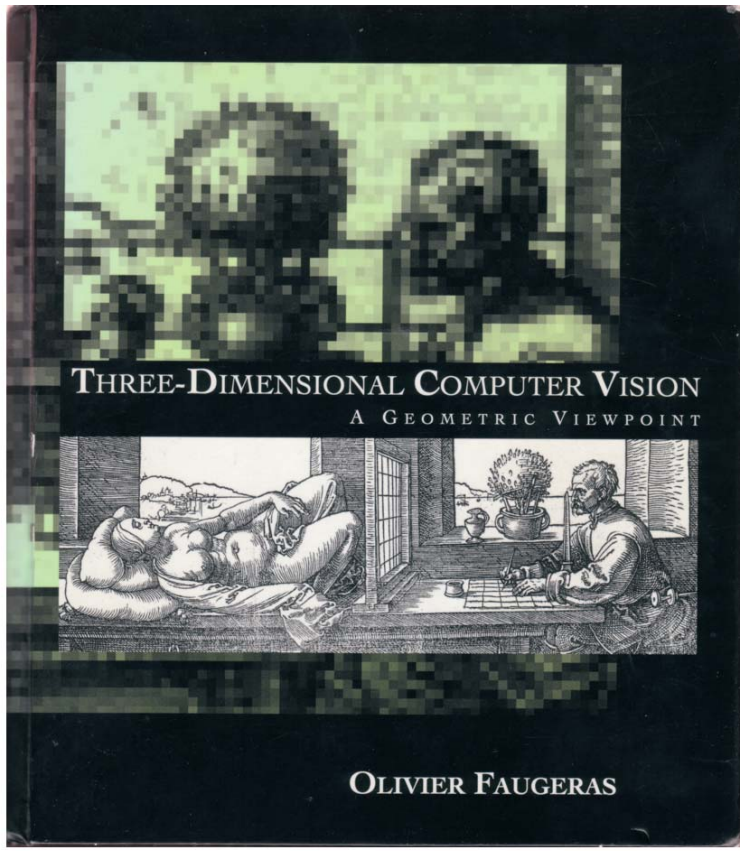
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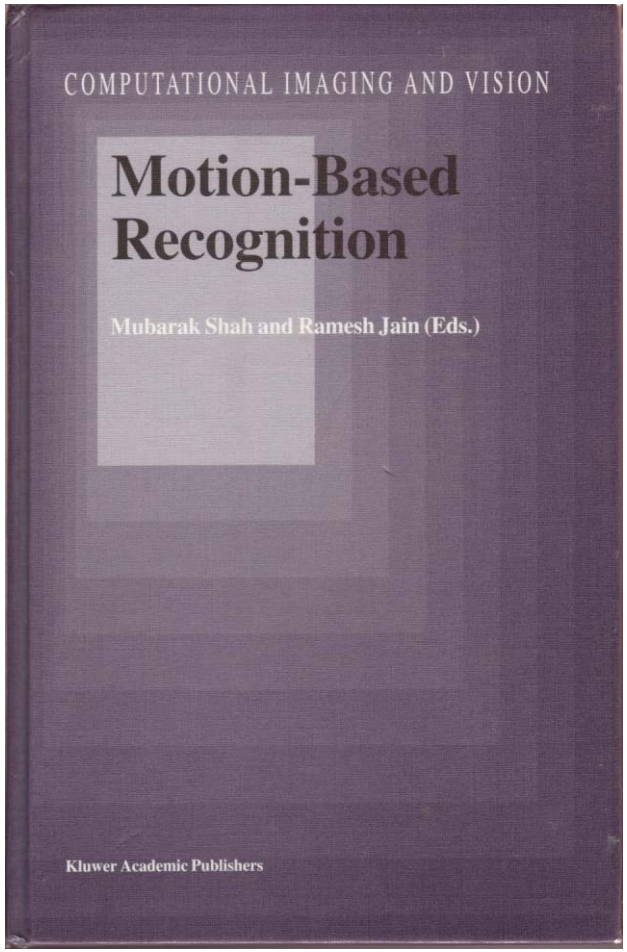
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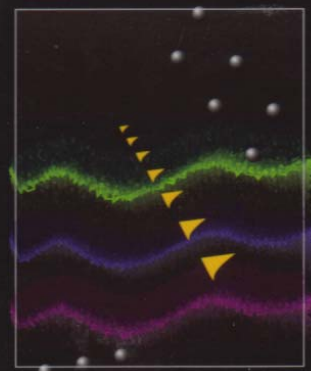

A. MURAT TEKALP

PRENTICE HALL SIGNAL PROCESSING SERIES

Vision Ph.D. Graduates

Donna J Williams, 1989

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End of Story