Binary Vision
to Filtering
Computer Vision
CSE 190-B
Lecture 6

Announcements

• First assignment was available last Thursday
  – Use whatever language you want.
  – Link to matlab resources from web page
• Always check web page for updates on readings, etc.
• Discussion group for course is available as link from the course web page.
• Subscribe to class mailing list with send e-mail to majordomo@cs.ucsd.edu with body subscribe cse190-b my_email@something.something

The assignment
Irfanview: A good utility

Two parts:
1. Color classification
2. Binary image processing

Label
• Red pixels as 1
• Green Pixels as 2
• Black pixels as 0

More challenging (Extra Credit)

Other part: Binary Image Processing
(Next lecture)

RGB Color Cube

• Block of colours for (r, g, b) in the range (0-1).
• Convenient to have an upper bound on coefficient of each primary.
• In practice:
  – primaries given by monitor phosphors
  – (phosphors are the materials on the face of the monitor screen that glow when struck by electrons)
Color Matching

Not on a computer Screen

RGB Color Matching

RGB: primaries are monochromatic, energies are 645.2nm, 526.3nm, 444.4nm. Color matching functions have negative parts -> some colors can be matched only subtractively.

CIE XYZ Color Matching Functions

CIE XYZ: Color matching functions are positive everywhere, but primaries are imaginary. Usually draw x, y, where 
\[ x = X / (X+Y+Z) \]
\[ y = Y / (X+Y+Z) \]

CIE xyY (Chromaticity Space)

RGB to YIQ

The YIQ system is the colour primary system adopted by NTSC for color television broadcasting. The YIQ color solid is formed by a linear transformation of the RGB cube. Its purpose is to exploit certain characteristics of the human visual system to maximize the use of a fixed bandwidth.

\[
\begin{bmatrix}
Y \\
I \\
Q
\end{bmatrix} =
\begin{bmatrix}
0.299 & 0.587 & 0.114 \\
0.596 & -0.274 & -0.322 \\
0.212 & -0.523 & 0.311
\end{bmatrix}
\begin{bmatrix}
R \\
G \\
B
\end{bmatrix}
\]

Note that “Y” captures intensity whereas I & Q capture the effects of hue & saturation.

HSV Hexcone

Hue, Saturation, Value
AKA: Hue, Saturation, Intensity (HIS)

Hexagon arises from projection of cube onto plane orthogonal to (R,G,B) = (1,1,1)
**Connected Regions**

What are the connected regions in this binary image?
Which regions are contained within which region?

**Four & Eight Connectedness**

Four Connected
Eight Connected

**Jordan Curve Theorem**

Every closed curve in $\mathbb{R}^2$ divides the plane into two regions, the ‘outside’ and ‘inside’ of the curve.

**Problem of 4/8 Connectedness**

8 Connected:
- 1’s form a closed curve, but background only forms one region.

4 Connected
- Background has two regions, but ones form four “open” curves (no closed curve)

**To achieve consistency w.r.t. Jordan Curve Theorem**

1. Treat background as 4-connected and foreground as 8-connected.
2. Use 6-connectedness
Recursive Labeling

Connected Component Exploration

Procedure Label (Pixel)
BEGIN
Mark(Pixel) <- Marker;
FOR neighbor in Neighbors(Pixel) DO
  IF Image (neighbor) = 1 AND Mark(neighbor)=nil THEN
    Label(neighbor)
  END
END
BEGIN Main
Marker <- 0;
FOR Pixel in Image DO
  IF Image(Pixel) = 1 AND Mark(Pixel)=nil THEN
    BEGIN
      Marker <- Marker + 1;
      Label(Pixel);
    END;
  END
END

Globals:
Marker: integer
Mark: Matrix same size as Image, initialized to NIL

Image Filtering

Noise

• Simplest noise model
  – independent stationary additive Gaussian noise
  – the noise value at each pixel is given by an independent draw from the same normal probability distribution

• Issues
  – this model allows noise values that could be greater than maximum camera output or less than zero
  – for small standard deviations, this isn’t too much of a problem - it’s a fairly good model
  – independence may not be justified (e.g. damage to lens)
  – may not be stationary (e.g. thermal gradients in the ccd)