Subject Name: Wireless Communication

Subject Code: CSP311M

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Practical Number: 2

Aim: Write Matlab code of two radio propagation model (okumaras, Hata model) and Plot a Graph of frequency versus Path-loss and distance versus Path-loss

Brief Theory:

1. **Okumaras Model:**
   $L_{50\%}(dB) = LF - A_{mu}(f,d) - G(h_{re}) - G(h_{te}) - G_{area}$

   $L_{50\%}(dB)$: 50% $pathloss\ in\ dB$
   LF: $free\ space\ propagation\ loss$
   $A_{mu}(f,d)$: $Correlation\ function\ of\ frequency\ and\ distance$
   $G(h_{re})$: $Gain\ of\ Recieving\ Antenna$
   $G(h_{te})$: $Gain\ of\ transmiting\ Antenna$
   G_{area}: $Correlation\ factor\ due\ to\ Diffrent\ Environment$

2. **Hata Model:**
   Urban Area:

   $L_u = 69.55 + 26.16\log_{10} f - 13.82\log_{10} h_b - C_H + (44.9 - 6.55\log_{10} h_b)\log_{10} d$

   $C_H = 8.29(\log_{10} 1.54h_m)^2 - 1.1dB \quad ; f \leq 300MHz$

   $C_H = 3.2(\log_{10} 11.75h_m)^2 - 4.97dB \quad ; f \geq 300MHz$

   L_u: $Pathloss\ in\ Urban\ area$

   h_b: $Hieght\ of\ Basestation$

   h_m: $Height\ of\ Mobilestation$

   C_H: $Antenna\ Hieght\ Correlation\ factor$

   d: $Distance\ between\ Basestation\ and\ Mobilestation(Km)$

Sub−Urban:

$$L_{su} = L_u - 2(\log_{10}\left(\frac{f}{28}\right))^{2} - 5.4$$

$$C_H = 3.2(\log_{10} 11.75 h_m)^{2} - 4.97 dB \quad ; f \geq 300MHz$$

L_u: *Avrege pathloss in Urban Area in Small City in dB*

L_{su}: *Pathloss in Sub − Urban Area in dB*

f: *frequency*

Open Area:

$$L_o = L_u - 4.78(\log_{10} f)^{2} - 18.33 \log_{10} f - 40.94\, dB \quad ; f \geq 300MHz$$

L_u: *pathloss in Urban Area in Small City in dB*

L_o: *Path loss in open area in dB*

Matlab Code:

1. Okumaras (Distance -> Path-loss):

```
c=3*10^8;%speed of light
f=900*10^6;%freq.
lamda=c/f;%wavelenght

h_t= 100;%hight of transmiting antenna
h_r= 10;%hight of receving antenna
g_hte=20*log10(h_t/200);%gain of transmiting antena
d=[100*10^3,90*10^3,80*10^3,70*10^3,60*10^3,50*10^3,40*10^3,30*10^3,20*10^3,10*10^3];
amu=[58 , 55 , 53 , 52 , 46 , 43 , 38 , 33 , 28 , 26];
Garea=9;
g_hre=0;

if ( h_r <3 )
    then
    g_hre=10*log10(h_r/3);%gain of recieving antena

else if( h_r>3 && h_r<10)
        then
        g_hre=20*log10(h_r/3);%gain of Recieving antena
    end
end


lf= 10*log10((4*pi)^2.*d.^2/lamda^2);%free space prapogation loss
lfifty=lf + amu-g_hte-g_hre-Garea;%50% path loss in dB

plot(d,lfifty);%plot
title('Okumura model (distance->pathloss)');
xlabel('Distance ->');
ylabel('pathloss(dB)->');
```

2. Okumaras (Frequency -> Path-loss):

```
c=3*10^8;%speed of light
lamda=c./f;%wavelenght
d=50*10^3;%distance between two antenna
h_t= 100;%hieght of transmiting antenna
h_r= 3;%hieght of recieving antenna
g_hte=20*log10(h_t/200);%gain of transmiting antenna
f=[100*10^7,90*10^7,80*10^7,70*10^7,60*10^7,50*10^7,40*10^7,30*10^7,20*10^7,10*10^7];%freq.
amu=[47,46,45.5,45,44,42,41.5,41,39,37];%correlation factor
Garea=[30,28.5,28.25,28,27,26,25,24,23.5,22];%Correlation factor for diff. envierment
g_hre=0;

if ( h_r <3 )
    then
    g_hre=10*log10(h_r/3);% gain of recieving antenna

else if( h_r>3 && h_r<10)
        then
        g_hre=20*log10(h_r/3);% gain of recieving antenna
    end
end

lf= 10*log10((4*pi)^2.*d.^2./lamda.^2);%free space prapogation loss
lfifty=lf + amu - g_hte - g_hre - Garea;%50% path loss in dB
plot(f,lfifty);%plot
title('Okumura model (frequency->pathloss)');
xlabel('Frequency ->');
ylabel('pathloss(dB)->');
```

3. Hata (Frequency -> Path-Loss):

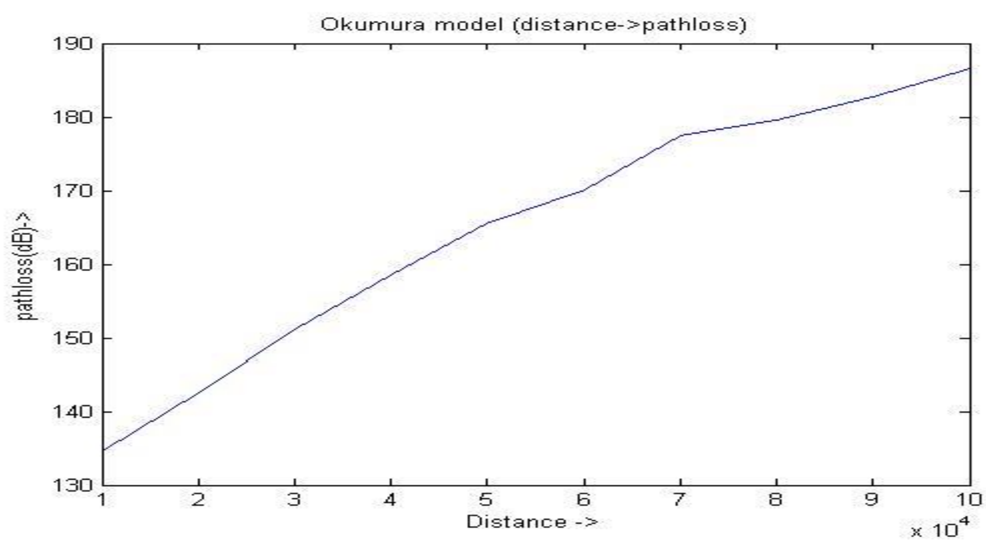
```
c=3*10^8;%speed of light
lamda=c./f;%wavelenght
d=50*10^3;%distance between two antenna
h_b= 100;%hieght of transmiting Basestation antenna
h_m= 3;%hieght of recieving mobilestation antenna
g_hte=20*log10(h_b/200);%gain of transmiting antenna
f=[100*10^7,90*10^7,80*10^7,70*10^7,60*10^7,50*10^7,40*10^7,30*10^7,20*10^7,10*10^7];%freq.
amu=[47.2,46.4,45.5,45,44,42,41.5,41.1,39,37];%correlation factor
Garea=[30,28.5,28.25,28,27.2,26.6,25,24,23.5,22];%Correlation factor for diff. envierment
g_hre=0;
if ( h_m <3 )
    g_hre=10*log10(h_m/3);% gain of recieving antenna
else if( h_m>3 && h_m<10)
        g_hre=20*log10(h_m/3);% gain of recieving antenna
    end
end
chl=zeros(1,10);%making an array
for i=1:10
    if (f(i)<300)
        cHl = 8.29*(log10(1.54*h_m))^2 - 1.1 ;%antenna hieght correlation factor
    else
        cHl=3.2 * (log10(11.75*h_m))^2 - 4.97;%antenna hieght correlation factor
    end
end
CH= 0.8 + (1.1.*log10(f) - 0.7)*h_m - 1.56.*log10(f);%antenna hieght correlation factor openarea
Luo  = 69.55+26.16.*log10(f)-13.82*log10(h_m)-CH +(44.9- 6.55*log10(h_m))*log10(d);%pathloss in urban area :
Lu= 69.55 + 26.16.*log10(f) - 13.82*log10(h_b) - cHl + (44.9 - 6.55*log10(h_b))*log10(d);%pl in urban areas
Lsu = Lu - 2.*(log10(f./28)).^2 -5.4;%pl in sub-urban area in city
Lo=Luo - 4.78.*(log10(f)).^2 + 18.33.*log10(f) - 40.94;%pl in open area
plot(f,Lu,f,Lsu,'--',f,Lo,':');%plot
title('Hata Model (frequency->pathloss)');
xlabel('frequency ->');
ylabel('pathloss(dB)->');
legend('urban','sub-Urban','openArea');
```

4. Hata (Distance -> Path-Loss):

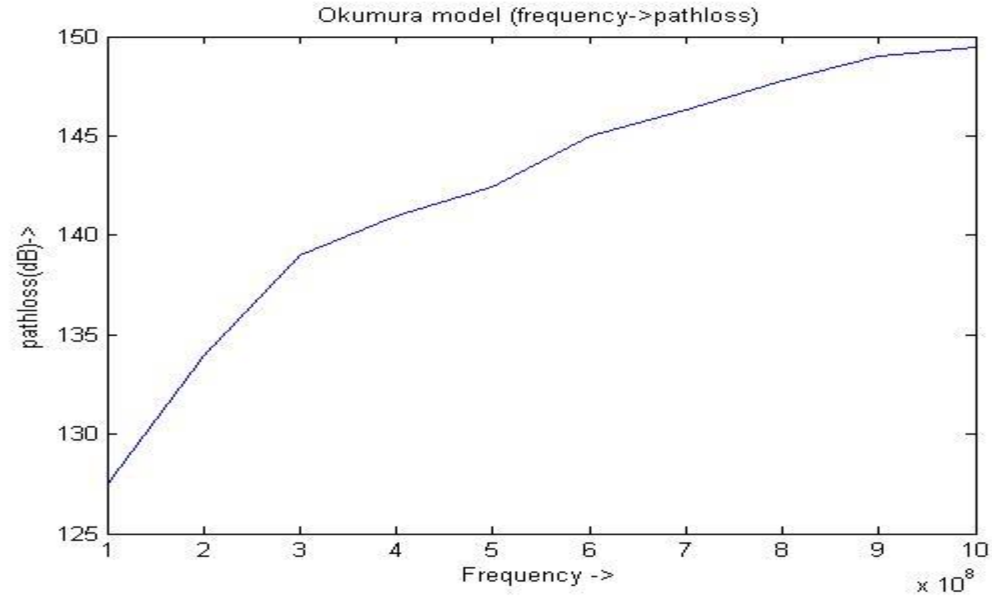
```
c=3*10^8;%speed of light
f=900*10^6;%distance between two antenna
lamda=c./f;%wavelenght
h_b= 100;%hieght of transmiting Basestation antenna
h_m= 3;%hieght of recieving mobilestation antenna
g_hte=20*log10(h_b/200);%gain of transmiting antenna
d=[100*10^3,90*10^3,80*10^3,70*10^3,60*10^3,50*10^3,40*10^3,30*10^3,20*10^3,10*10^3];%freq.
amu=[47.2,46.4,45.5,45,44,42,41.5,41.1,39,37];%correlation factor
Garea=[30,28.5,28.25,28,27.2,26.6,25,24,23.5,22];%Correlation factor for diff. envierment
g_hre=0;
if ( h_m <3 )
    g_hre=10*log10(h_m/3);% gain of recieving antenna
else if( h_m>3 && h_m<10)
        g_hre=20*log10(h_m/3);% gain of recieving antenna
    end
end
chl=zeros(1,10);%making an array
for i=1:10
    if (f<300)
        cHl = 8.29*(log10(1.54*h_m))^2 - 1.1 ;%antenna hieght correlation factor
    else
        cHl=3.2 * (log10(11.75*h_m))^2 - 4.97;%antenna hieght correlation factor
    end
end
CH= 0.8 + (1.1*log10(f) - 0.7)*h_m - 1.56*log10(f);%antenna hieght correlation factor openarea
Luo  = 69.55+26.16*log10(f)-13.82*log10(h_m)-CH +(44.9- 6.55*log10(h_m)).*log10(d);%pathloss in urban area i
Lu= 69.55 + 26.16*log10(f) - 13.82*log10(h_b) - cHl + (44.9 - 6.55*log10(h_b)).*log10(d);%pl in urban areas
Lsu = Lu - 2*(log10(f/28))^2 -5.4;%pl in sub-urban area in city
Lo=Luo - 4.78*(log10(f))^2 + 18.33*log10(f) - 40.94;%pl in open area
plot(d,Lu,'--',d,Lsu,d,Lo,':');
title('Hata Model (Distance->pathloss)');
xlabel('Distance ->');
ylabel('pathloss(dB)->');
legend('urban','sub-Urban','openArea');
```

Output:

1. Okumaras (Distance -> Path-loss):



2. Okumaras (Frequency -> Path-loss):



3. Hata (Frequency -> Path-Loss):

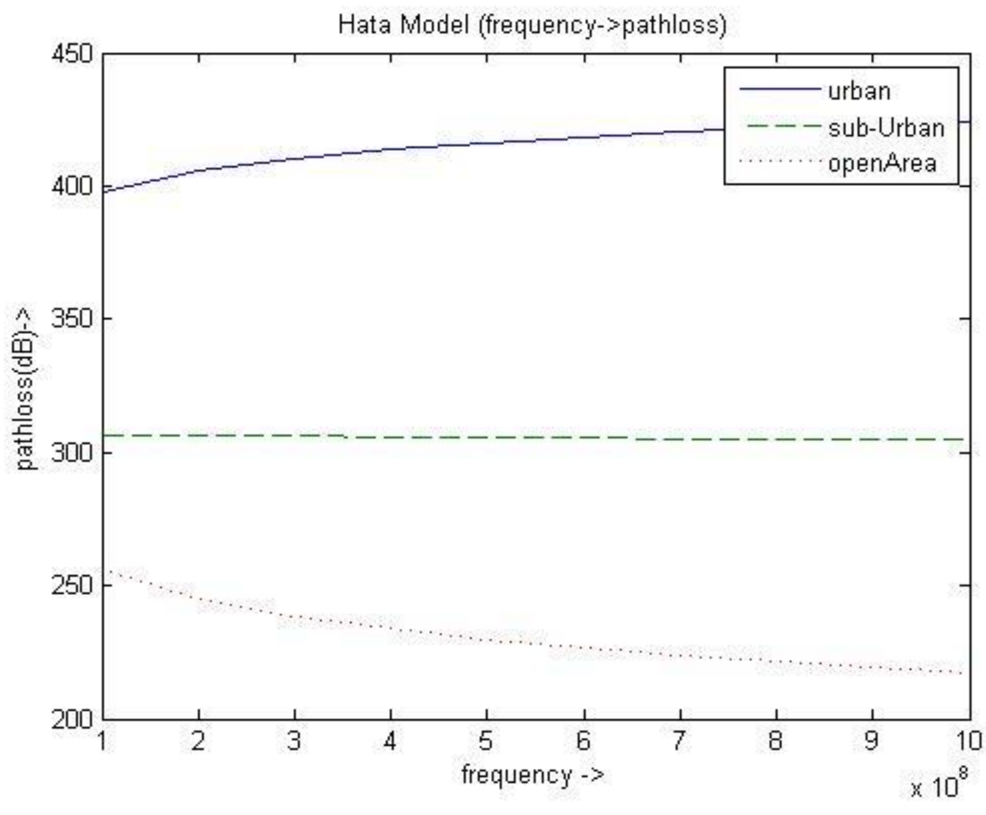


Figure 1 Sub-Urban Graph is Decressing Minor

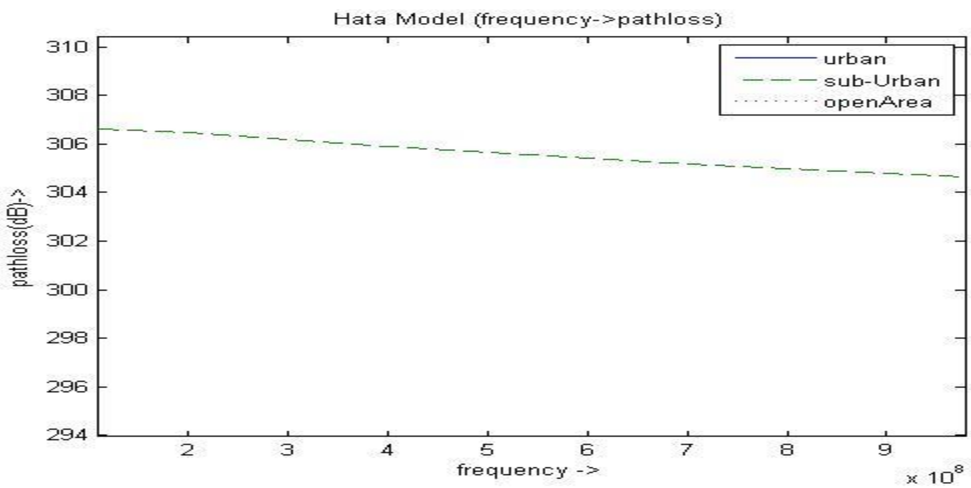
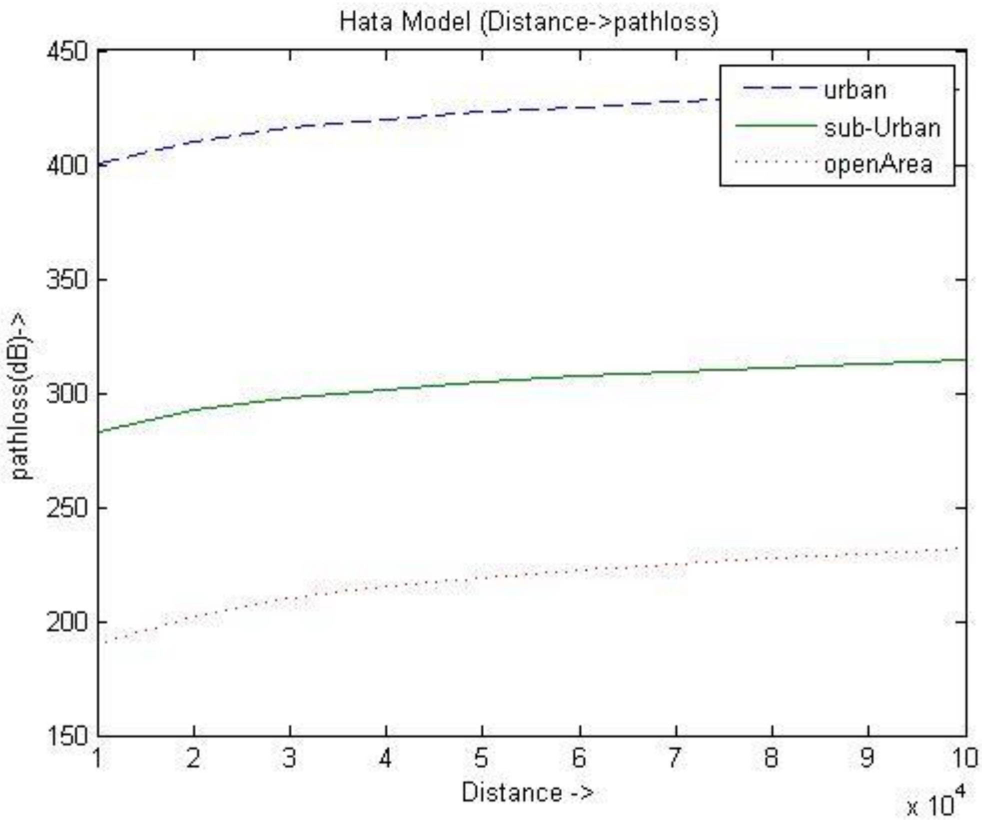


Figure 2 Close-up look of sub-urban

4. Hata (Distance -> Path-Loss):



Result Interpretation:

As Distance Increases between Receiving Antenna and Transmitting Antenna Path-loss goes on Increasing Similarly Frequency Increases Path-loss Goes on increasing.