Subject Name: Wireless Communication

Subject Code: CSP311M

Name: Charvik Patel

Roll no: 1401079

Practical Number: 3

Aim: Write an Matlab Code and Represent Multipath Shadowing and Path-loss, outage Probability with respect to Distance.

Brief Theory:

1. Combine path-loss with Shadowing

$$p_r\, dB = p_t dB + k - 10\gamma \log_{10}\left(\frac{d}{d_0}\right) - \psi dB$$

$$F(\gamma) = \sum_{i=1\ to\ 5} \left[M_{\{measured\}} - M_{\{Model\}}\right]^2$$

$p_r\, dB$: *Recieving Antenna Power in dB*

$p_t dB$: *Transmiting Antenna power in dB*

k: *Coefficient Factor*

γ: *Pathloss Exponent*

d: *distance from Transmiter*

ψdB: *Gaussian Distribusion with zero mean*

$$k = 20 \log_{10}\left(\frac{\gamma}{4\pi d_0}\right)$$

$$\sigma^2 = \frac{1}{5} \sum_{i=1\ to\ 5} \left[M_{\{measured\}} - M_{\{Model\}}\right]^2$$

$M_{\{Measured\}}\, Table$

Distance from Transmitter	$M = \frac{P_r}{P_t}$
10	-70 dB
20	-75 dB
50	-90 dB
100	-110 dB
300	-125 dB

$k = -31.5307$

$M_{\{Model\}1} = k - 10\gamma \log_{10} 10$

$M_{\{Model\}2} = k - 10\gamma \log_{10} 20$

$M_{\{Model\}3} = k - 10\gamma \log_{10} 50$

$M_{\{Model\}4} = k - 10\gamma \log_{10} 100$

$M_{\{Model\}5} = k - 10\gamma \log_{10} 300$

$$F(\gamma) = \sum_{i=1\ to\ 5} \left[M_{\{measured\}} - M_{\{Model\}}\right]^2$$

$$= (-70 + 31.6107 + 10\gamma \log_{10} 10)^2 + (-75 + 31.6107 + 10\gamma \log_{10} 20)^2 + (-90 + 31.6107 + 10\gamma \log_{10} 50)^2 + (-110 + 31.6107 + 10\gamma \log_{10} 10\,0)^2 + (-125 + 31.6107 + 10\gamma \log_{10} 300)^2$$

$$\gamma = \frac{dF(\gamma)}{d\gamma} \quad (\because consider\ x = \gamma\ )$$

$$\gamma = \frac{d}{dx}\left((10\,x\log(10) - 38.3893)^2 + (10\,x\log(20) - 43.3893)^2 + (10\,x\log(50) - 58.3893)^2 + (10\,x\log(100) - 78.3893)^2 + (10\,x\log(300) - 93.3893)^2\right) = 16\,664.2\,x - 26\,809.3$$

$\gamma = 1.6087$

$$\sigma^2 = \frac{1}{5}\left((-70 + 31.6107 + 10\,x\log(10))^2 + (-75 + 31.6107 + 10\,x\log(20))^2 + (-90 + 31.6107 + 10\,x\log(50))^2 + (-110 + 31.6107 + 10\,x\log(100))^2 + (-125 + 31.6107 + 10\,x\log(300))^2\right)$$

$= 13.7109$

$\sigma = 3.709$

2. Outage Probability

$$p(P_r(d) \le P_{min}) = 1 - Q(\frac{P_{min} - (P_t + 10log_{10}(K) - 10\gamma log_{10}(\frac{d}{d_0}))}{\sigma_{\psi_{dB}}})$$

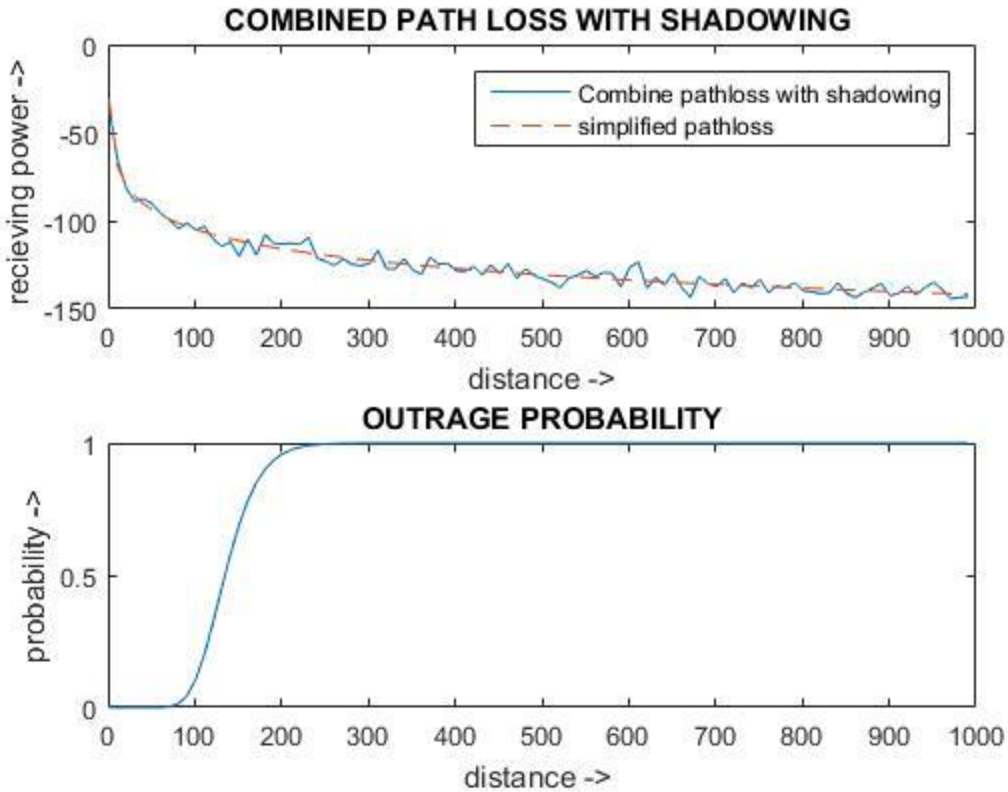
P_{min}: *Minimum Power Required*

$P_r(d)$: *Riecivar Power at distance d*

Matlab Code:

```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%plot 1. COMBINED PATH LOSS WITH SHADOWING & SIMPLIFIED PATHLOSS
%plot 2. OUTRAGE PROBABILITY
lamda=0.333;%wavelenght
k=-31.53;
gamma=3.709;%pathloss exponetial
var=13.71;%variance of gaussian distribution
d=1:10:1000;
d_o=1;
p_t=1;
p_r=p_t+(k)-10*gamma*log10(d/d_o)-normrnd(0,sqrt(var),size(d));%recieving power at distance d in dB
p_min=-110.5;%minimum power in dBm
p_tp=10*10^-3;%Transmit power in mW
p=1-qfunc(((p_min-(p_tp+k-10*gamma*log10(d/d_o)))/sqrt(var)));%outrange probability
p_simpli = p_t + k - 10*gamma*log10(d/d_o);%simplified pathloss
subplot(2,1,1);
plot(d,p_r,d,p_simpli,'--');
legend('Combine pathloss with shadowing','simplified pathloss');
xlabel('distance ->');
ylabel('recieving power -> ');
title('COMBINED PATH LOSS WITH SHADOWING ');
subplot(2,1,2);
plot(d,p);
xlabel('distance -> ');
ylabel('probability ->');
title('OUTRAGE PROBABILITY');
```

Output:



Result Interpretation:

Outage Probability is use to find at what minimum power signal can retrive to its form and signal can't distroy.

Simplified Path-loss discribe how the reciever power goes on decresing as distance goes on increse, similarly Combine path-loss discribe the same thing but with consideration of normal distribution function.