

UNIVERSITY OF TEXAS AT DALLAS
Department of Electrical Engineering

EE 4365 - Introduction to Wireless Communications Systems

Problem Set #3: Log-Distance Path Loss with Shadowing and Small Scale Fading

Date assigned: 6/3/2004

Date due: 6/10/2004

Late homework will not be accepted. Please check the course web site for updates.

Reading: *Introduction to Wireless Systems*, ch. 2

Please use MATLAB to help you solve these problems, check answers, etc.

Problem 3.1 Log-Normal Fading

As we discussed in the class, the cell coverage in practice depends on the propagation environment. Consider a log-normal propagation (random) environment. The received signal power P_r at a distance $d(> d_0)$ is

$$P_{r(dBm)} = P_{0(dBm)} - 10\kappa \log_{10} \left(\frac{d}{d_0} \right) + X_{(dB)}$$

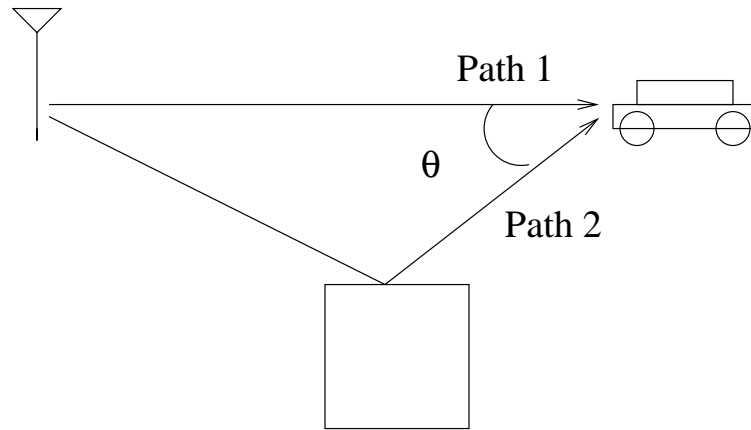
where $P_0 = 0\text{dBm}$ is the received power at a reference distance $d_0 = 1\text{m}$, $\kappa = 3$ is the path loss exponent, $X_{(dB)}$ is a discrete random variable distributed with

$$P_{X_{(dB)}}(X_{(dB)}) = \begin{cases} 0.2 & X_{(dB)} = 0 \text{ dB} \\ 0.2 & X_{(dB)} = -2 \text{ dB} \\ 0.2 & X_{(dB)} = -1 \text{ dB} \\ 0.2 & X_{(dB)} = 1 \text{ dB} \\ 0.2 & X_{(dB)} = 2 \text{ dB} \\ 0 & \text{otherwise} \end{cases}$$

Find the maximum radius of this basestation such that the power signal received (from basestation) is larger than -90dBm with a probability of 0.8.

Problem 3.2 Log-Normal Fading

P2.30 in *Introduction to Wireless Systems*



Problem 3.3 Small scale fading

If the Doppler shift on the Path 2 is 60.6 Hz, the carrier frequency is $f_c = 900$ MHz, and the angle $\theta = 60^\circ$ degrees, find the speed of the mobile. What is the Doppler shift on the Path 1?

Problem 3.4 Small scale fading- Computer project

A figure for a typical Rayleigh fading envelope at baseband for a duration of 2 seconds is given in Homework section at <http://www.utdallas.edu/~torlak/course/ee4365/homework>. Download the data (in MATLAB format) associated with the Rayleigh fading envelope figure from the same page.

Plot the data (in rdB) using `plot` in MATLAB. Based on the data, plot (use `hist` function MATLAB) the PMF of the data and estimate the maximum Doppler shift.

Hint: Use level crossings or average fade duration with a threshold value that you select. Use `hist` function in MATLAB for plotting PMF.