CS 6640 Week 3

* Assessments (redo)
* Quiz 1 : quiz1.jpg ; solutions online ; Know Matlab
* added image registration to topics
* p.34 slides 4

  p.37 : ? how to figure out

$$\begin{bmatrix} -1 & 0 & 1 \\ & & \\ & & \end{bmatrix} \qquad \begin{bmatrix} -1 \\ \\ \end{bmatrix} \begin{bmatrix} 1 & 0 & -1 \end{bmatrix}$$

* p.45 show cs6640-week3
* See Notes chapters 1-2 (from Spring 2018)

  Fourier Transform p.6

  be sure you understand basic nature of this computation
* Spatial filters
  - calculate how much image subwindow "aligns" with filter (i.e., dot product)
  - use for texture analysis
    show Brodatz (cs6640/Brodatz)
* Ken Laws : energy approach

* Laws:

the image is convolved with a ~~set~~ set of fiters (kernels)
I $g_1, g_2, \dots g_N$

$J_n = I * g_n$ ← convolution

Then a feature vector based on energy is found:

$$S_n(r,c) = \frac{1}{49} \sum_{i=-3}^{3} \sum_{j=-3}^{3} |J_n(r+i, c+j)|$$

basis kernels are:

$L3 = [1 \ 2 \ 1]$
$E3 = [-1 \ 0 \ 1]$
$S3 = [-1 \ 2 \ -1]$

1x5 kernels are found by convolving 1x3 kernels:

$L5 = [1 \ 4 \ 6 \ 4 \ 1]$ = conv(L3, L3)
$E5 = [-1 \ -2 \ 0 \ 2 \ 1]$ L3, E3
$S5 = [-1 \ 0 \ 2 \ 0 \ -1]$ L3 S3 -(E3, E3)
$W5 = [+1 \ -2 \ 0 \ +2 \ -1]$ E3 S3
$R5 = [1 \ -4 \ 6 \ -4 \ 1]$ S3 S3

L7 = [1 6 15 20 15 6 1]
E7 = [-1 -4 -5 0 5 4 1]
S7 = [-1 -2 +1 +4 +1 -2 -1]
W7 = [-1 0 3 0 -3 0 1]
* R7 = [-1 2 1 -4 1 2 -1]
O7 = [-1 6 -15 20 -15 6 -1]

L3, L3, L3
E3, L3, L3
L3, S3, L3
E3, E3, E3
E3, E3, S3
S3, S3, S3

Use 7x7 filters calculated as:

g1 = L7' * L7
g2 = L7' * E7
g3 = L7' * S7
g4 = L7' * W7
g5 = L7' * R7
g6 = L7' * O7
g7 = E7' * E7
g8 = W7' * R7
g9 = W7' * O7
g10 mean

* Develop a Laws texture function, and use kmeans to classify the resulting vectors and apply to our video images

* Geometric transforms slides 2 p. 26

Harris detector

$$H = \sum \nabla I \, (\nabla I)^T$$

$$= \begin{bmatrix} \frac{\partial^2 G_x(I)}{\partial x^2} & \frac{\partial^2 G_x(I)\, G_y(I)}{\partial x \, \partial y} \\ \frac{\partial^2 G_y(I)\, G_x(I)}{\partial \partial y \, \partial x} & \frac{\partial^2 G_y(I)}{\partial y^2} \end{bmatrix}$$

p = local maxima of: $\det(H) - k\,(\mathrm{trace}(H))^2$

$k \in [0.04, 0.06]$

How to compute:

<u>for</u> every pixel (x,y)

$W = k \times k$ window at (x,y)

pts = create $k^2 \times 2$ set of points $\begin{bmatrix} dx_1, dy_1 \\ \vdots \\ dx_{k^2} \; dy_{k^2} \end{bmatrix}$ in window

$H = pts' * pts$ covariance matrix

$R = \det(H) - K * \mathrm{trace}(H)^2$

<u>end</u>