Department of Electrical Engineering, IIT Madras

EE5141 : Fundamentals of Wireless and Cellular Communications

Marks 25 **Simulation Assignment** **Nov. 5, 2014**

1. [2+2+2=6 marks] Time-selective Fading: A vehicle is moving with velocity v m/s where the wireless link uses a carrier-frequency of f_c=2GHz and a pass-band message bandwidth of 2W=100KHz. Simulate and plot 5 independent runs of the fading channel (sampled every T_s=1/2W=10μsecs), where each run is over N=8000 samples, using each of the 3 following fading models:
(a) Smith's model (using FFTs) – see Rappaport's book; use N=8192 here.
(b) Sum of sinusoids model – see presentation from TAs
(c) Modified sum of sinusoids model – see presentation from TAs
Repeat the above for 2 choices of velocity, namely (i) v=1m/s; (ii) v=10m/s. Interpret your answer(s) briefly. How does the model in (c) differ from (b) in cross-correlation performance (i.e., over the 5 different runs, what is the mutual correlation?).

2. [2+2=4 marks] Frequency-selective Fading: Consider a wide-band signal with pass-band bandwidth 2W=10MHz, which is transmitted over two multi-path models, defined by their power delay profiles (PDP) as follows:

Channel Model #**1**

Path Gain σ_i^2(in dB)	0	-3	-8	-15
Path Delay τ_i (in μsecs)	0	0.5	1.7	2.2

Channel Model #**2**

Path Gain σ_i^2(in dB)	-2	0	-1	-6	-9	-14
Path Delay τ_i (in μsecs)	0	1.8	3.5	5.7	8.1	12.3

Hint: To normalize average channel gain to unity, in each of these models, rescale the (linear value of) the path variance σ_i^2 to ensure that over the L paths, $\sum_{i=0}^{L-1} \sigma_i^2 = 1$.
Each zero-mean path gain a_i, where $E[|a_i|^2]= \sigma_i^2$, is a complex Gaussian random variable with each dimension having a variance of σ_i^2 /2. The impulse-response snap-shot h[n] corresponding to a given PDP is obtained by calling a circular Gaussian rv L times, and scaling the gain based on the power profile. The frequency response snap-shot H[k] is obtained by zero-padding plus FFT (of typically large size to visualize shape easily). For each of the above PDPs, take a 2048 point FFT of the instantaneous h[n] (by appropriate zero-padding) to get H[k]. Plot in dB scale the squared gain, i.e., $10\log_{10}(|H(k)|^2)$, to interpret the coherence band-width of models #1 and #2 and comment. Repeat for each model over 3 different (independent) channel realisations, and plot in the same figure.

3. [2 marks] Now, for 100Hz Doppler, use PDP #2 in Pbm. 2, to generate frequency+time varying fading plots (use 3-D plotting feature in Matlab). Plot the time-varying frequency response, obtained every 5msec, over a duration of 30msecs (i.e., plot 7 consecutive snapshots, obtained at 0msec, 5msec, 10msec,….., up to 30msec).

Remaining questions on BWSim to be updated soon.

KG/IITM/Nov. 2014