SIMG-717-20052
Homework Assignment #1 Due 12/7/2005 (W)

Read §11 in notes on *Hankel transform* (if you have not yet done so), §12 on the *Radon transform*, and §13.1 on *moments*

1. Find the zero-order Hankel transforms of the following functions and make "appropriate" sketches of your results IN BOTH DOMAINS (e.g., axial profiles, top views, perspective plots, etc.)

   (a) $f(r) = CYL(2r)$

   (b) $g(r) = CYL(2r) \bigstar CYL(2r)$ (where "$\bigstar$" denotes 2-D correlation)

   (c) $h(r) = CYL(0.25r) - CYL(0.5r)$

   (d) $t(r) = SOMB^2(r) \bigstar SOMB(5r)$

   (e) $v(r) = -4\pi^2 r^2 GAUS(2r) = (2\pi i r)^2 GAUS(2r)$

2. Given an LSI system with impulse response:

$$h[x,y] = 25\ SINC^2[5x, 5y]$$

   find the output $g_i[x,y]$ for the following input signals:

   (a) $f_1[x,y] = 1 + \cos[6\pi x] + \cos[12\pi x]$

   (b) $f_3[x,y] = \delta[x]\,1[y]$ (note that $g_3[x,y]$ is a "line response")

3. Evaluate the results of the following operations, where the symbols "$*$" and "$\bigstar$" denote 2-D convolution and correlation, respectively:

   (a) $J_0(2\pi\rho_0 r) * J_0(2\pi\rho_1 r)$, where $\rho_0 \neq \rho_1$

   (b) $CYL(r) * (\delta[x]\ \ 1[y])$

   (c) $CYL(r) * \left(\delta\left[\underline{\mathbf{r}} \bullet \underline{\hat{\mathbf{p}}}\right]\ \ 1\left[\underline{\mathbf{r}} \bullet \underline{\hat{\mathbf{p}}}^{\perp}\right]\right)$ where $\underline{\hat{\mathbf{p}}} = \begin{bmatrix} \frac{\sqrt{3}}{2} \\ -\frac{1}{2} \end{bmatrix}$

   (d) $\delta(r - r_0) * (\delta[x]\ \ 1[y])$

4. Evaluate the following 2-D convolutions and make appropriate sketches of the results:

   (a) $\left(\cos\left[2\pi\frac{x}{4}\right]\ \ 1[y]\right) * (\delta[x]\ \ 1[y])$

   (b) $\left(\cos\left[2\pi\frac{x}{4}\right] 1[y]\right) * CROSS[x,y]$ (where $CROSS[x,y] \equiv \delta[x]\ \ 1[y] + 1[x]\ \ \delta[y]$)

   (c) $e^{+i\pi r^2} * \delta[x]\,1[y]$, where $r = \sqrt{x^2 + y^2}$

   (d) $e^{+i\pi r^2} * CROSS[x,y]$