

CSE 455  
Computer Vision  
Autumn 2010

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# Introduction

- What IS computer vision?

The analysis of digital images by a computer

- Where do images come from?

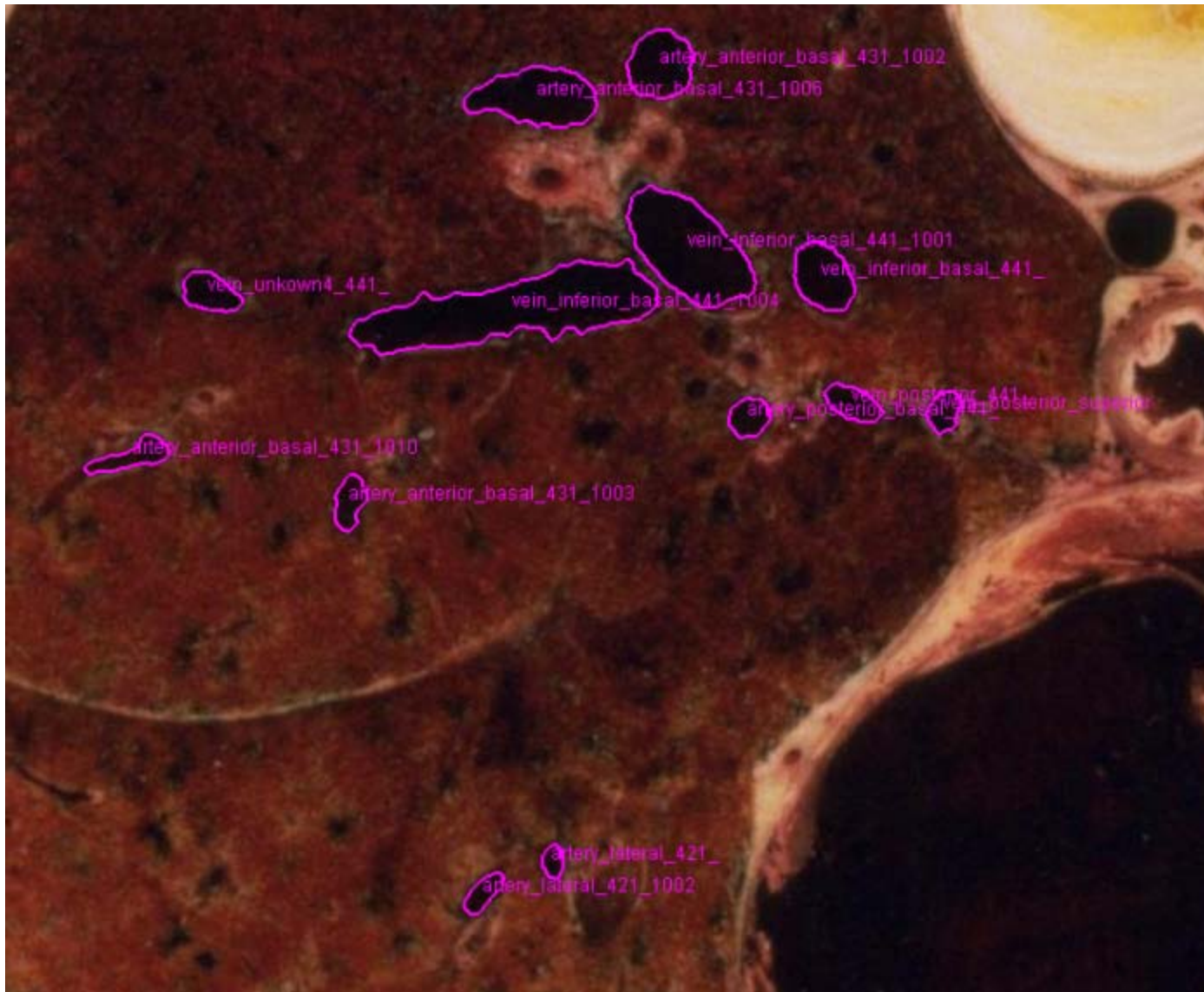
You tell me!

# Applications: Medical Imaging

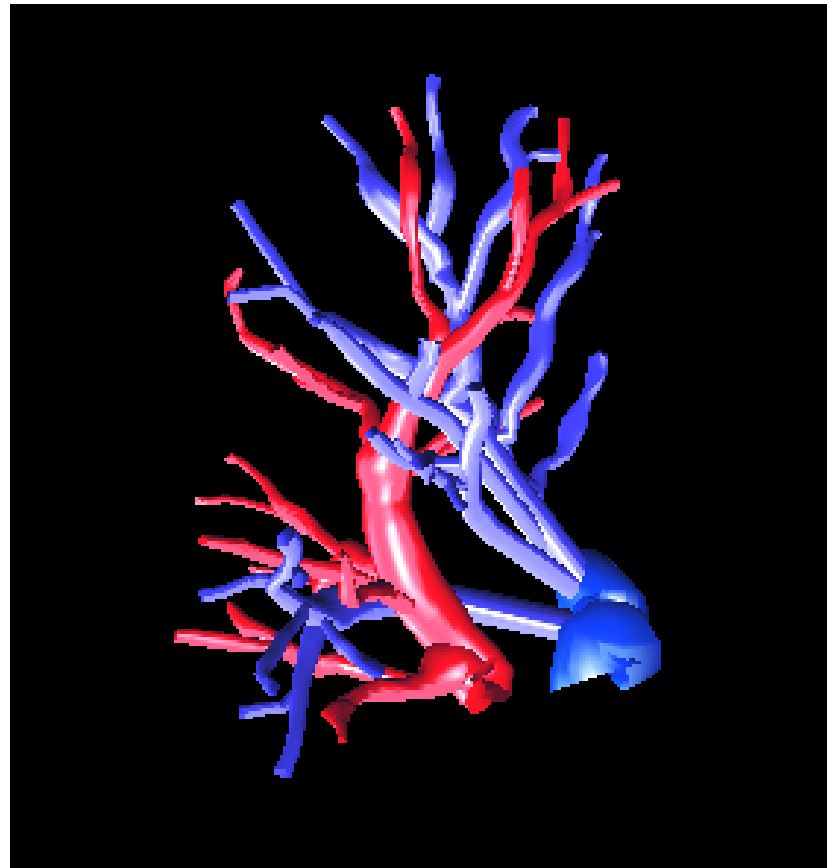
CT image of a patient's abdomen



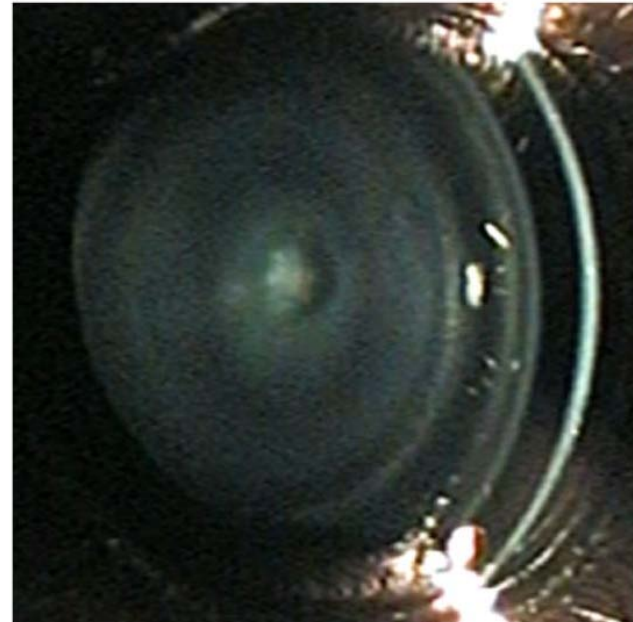
# Visible Man Slice Through Lung



# 3D Reconstruction of the Blood Vessel Tree



# Mouse Eye Image Retrieval for Genetic Studies



# Robotics

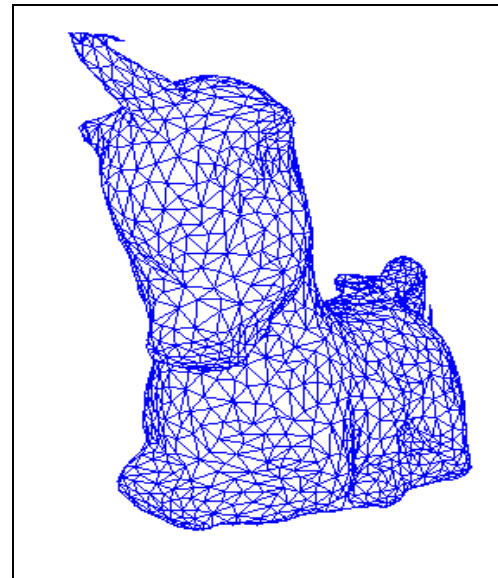
- 2D Gray-tone or Color Images

“Mars” rover



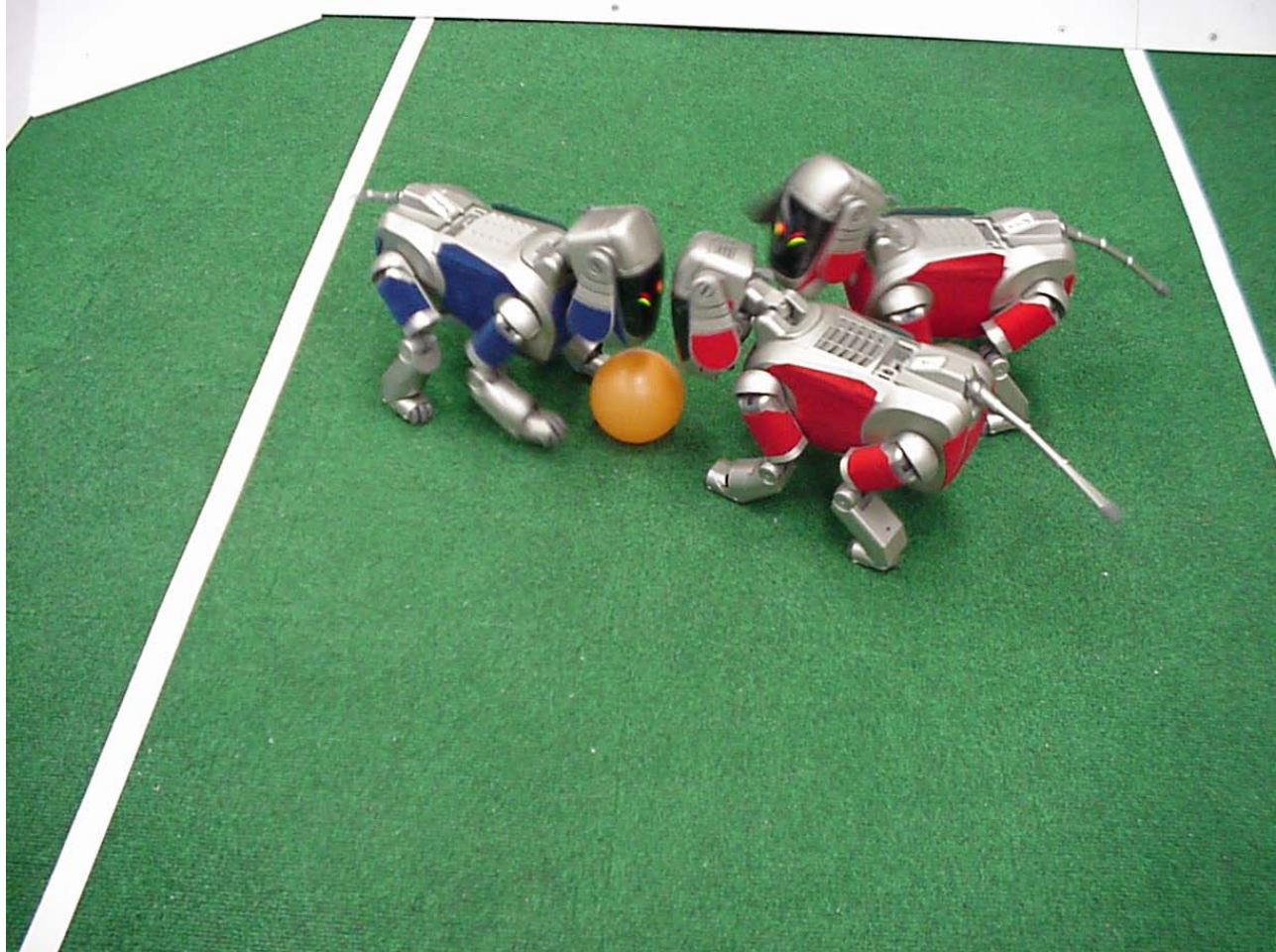
- 3D Range Images

What am I?





# Robot Soccer

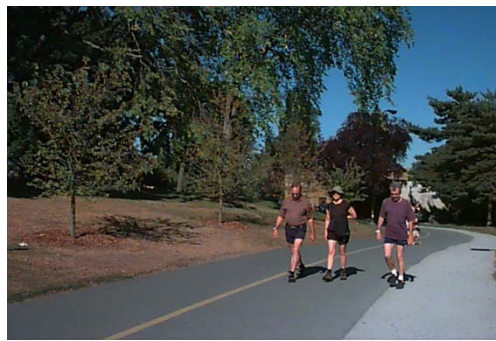




# Image Databases:

Images from my Ground-Truth collection:

<http://www.cs.washington.edu/research/imagedatabase/groundtruth>



- Retrieve images containing trees

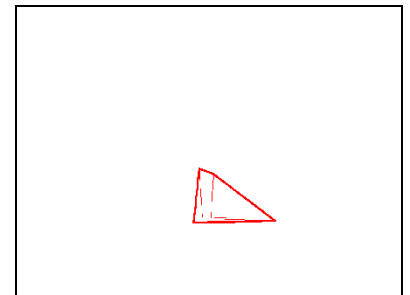
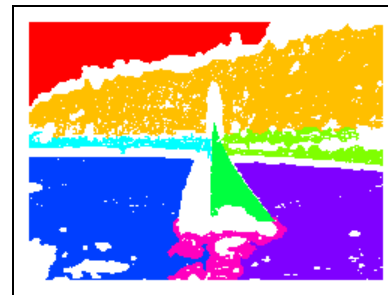
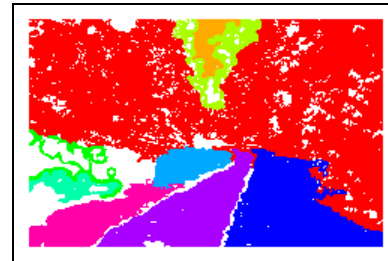
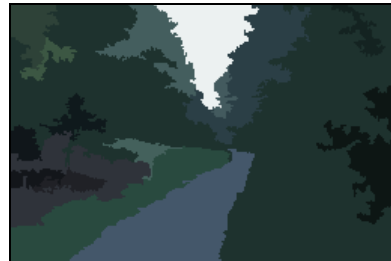
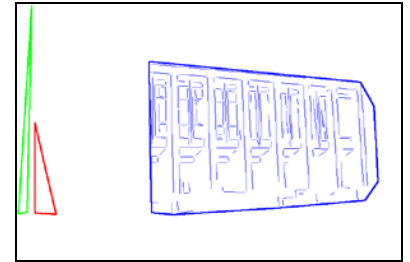
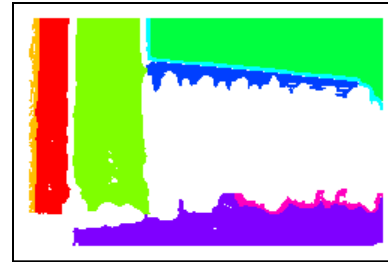
# Some Features for Image Retrieval

Original Images

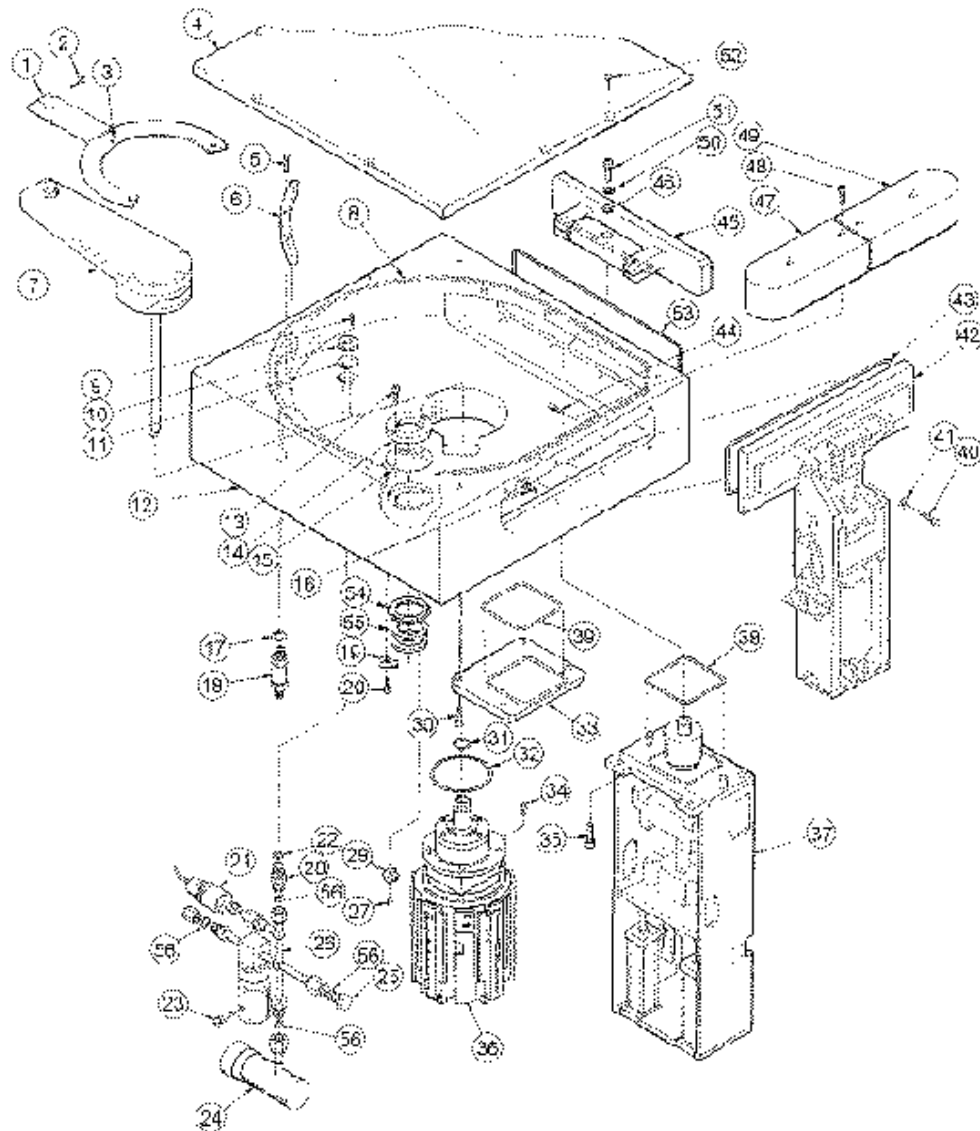
Color Regions

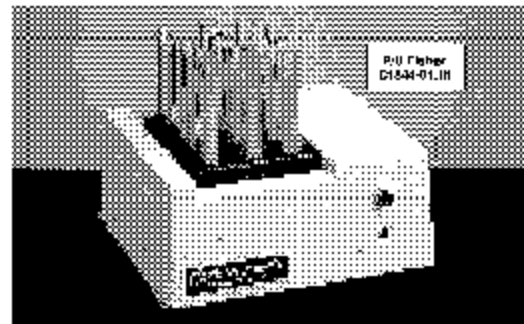
Texture Regions

Line Clusters



# Documents:





**Model 145 Isotemp® Dry Bath Incubator**

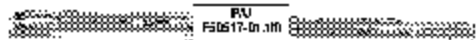
- Holds 1 to 4 heating blocks with choice of 11 well sizes
- Maintains every sample in within  $\pm 0.1^\circ\text{C}$  of temperature

In a sample well, the shape so that a uniform circle delivers same amount of heat to all parts of the sample tube. No lameness, no gradient - neither on top of the bottom nor on cold or hot top - that may invalidate tests. In tubes with drilled or indented walls. Sample tubes rest on insulating rings. No present localized heating. A low cost, density heater is mounted on a thick 1/4" alumina heat reflecting plate in the front of the bath. Plate is 1/2" thick, 9.5 mm. Dry bath maintains cleaner problems because tubes & wax stop.

Ambient to  $125^\circ\text{C}$  ( $255^\circ\text{F}$ ) -  $\pm 0.1^\circ\text{C}$  Control. Dial temperature controlled range from  $25^\circ\text{C}$  to  $95^\circ\text{C}$ . Ideal for enzyme reactions, inoculation of sera, Rh studies, blood cross matching and bioassay determinations. Dimensions: 8.1 x 15.9 x 4" H. 128 x 28 x 11 mm. With top cap and plug. Heating blocks sold separately (see lower right).

Electrical Requirements	Cat. No.	Each
120V, 60Hz, 300W (CSA approved)	11-715-100	229.50
240V, 50/60Hz, 800W	11-715-101	306.00

Maximum weight limit maximum 37.5 lb.  
Patentable Model



**Incu-Block® Partial Immersion Thermometers**

For all standard bath, ice blocks and water baths. Critical temperatures ( $25^\circ, 30^\circ, 37^\circ, 56^\circ\text{C}$ ) are marked with arrows. Available with stainless steel, contamination proof Teflon® coating. Total length: 1.75 mm. In immersion: 35 mm.

Range, $^\circ\text{C}$	Dia., mm	Teflon Coated	Cat. No.	Each
25-57	0.5"	Yes	14-882	45.00
25-57	0.5"	No	14-883	45.00

**Mini Thermometers**

For more thermometers, including digital types

see page 952

**Model 147 Isotemp® Dry Bath**

- Holds single heating block with choice of 11 well sizes

Similar to Model 145, but with 35" thick (2.0 mm) plate. Ideal for labs with smaller volumes of enzyme and carbohydrate assays. Rh studies, and dry incubators. Provides better adjusted temperature control between ambient and  $95^\circ\text{C}$  ( $203^\circ\text{F}$ ). Observe thermometer panel in case a sample tube is set, adjust control through hole in front panel. Maintains set temperature with consistency and uniformity  $\pm 0.05^\circ\text{C}$ .

Supplier with strong nylon case. Thermistorally controlled heater and indicator amp. line case and plug, see instructions. Dimensions: 8.1 x 6.5 x 3" H. 115 x 17 x 8 mm. CSA approved. Heating blocks sold separately (see below).

Electrical Requirements	Cat. No.	Each
120V 50/60Hz, 120W	11-715-102	223.50

**Interchangeable Heating Blocks for Isotemp® Dry Baths**

For Models 145 and 147 Dry Baths. Composed of blocks and sized aluminum alloy. (Chemical resistant). Dimensions: 1 x 0.75 x 1.25" H. (25 x 19 x 32 mm).

The 11-715-123 block provides a safe dry bath alternative for warming 1-4 Spalte of tissue loops. Avoids hazardous use of burners and inflammable biological reagents.

The 11-715-120 block is specifically designed to hold twenty 9.5 mm Berko Diagnostics Placenta® pregnancy test tubes. This special baller wall block is similar to the other block with 0.9 mm holes, but sample wells are only 0.1" deep (1.0 mm) to meet test requirements. Wells in all other blocks are 1.5" deep (16.4 mm).



Tube Size, mm	Wells/Block	Cat. No.	Each
6	35	11-715-105	71.00
10	20	11-715-107	71.00
12	20 (see below)	11-715-120	71.00
12	12	11-715-108	71.00
12.5	12	11-715-121	71.00
13	12	11-715-111	71.00
15	12	11-715-113	71.00
16	8	11-715-122	71.00
18	12	11-715-115	71.00
21	8	11-715-117	71.00
25	8	11-715-119	71.00

Incubator heater  
For use with 120V 50/60Hz, 120W (CSA approved) circuit, see page 952

# Science



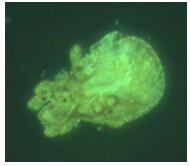
## Previous Classification Results:

Classified	as Cal	as Yor
Cal	171	16
Yor	0	99

Classified	as Cal	as Dor
Cal	114	72
Dor	70	133



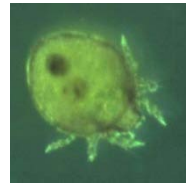
# Soil Mesofauna



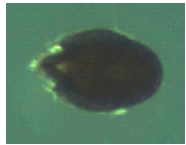
TraychetesA



XenillusA



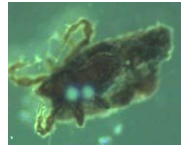
ZygoribafulaA



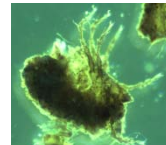
AchipteriaA



BdellozoniiumI



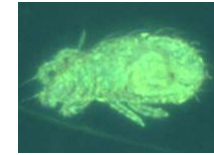
BelbaA



Belbal



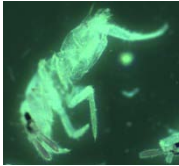
CatoposurusA



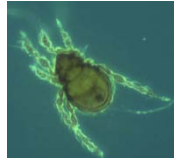
EniochthoniusA



PtenothrixV



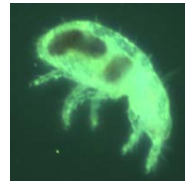
EntomobryaTM



EpidamaeusA



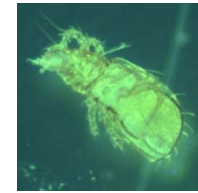
EpilohmanniaA



EpilohmanniaD



EpilohmanniaT



HypochthoniusLA



PtiliidaA



HypogastruraA



IsotomaA



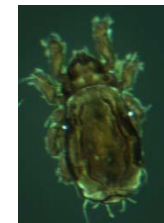
IsotomaVI



LiacarusRA



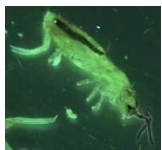
MetrioppiaA



NothrusF



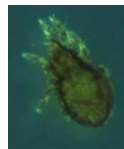
QuadropiaA



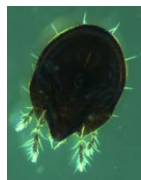
TomocerusA



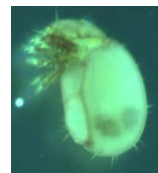
OnychiurusA



OppiellaA



PeltenuialaA



PhthiracarusA



PlatynothisF



PlatynothisL

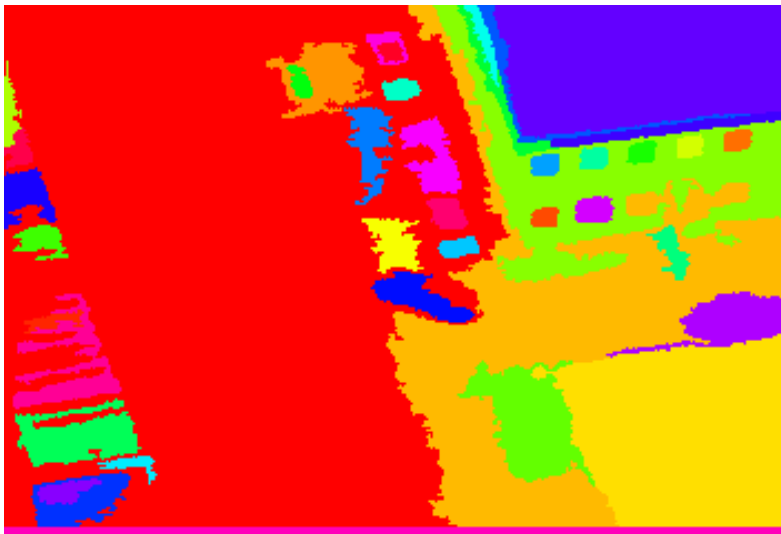


SiroVI



# Surveillance: Event Recognition in Aerial Videos

Original Video Frame

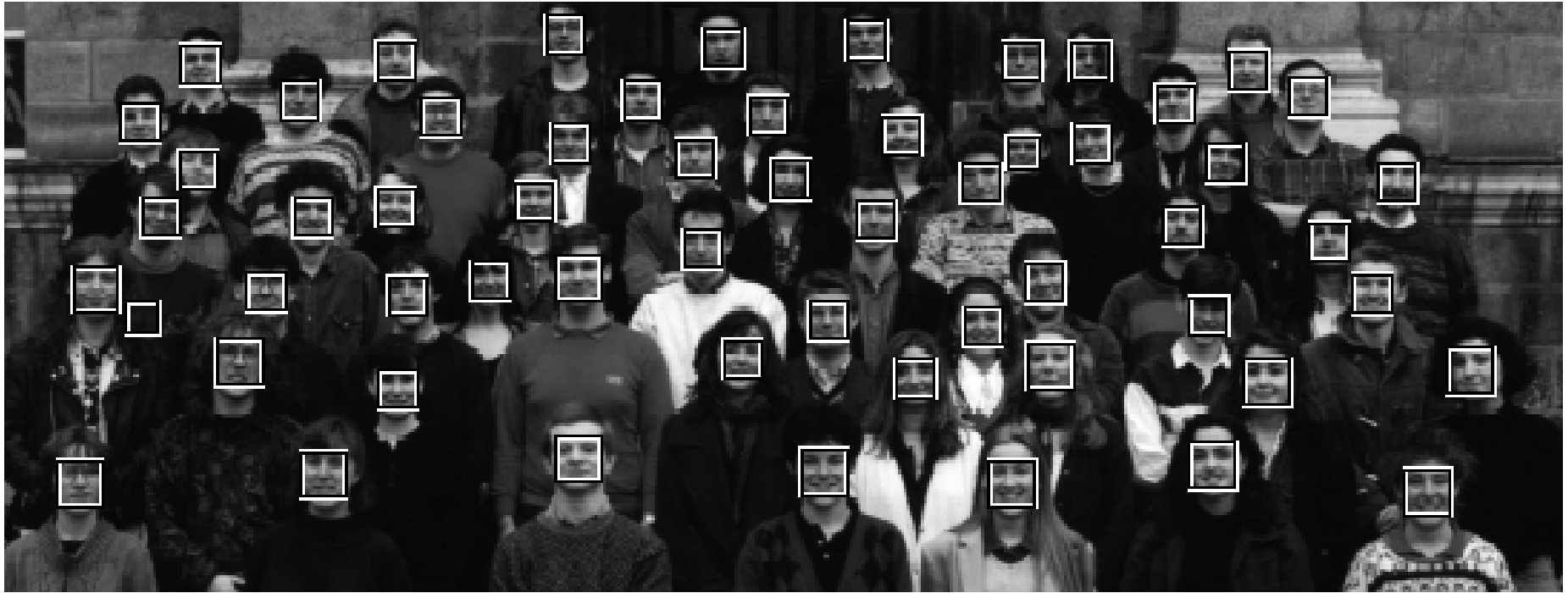


Color Regions



Structure Regions

# 2D Face Detection



# Face Recognition

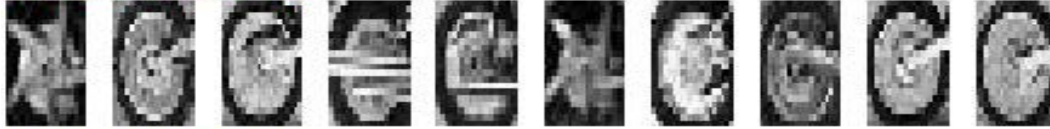


# 2D Object Recognition from “Parts”

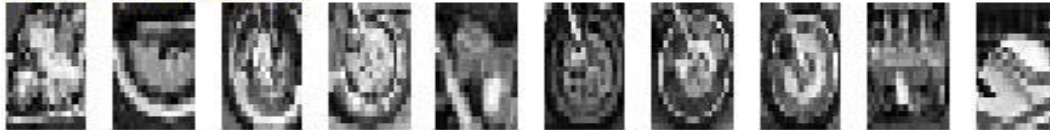
Part 1 – Det:5e-18



Part 2 – Det:8e-22



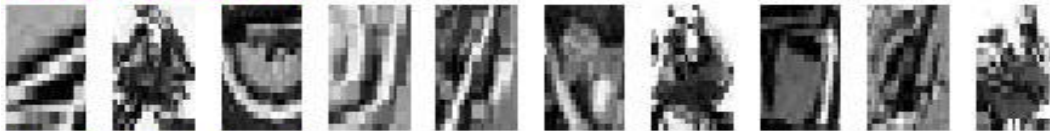
Part 3 – Det:6e-18



Part 4 – Det:1e-19



Part 5 – Det:3e-17



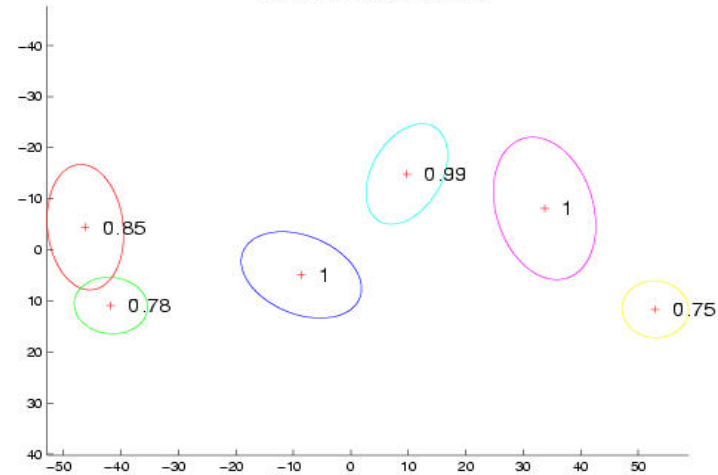
Part 6 – Det:4e-24



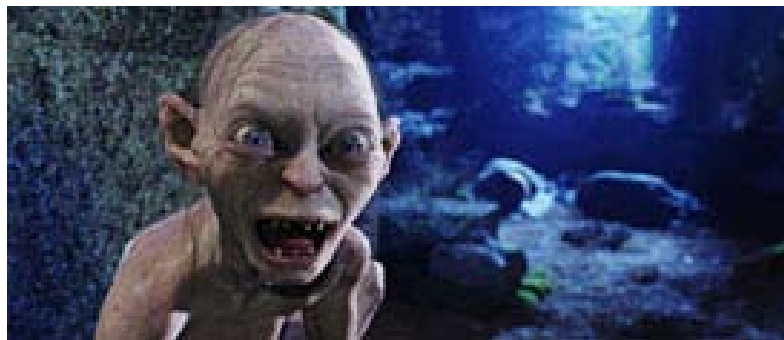
Background – Det:5e-19



Motorbike shape model

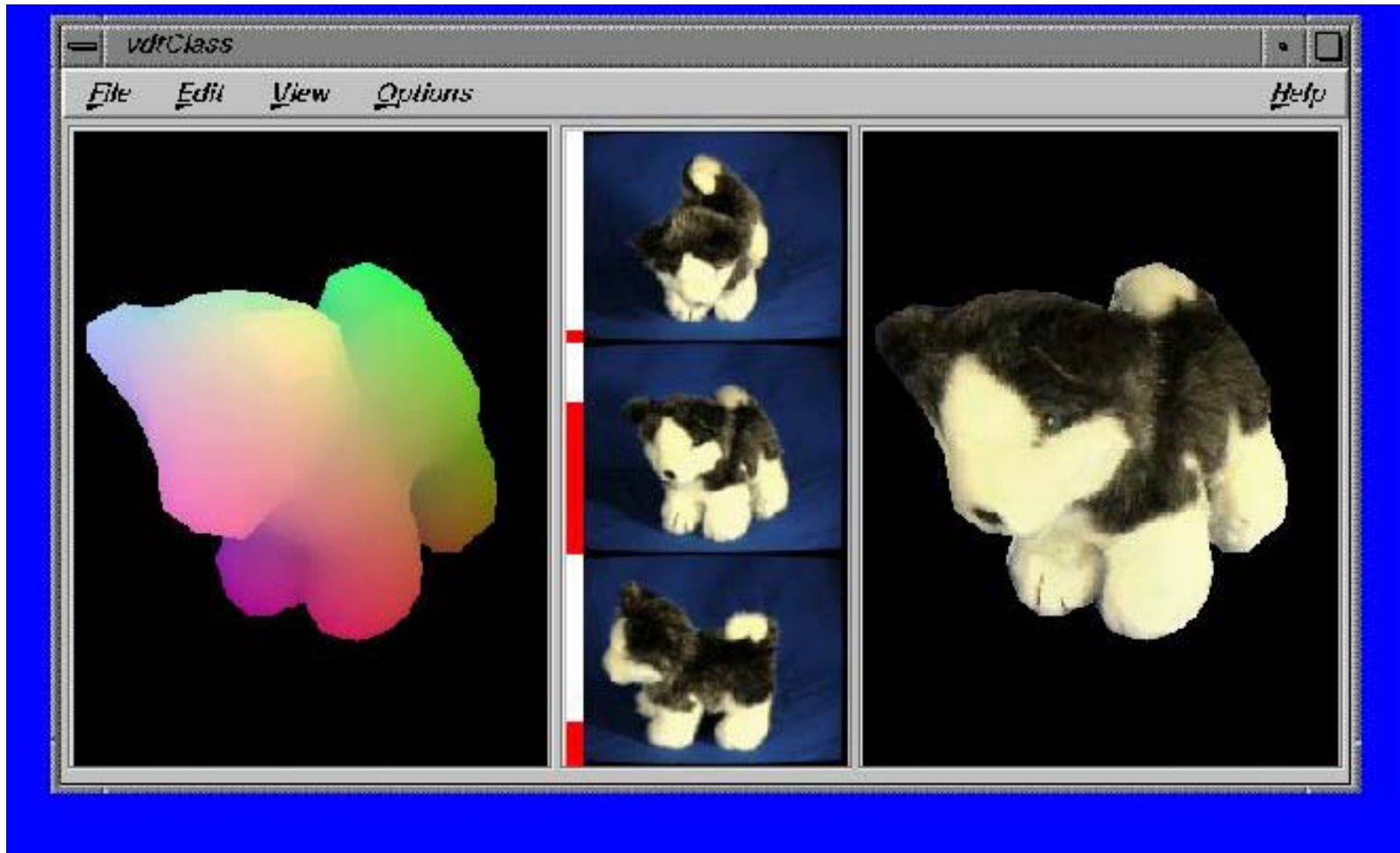


# Graphics: Special Effects



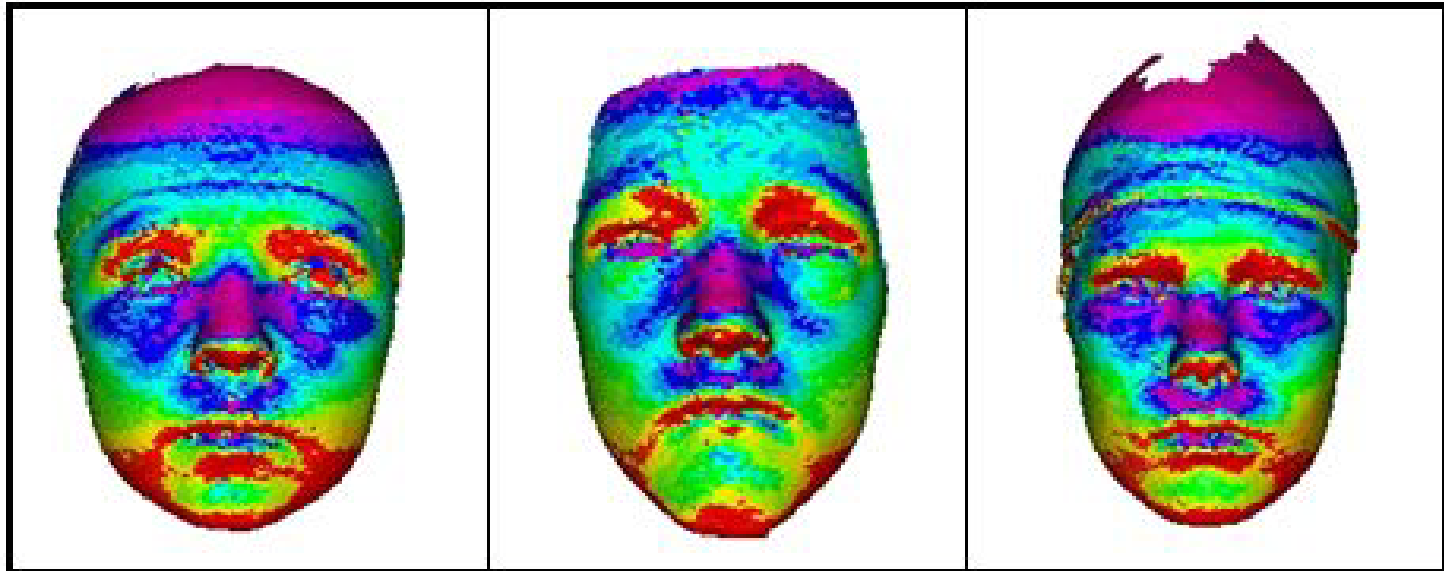
Andy Serkis, Gollum, Lord of the Rings

# 3D Reconstruction and Graphics Viewer

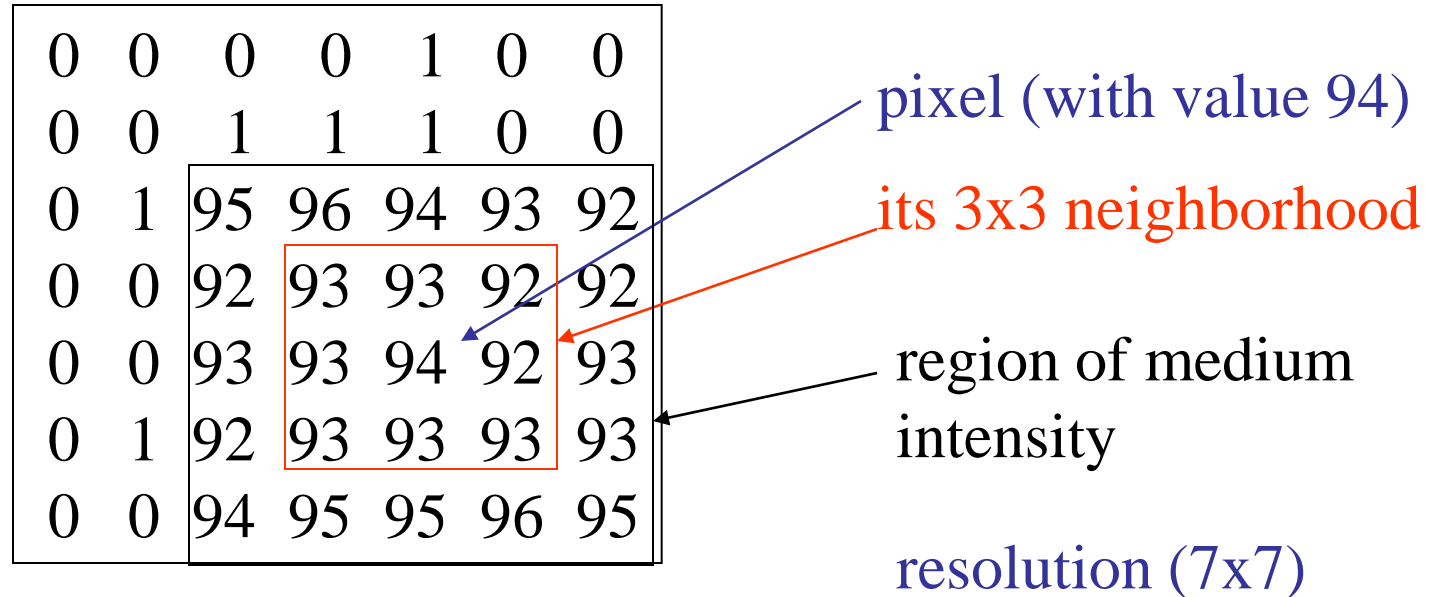




# 3D Craniofacial Shape Analysis from Meshes of Children's Heads



# Digital Image Terminology:



- binary image
- gray-scale (or gray-tone) image
- color image
- multi-spectral image
- range image
- labeled image

# The Three Stages of Computer Vision

- low-level

image → image

- mid-level

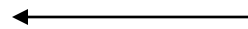
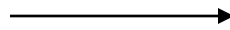
image → features

- high-level

features → analysis

# Low-Level

sharpening



blurring

# Low-Level



original image

Canny  
→



edge image

# Mid-Level



edge image

ORT  
↓

data  
structure



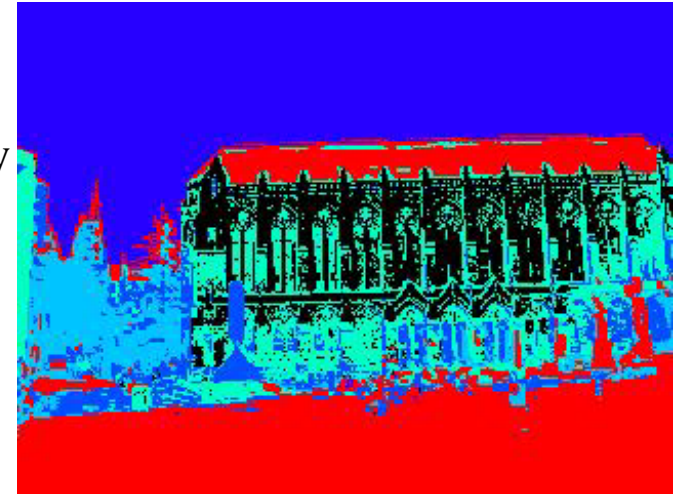
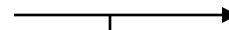
circular arcs and line segments

# Mid-level

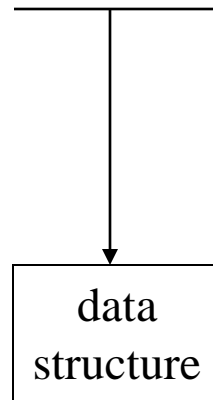


original color image

K-means  
clustering  
(followed by  
connected  
component  
analysis)



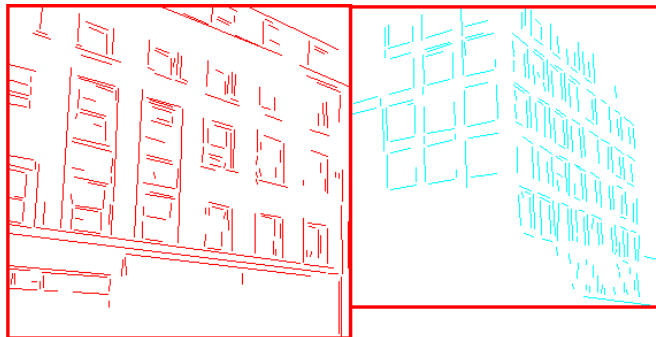
regions of homogeneous color



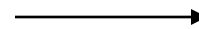
data  
structure



# Low- to High-Level



low-level

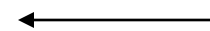


edge image

mid-level



consistent  
line clusters



high-level