CSE 455
Computer Vision
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Introduction

- What IS computer vision?

  The analysis of digital images by a computer

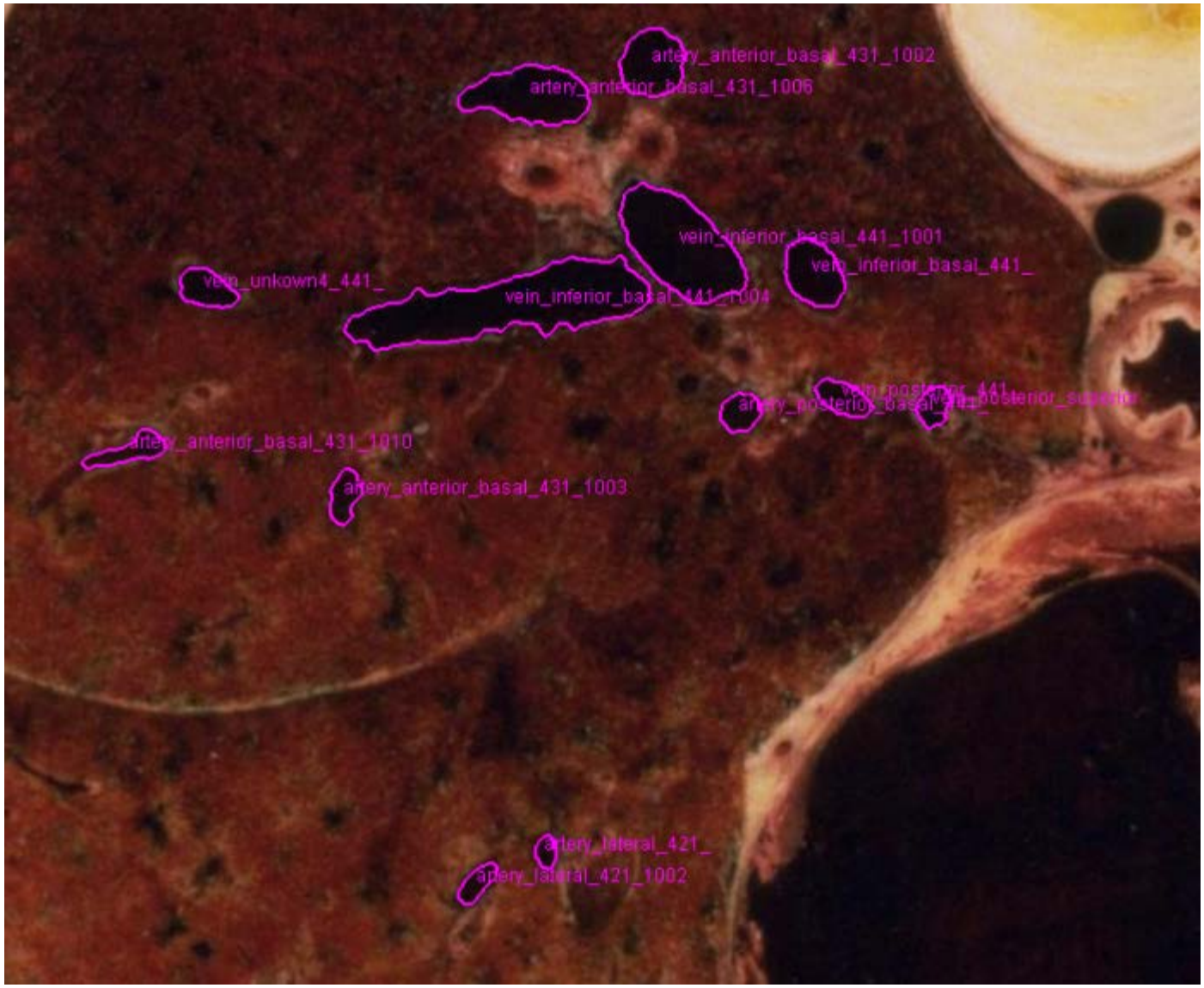
- Where do images come from?

  You tell me!

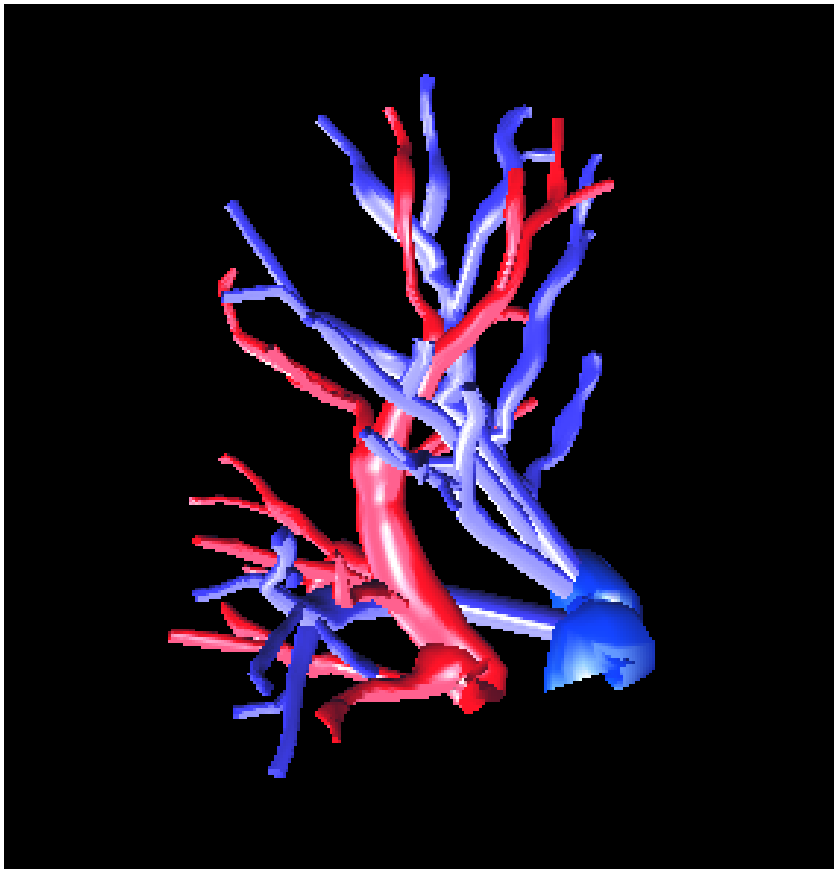
Applications: Medical Imaging

CT image of a patient's abdomen

Visible Man Slice Through Lung



3D Reconstruction of the Blood Vessel Tree



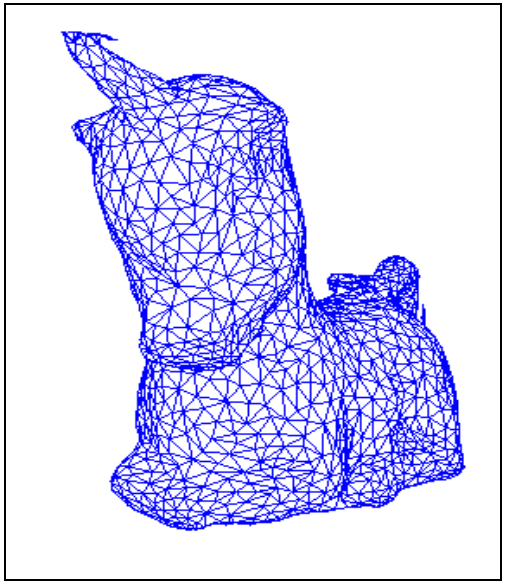
Robotics

- 2D Gray-tone or Color Images

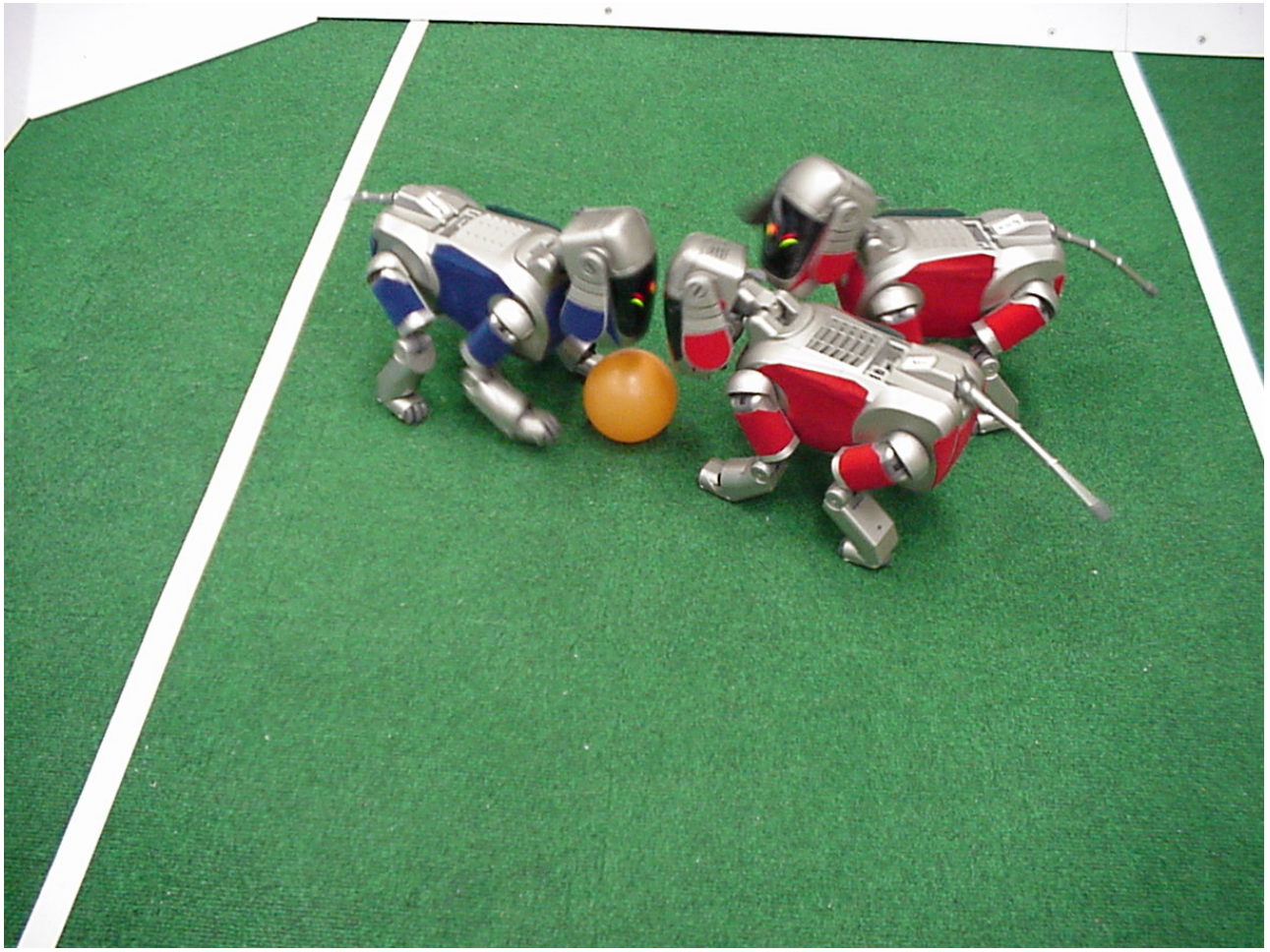
"Mars" rover

- 3D Range Images

What am I?



Robot Soccer



Google Driverless Car

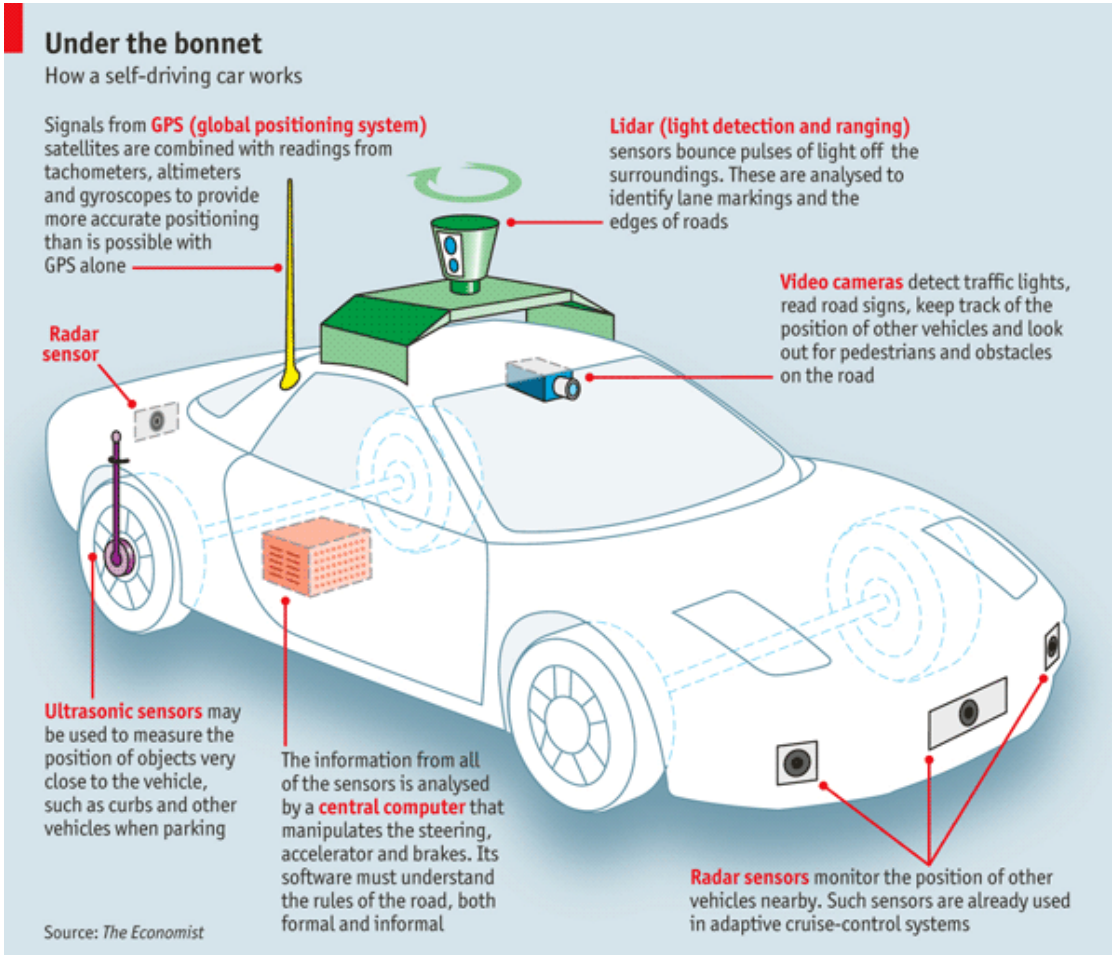


Image Databases:

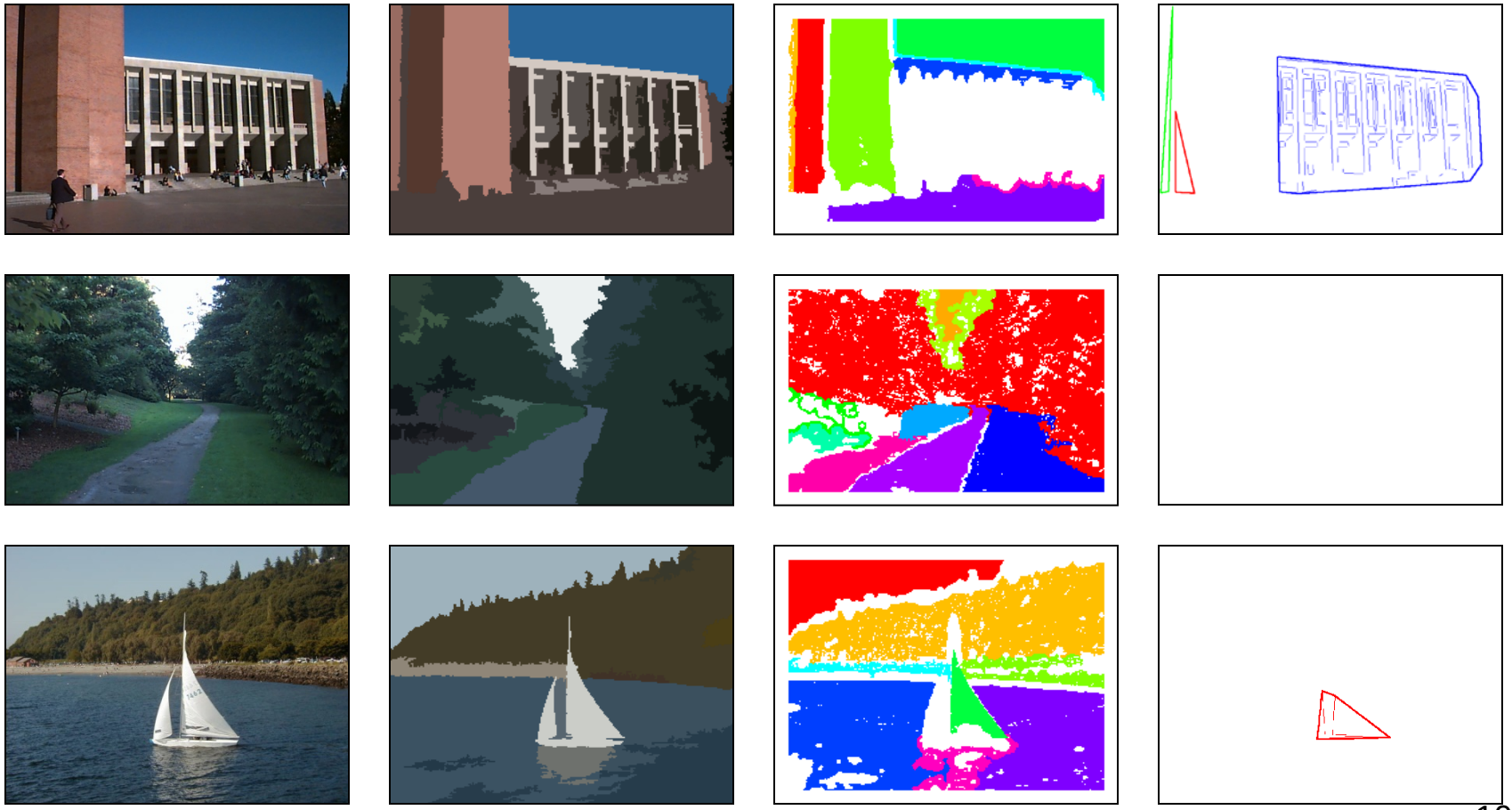
Images from my Ground-Truth collection:
http://www.cs.washington.edu/research/imagedatabase/groundtruth



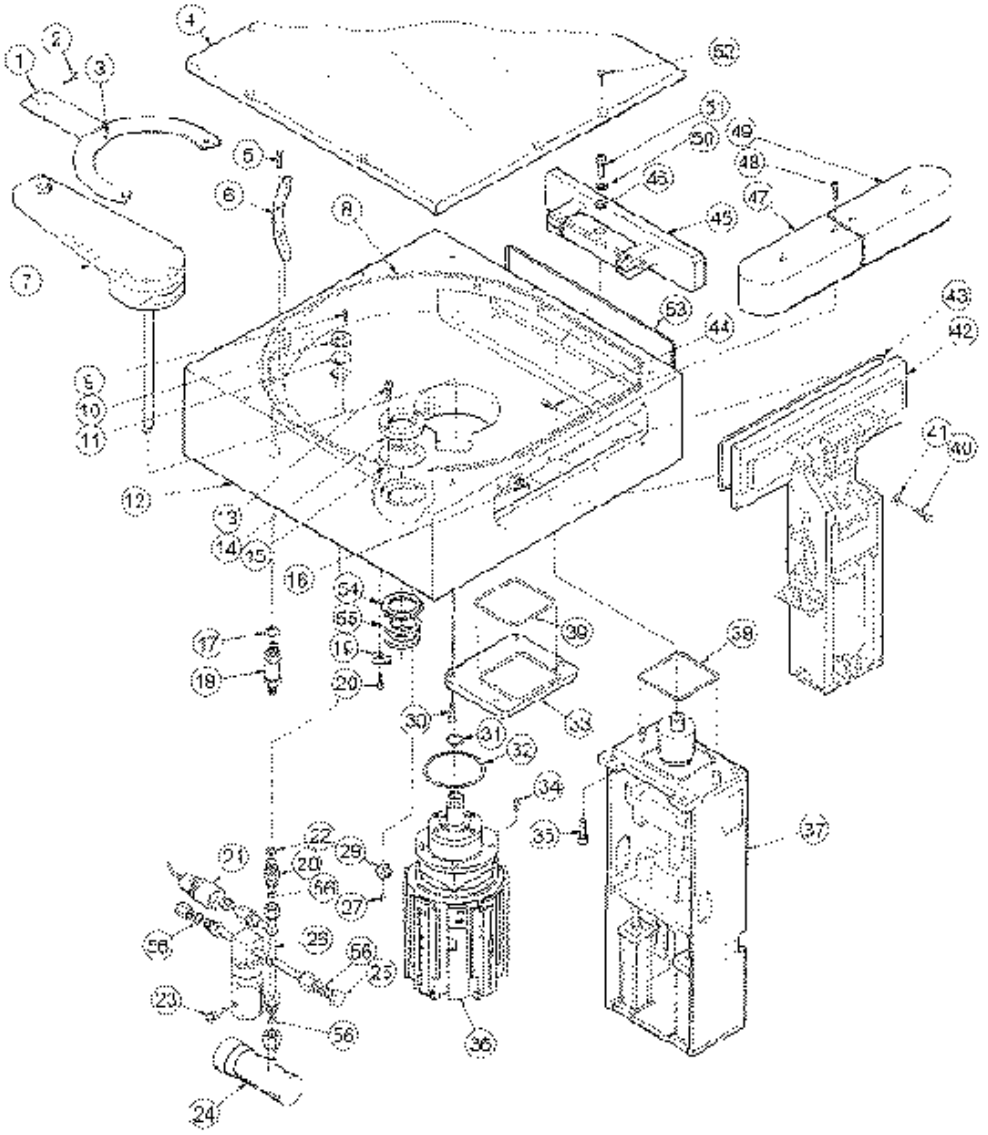
- Retrieve images containing trees

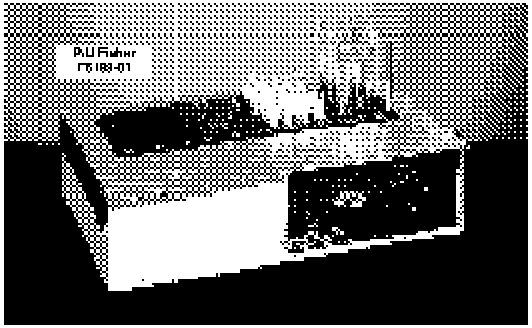
Some Features for Image Retrieval

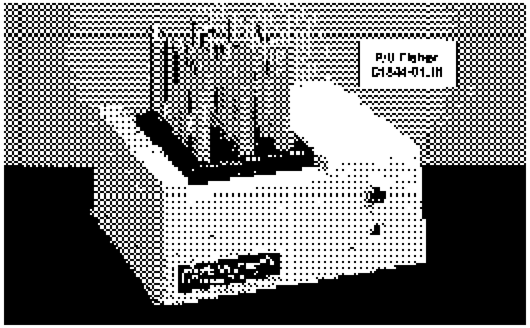
Original Images | Color Regions | Texture Regions | Line Clusters



Documents:







Model 145 Isotemp* Dry Bath Incubator

- *Holds 1 to 4 heating blocks with choice of 11 well sizes*
- *Maintains every sample to within ±0.1° C of temperature*

Unique sample wells are shaped so that aluminum blocks deliver same amount of heat to all parts of the sample tube. No temperature gradient—neither too hot at the bottom nor too cold at the top—that may invalidate tests in tubes with drilled cylindrical wells. Sample tubes rest on insulating plugs to prevent localized heating. A low watt-density heater is mounted on a thick aluminum heat distribution plate in the floor of the bath. Plate is ⅜" thick (9.5 mm). Dry bath minimizes cleanup problems because tubes stay dry.

Ambient to 125° C (257° F) with ±0.1° C control. Dial temperature control graduated from 25° to 125° C. Ideal for enzyme reactions, inactivation of sera, Rh studies, cross-matching and thrombin determinations. Dimensions: 9 L x 15 ¼ W x 4" H (23 x 39 x 10 cm). With line cord and plug. **Heating blocks sold separately** (see lower right).

Electrical Requirements	Cat. No.	Each
120V 50/60 Hz, 300W (CSA approved)	11-715-100	[illegible]
240V 50/60 Hz, 600W	11-715-101	385.25

[illegible] 37° C
[illegible] Model

Incu-Block* Partial Immersion Thermometers

For all standard heating blocks and water baths. Critical temperatures (25°, 30°, 37°, 56° C) are marked with arrows. Available with shatter-proof, contamination-proof Teflon* coating. Total length: 175 mm. Immersion: 35 mm.

Range, °C	Div., °C	Teflon-Coated	Cat. No.	Each
25-57	0.5	No	14-982	45.84
25-57	0.5	Yes	14-983	45.15

More 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 ⅜" thick (2.0 mm) plate. Ideal for labs with smaller volumes of enzyme and cholesterol assays, Rh studies, and dry incubations. Screwdriver-adjusted temperature control between ambient and 95° C (204° F). Observe thermometer placed in unused sample tube to set; adjust control through hole in front panel. Maintains set temperature with consistency and uniformity of ±0.5° C.

Supplied with strong nylon case, thermostatically controlled heater, pilot indicator lamp, line cord and plug, and instructions. Dimensions: 8 L x 6¾ W x 3" H (15 x 17 x 8 cm). CSA approved. **Heating blocks sold separately** (see below).

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

Interchangeable Heating Blocks for Isotemp* Dry Baths

For Models 145 and 147 Dry Baths. Composed of black anodized aluminum alloy. Chemical resistant. Dimensions: 4 L x 3 W x 2⅜ H (10 x 7.5 x 5 cm).

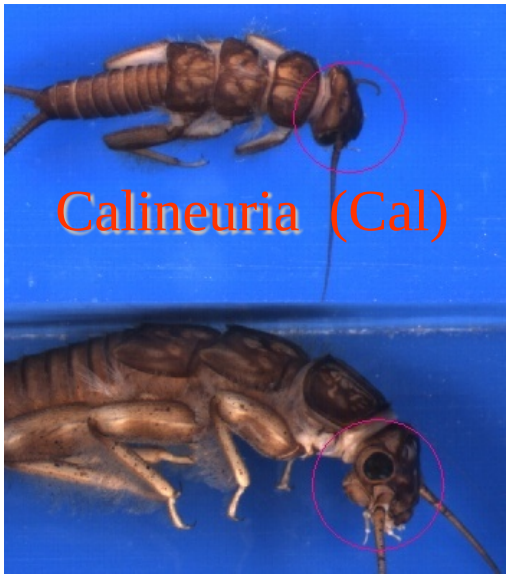
The 11-715-123 block provides a safe, dry bath alternative for warming the Superior of tissue [illegible]. Avoids hazardous use of burners around flammable histologic solvents.

The 11-715-120 block is specifically designed to hold twenty 9.5 mm Roche Diagnostics Placentex* pregnancy test tubes. This special shallow well block is similar to the other blocks with 10 mm holes, but sample wells are only ½" deep (1.3 cm) to meet test requirements. Wells in all other blocks are 1¾" deep (4.4 cm).

Tube Size, mm	Wells/Block	Cat. No.	Each
6	35	11-715-105	71.[illegible]
10	20	11-715-107	71.[illegible]
9.5	20 (shallow)	11-715-120	71.[illegible]
12	12	11-715-109	71.[illegible]
12 x 4	12	11-715-121	71.[illegible]
13	12	11-715-111	71.[illegible]
15	12	11-715-113	71.[illegible]
16	8	11-715-123	71.[illegible]
18	12	11-715-115	71.[illegible]
20	6	11-715-117	71.[illegible]
25	5	11-715-119	71.[illegible]

[illegible]
[illegible]

Science

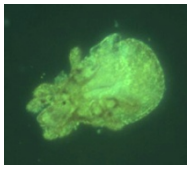


Previous Classification Results:

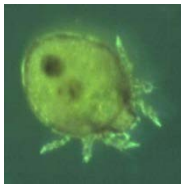
Classified	as Cal	as Yor
Cal	171	16
Yor	0	99

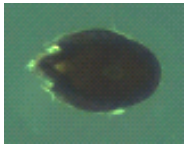
Classified	as Cal	as Dor
Cal	114	72
Dor	70	133

Soil Mesofauna

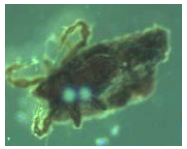

TraychetesA

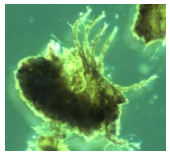

XenillusA


ZyqoribafulaA

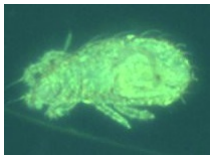

AchipteriaA


BdellozoniumI

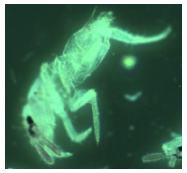

BelbaA

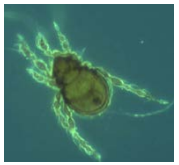

BelbaI


CatoposurusA

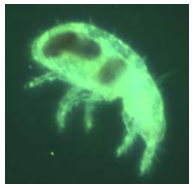

EniochthoniusA


PtenothrixV

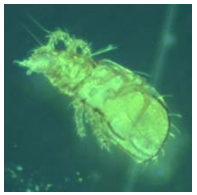

EntomobrgaTM


EpidamaeusA

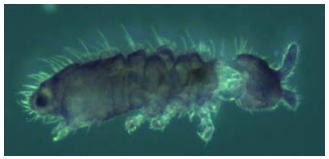

EpilohmanniaA


EpilohmanniaD


EpilohmanniaT


HypochthoniusLA

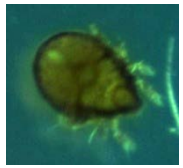

PtiliidA

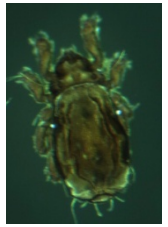

HypogastruraA


IsotomaA

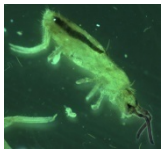

IsotomaVI


LiacarusRA

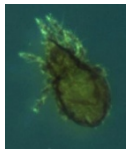

MetrioppiaA


NothrusF


QuadroppiaA


TomocerusA


onychiurusA


OppiellaA


PeltenualaA


PhthiracarusA

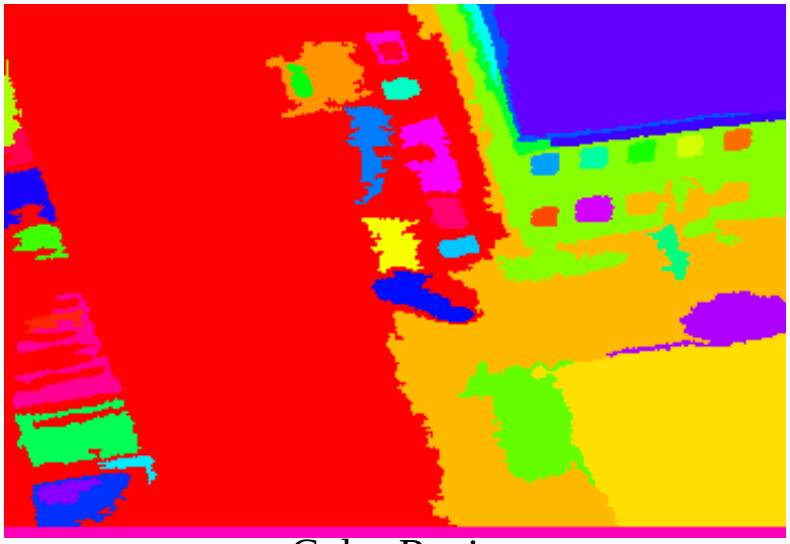

PlatynothrusF


PlatynothrusI


SiroVI

Surveillance: Event Recognition in Aerial Videos

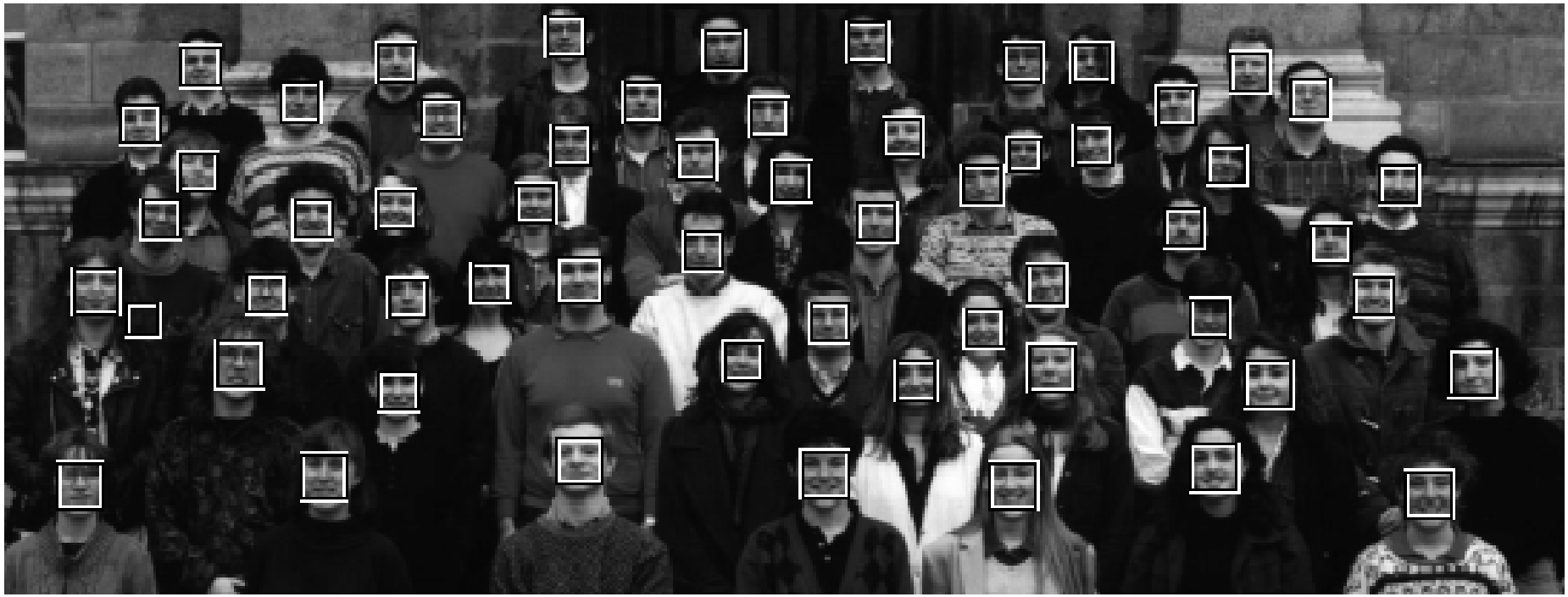
Original Video Frame



Color Regions

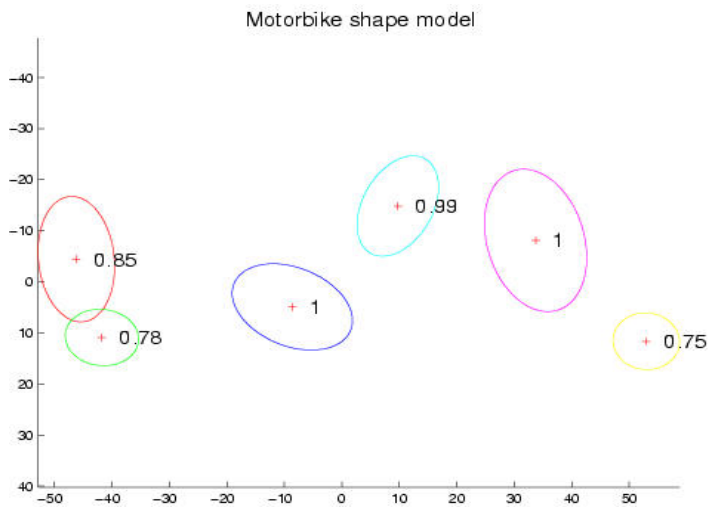
Structure Regions

2D Face Detection



Face Recognition

2D Object Recognition from “Parts”

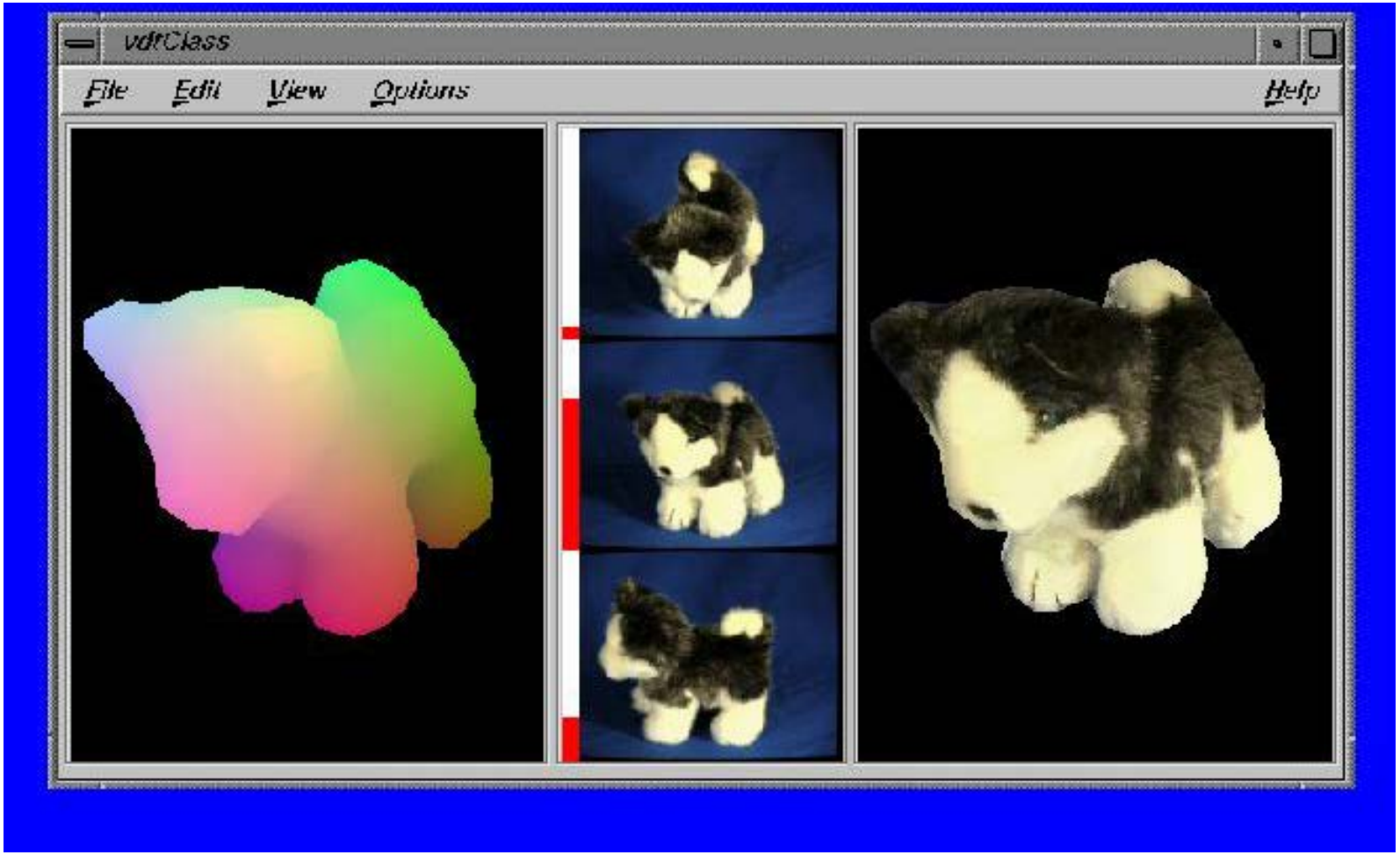


Oxford University

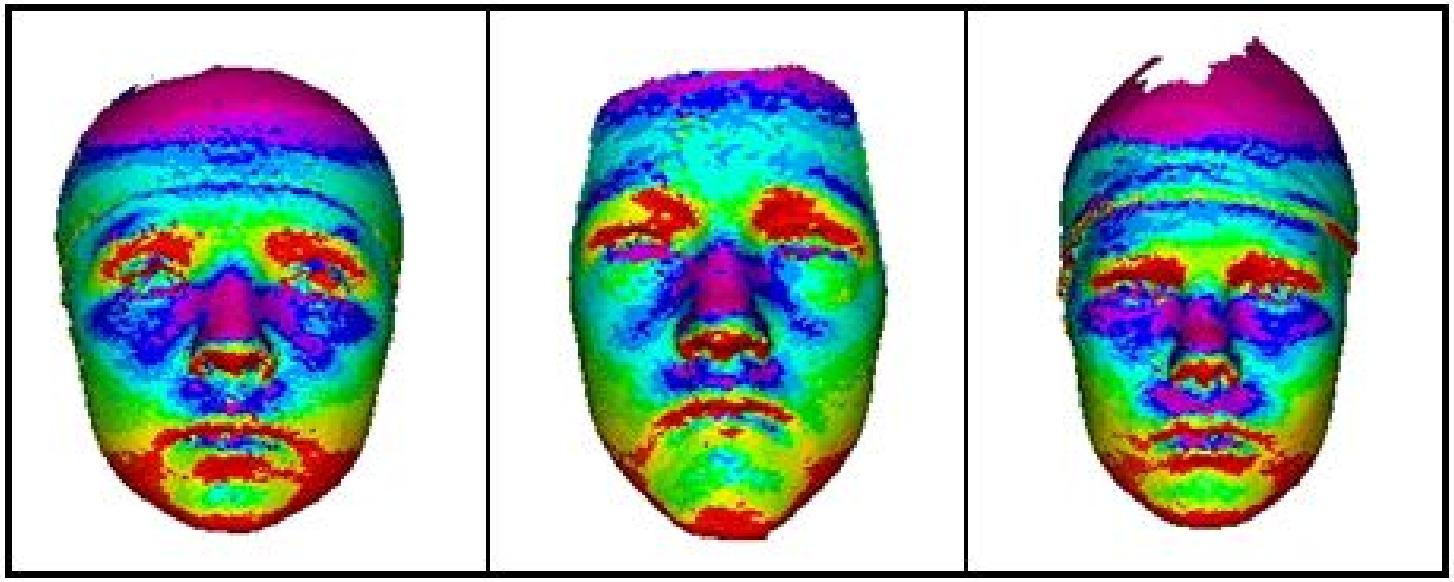
Graphics: Special Effects

Andy Serkis, Gollum, Lord of the Rings

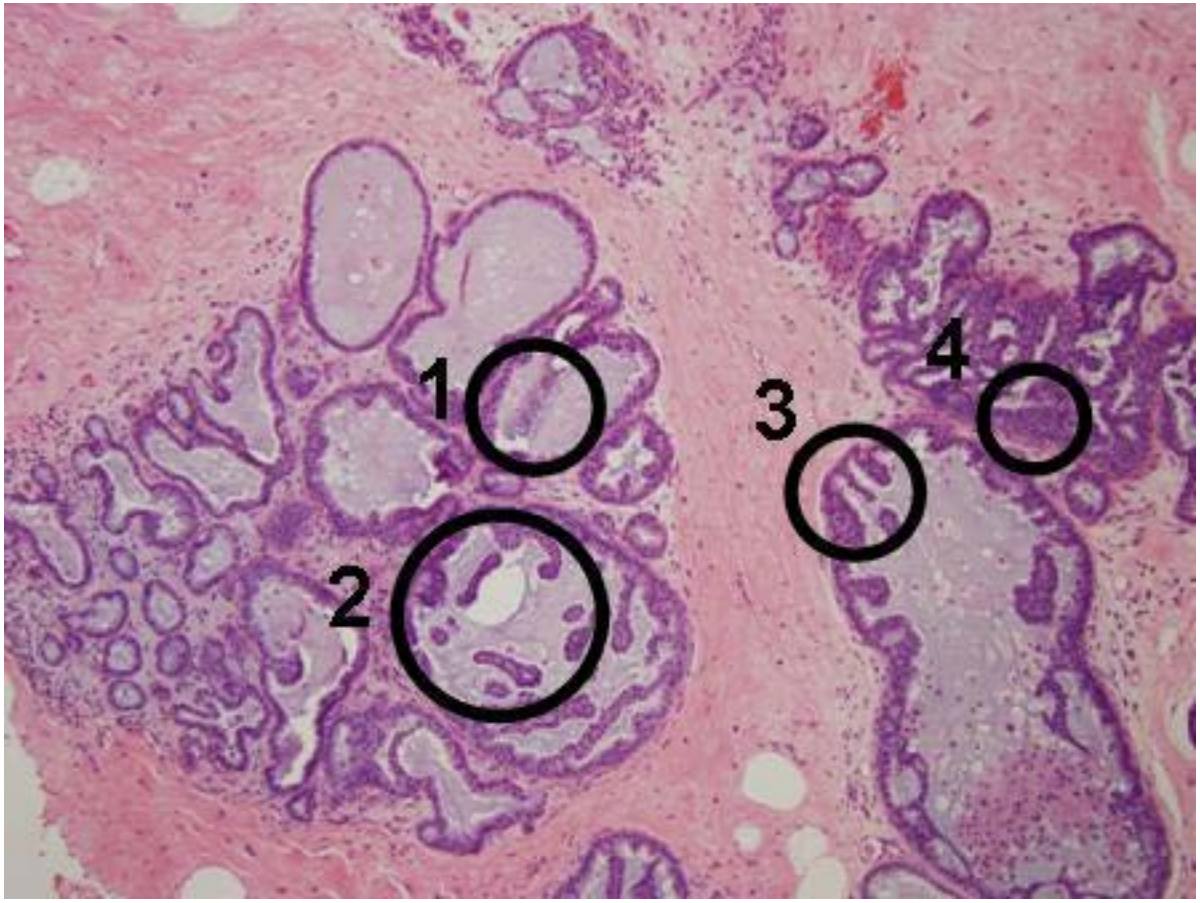
3D Reconstruction and Graphics Viewer



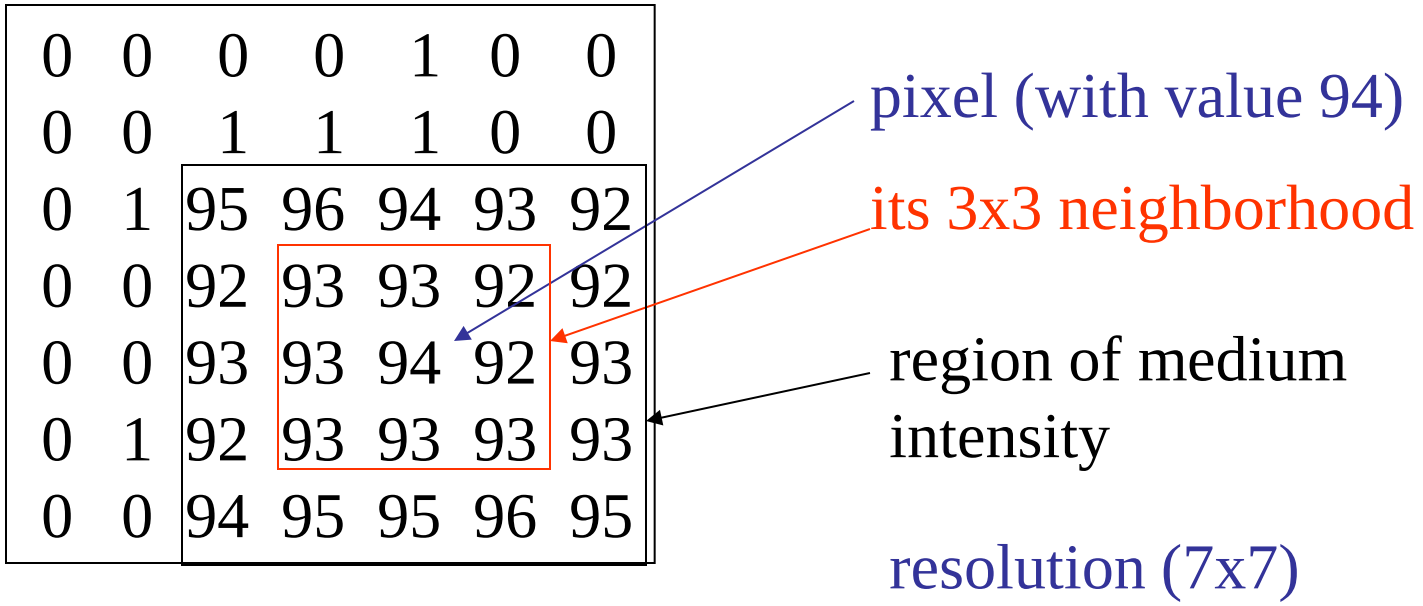
3D Craniofacial Shape Analysis from Meshes of Children's Heads



Digital Breast Biopsy Image Showing Regions of Interest



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

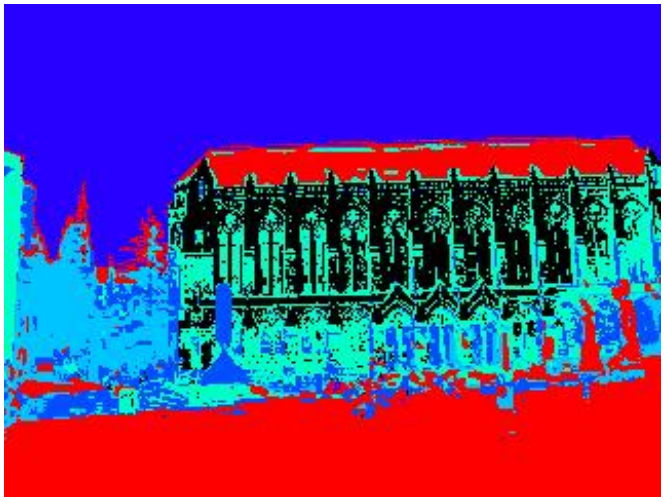
circular arcs and line segments

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