GEORGIA INSTITUTE OF TECHNOLOGY
School of Electrical and Computer Engineering

Course EE 6416

Multidimensional Digital Signal Processing

Assigned: October 9, 1998
Due: October 16, 1998
Due (video): October 30, 1998

Problem Set #3

Reading: Read Sections 2.2, 3.1, and 3.2 in the notes.

Announcement: Quiz #1 will be held on Wednesday, October 21, 1998 for the on-campus students. It will be *open book*. Its coverage will include material though this problem set, i.e. through Section 3.2 in the notes. You are *not* responsible for those sections in the notes that have not been assigned as reading.

Problem 3.1: Work problem 2.1 in the notes.

Problem 3.2: Work problem 2.2 in the notes. (Note that the referenced figure is Figure 2.11.)

Problem 3.3: Work problem 2.3 in the notes.

Problem 3.4: A 3-D signal $x[n_1, n_2, n_3]$ is isotropically bandlimited with a spectrum that satisfies

$$X(\Omega_1, \Omega_2, \Omega_3) = 0, \qquad \text{if } \Omega_1^2 + \Omega_2^2 + \Omega_3^2 \geq (10\pi)^2 \ .$$

(a) What is the minimum sampling density required (in samples per unit volume) if the signal is sampled rectangularly?

(b) The optimal sampling raster places the replicated copies of the bandlimited spectrum at the vertices of a dodecahedron (face-centered cubic lattice). The polar (aliasing) lattice is defined by the matrix

$$\boldsymbol{U} = \begin{bmatrix} \frac{20\pi}{\sqrt{2}} & -\frac{20\pi}{\sqrt{2}} & \frac{20\pi}{\sqrt{2}} \\ \frac{20\pi}{\sqrt{2}} & 0 & -\frac{20\pi}{\sqrt{2}} \\ 0 & \frac{20\pi}{\sqrt{2}} & 0 \end{bmatrix} .$$

Determine the ratio of the minimum sampling rate required with this lattice to that of the optimal rectangular lattice if no aliasing is to occur.

Problem 3.5: Work problem 3.3 in the notes.