EE 5359 Final exam Tuesday 10 Aug. 2004 8/10/04

(Closed book/notes) 6:00 – 7:30 PM

1) Draw a block diagram for DPCM and inverse DPCM. Identify all relevant parameters. Define causal, linear, order and dimension.

2) Show that $\underset{(K\times 1)}{\underline{a}} = \underset{(K\times K)}{\underline{R}}\ \underset{(K\times 1)}{\underline{r}}$ minimizes MSPE for a $K$th order causal linear predictor. $\underline{a} = (a_1, a_2, \cdots, a_K)^T$

3) Draw a block diagram for a 2D four equal subband decomposition (both analysis and synthesis stages). Identify the LL, LH, HL, and HH subbands. Input is an image of size (NxN). Identify the sizes at all relevant points. What does a PR mean?

4) Given the (constraint) average bit rate $R = \frac{1}{M}\sum_{k=1}^{M} R_k$, M= # of Subbands.

($R_k$ =average # of bpp for subband k). Minimize the total reconstruction error

$\sigma_r^2 = \alpha \sum_{k=1}^{M} 2^{-2R_k}\sigma_{yk}^2$, where $\sigma_{yk}^2$ is the reconstruction error variance for kth subband,

subject to the constraint, derive

$$R_k = R + \frac{1}{2}\log_2 \frac{\sigma_{yk}^2}{\left[\prod_{k=1}^{M}(\sigma_{yk}^2)\right]^{\frac{1}{M}}}$$

Hints:

Set up the minimization problem in terms of Lagrange multiplier as

$$J = \alpha \sum_{k=1}^{M} 2^{-2R_k}\sigma_{y_k}^2 - \lambda\Big(R - \frac{1}{M}\sum_{k=1}^{M} R_k\Big)$$

$$d(a^u) = a^u(\log_e a)du$$

5) (a), Show that the symmetric low pass filter $h_n = h_{N-1-n}$ is linear phase for length 8. (N= 0, 1, 2,..., 7)

(b), Show that high pass filter $h_n = (-1)^n h_{N-1-n}$ is also linear phase for length 8. (N= 0, 1, 2,..., 7)

(All problems carry equal weights.)

(Prob. 2) $\underset{(K\times 1)}{\underline{a}} = \underset{(K\times K)}{\underline{R}^{-1}}\ \underset{(K\times 1)}{\underline{r}}$