Image Understanding

Course Objectives

1. Background in Computer Vision
2. Mastery of Tools and Skills

   (Languages and Systems, including MSVC, MATLAB + Image Processing Toolbox, KHOROS + CANTATA, Lisp, Mathematica)
3. Intellectual Fulfillment (and enjoyment)
4. Completion of Interesting Projects
5. Experiments with New Educational Technology

   (Image processing on the World-Wide Web)
6. Understanding of Relationships between Human and Machine Vision

Image Understanding

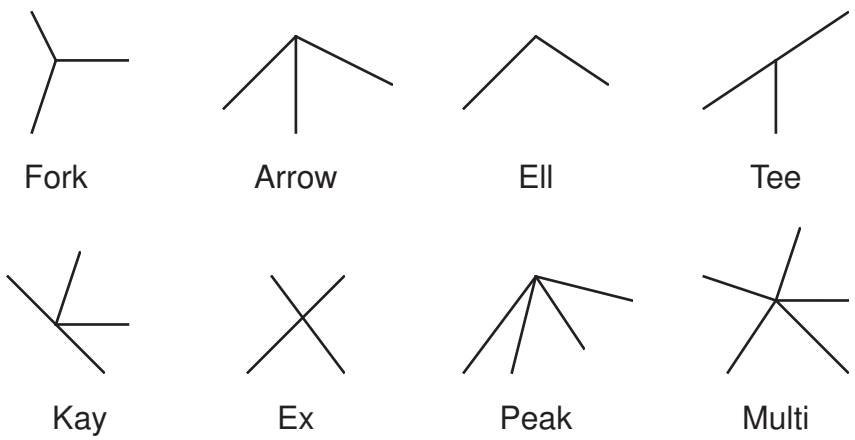
Levels of the Visual Processing Hierarchy

1. Scene Geometry
2. Image Formation
3. Sensing
4. Preprocessing
5. Segmentation
6. Feature Extraction
7. Classification and Symbolic Description
8. (Action)

An Example of High-Level Image Understanding

Scene Labelling with the Method of Adolfo Guzman (MIT, 1968)

1. Begins with an accurate line drawing, represented in the computer.
2. Analyzes the junctions in terms of valences and angles.
3. Applies linking rules to the regions (faces) of the drawing.
4. Outputs the lists of faces associated with the polyhedra in the scene.



Color

Trichromatic Color Perception

1. Rods and cones transduce light energy to neural impulses.
2. A cone contains one of three pigments, sensitive to either red, green, or blue.
3. Response of a receptor to the incoming spectrum:
   $b = \int_{350}^{720} d(\lambda)B(\lambda)d\lambda$
   The wavelength λ is in nanometers
4. Traditional means of color description: (Hue, Saturation, Brightness).
5. Brightness $= R + G + B$
6. Saturation $= 1 - \frac{3\min(R,G,B)}{R+G+B}$
7. Hue $= \cos^{-1} \frac{2R-G-B}{2\sqrt{R^2+G^2+B^2-RG-GB-RB}}$

Additive and "Subtractive" Color Mixing

1. Additive mixing: superimposition of light.

   $f_3(\lambda) = f_1(\lambda) + f_2(\lambda)$

   Here the f_i are distributions of light energy across the spectrum.

   (The values are nonnegative.)

2. "Subtractive" mixing: superimposition of filters.

   $f_3(\lambda) = f_1(\lambda) \cdot f_2(\lambda)$

   Here the f_i are transmittances of light through the filter as functions of wavelength.

   (The values are in the range 0 to 1).

3. So-called subtractive mixing is really multiplicative.

4. Mixing of colors due to mixing of paints is neither purely additive nor purely subtractive, but a combination that depends upon the ways the pigment particles tend to interact.