EE 5359 Video Coding
Final Exam

K. R. Rao
UTA Engineering
Closed book

SHOW ALL STEPS

$$H(e^{j\omega}) = \sum_{n=0}^{N-1} h(n)\, e^{-j\omega n}$$

1. Show that a symmetric filter has linear phase. Show this clearly for $N = 8$.

   $h_n = h_{N-1-n}$. Impulse response.

   $(n = 0, 1, \cdots, \frac{N}{2}-1)$, $h(n) = h(N-1-n)$

2. A 512×512 input image (8 bit PCM) is decomposed into 7 unequal subbands as shown in fig.2. Assume that 8 bits are allocated to each sample in the first subband, 4 bits are allocated to each sample in subbands 2,3,4 and 2 bits are allocated to the rest. This decomposed image is sent through a 9600 bits-per-second channel in a progressive manner. Specifically, stage 1 of transmission contains information of subband 1 only, stage 2 contains information of subbands 2,3,4 and stage 3 contains information of subbands 5,6,7. How long would it take to transmit each stage of transmission and what fraction of image is sent during the same time by normal transmission (without coding).

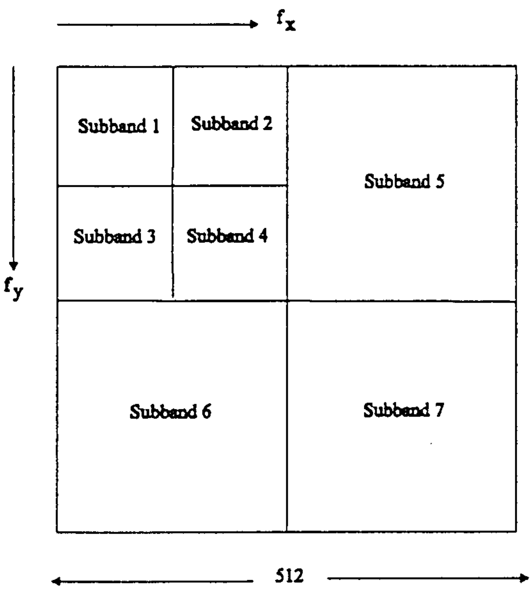

figure 2.

3. a) Show in a block diagram format (using LPF, HPF and decimators) how you can obtain the subband decomposition shown in Fig. 2.

   b) Repeat a) to obtain the original (512 x 512) image, ie, Subband synthesis (using also interpolators).

4. Given the (constraint) average bit rate $R = \frac{1}{M}\sum_{K=1}^{M} R_K$
(R$_k$ = average # of bpp for subband k).
Minimize the total reconstruction error

$$\sigma_r^2 = \alpha \sum_{K=1}^{M} 2^{-2R_K} \sigma_{y_K}^2$$

where $\sigma_{y_K}^2$ is the reconstruction error variance for kth quantizer, subject to the constraint., i.e., derive

$$R_K = R + \frac{1}{2}\log_2 \frac{\sigma_{y_K}^2}{\left[\prod_{K=1}^{M}\left(\sigma_{y_K}^2\right)\right]^{1/M}}$$

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

5. Given an input sequence

$$x_n = \begin{cases} (-1)^n & n = 0, 1, 2, \ldots \\ 0 & \text{otherwise} \end{cases}$$

(a) Find the output sequence y_n if the filter impulse response is

$$h_n = \begin{cases} \frac{1}{\sqrt{2}} & n = 0, 1 \\ 0 & \text{otherwise.} \end{cases}$$

(b) Find the output sequence w_n if the impulse response of the filter is

$$h_n = \begin{cases} \frac{1}{\sqrt{2}} & n = 0 \\ -\frac{1}{\sqrt{2}} & n = 1 \\ 0 & \text{otherwise.} \end{cases}$$

(c) Looking at the sequences y_n and w_n, what can you say about the sequence x_n?