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ET3202 - Wireless Communication I

Practical 03 – Hata-Okumura model for outdoor propagation

AIM- Matlab simulation for large scale path loss using Hata Okumura model for outdoor propagation

OBJECTIVES

- Learn about outdoor propagation (Large scale propagation models).
- Familiarize with Hata Okumura model.
- Analyze path loss Hata Okumura model.

Software Requirements – Matlab

THEORY

Large scale propagation models predict the mean signal strength for an arbitrary large transmitter receiver separation distance. They are useful in estimating the radio coverage area of a transmitter. Where else, small scale propagation modes characterize the rapid fluctuations of the received signal strength over short distance (a few wavelengths or few seconds).

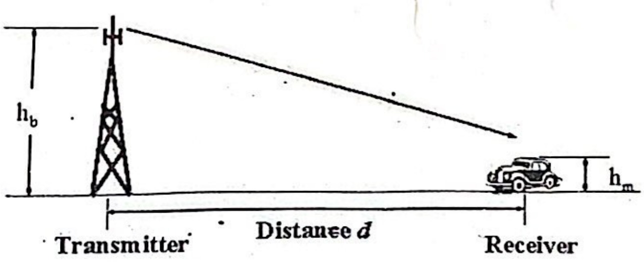

Figure 1

Pathloss is the difference of Transmitter and receiver power expressed in dB. Figure 2 shows signal strength fluctuation along the distance

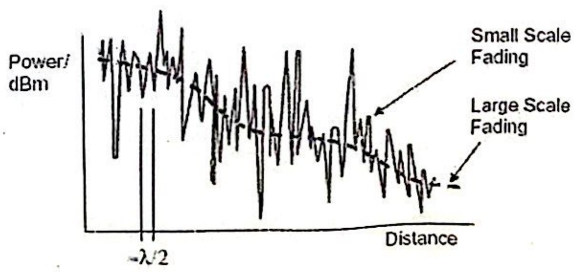

Figure 2

The Hata Model for Urban Areas (also known as the Okumura-Hata model), is a widely used propagation model for predicting path loss in urban areas. This model takes into account the effects of diffraction, reflection and scattering caused by city structures. The model also has formulations for predicting path loss in Suburban and Open Areas.

The Hata Model for Urban Areas has the following parameters:

- Frequency Range: 150 MHz to 1500 MHz
- Transmitter Height: 30 m to 200 m
- Link distance: 1 km to 20 km
- Mobile Station (MS) height: 1 m to 10 m

The generic closed form expression for path loss in dB is given by,

$$P_L(dB) = A + B log_{10}(d) + C$$

The factors A,B,C depend on the frequency of transmission, antenna heights and the type of environment.

$$A = 69.55 + 26.16\ log_{10}(f_c) - 13.82\ log_{10}(h_b) - a(h_m)$$
$$B = 44.9 - 6.55\ log_{10}(h_b)$$

- f_c = frequency of transmission in MHz (150 – 1500 MHz)
- h_b = effective height of transmission antenna in meters (30-200m)
- h_m = effective height of transmission antenna in meters (1-10m)
- $a(h_m)$= receiver antenna height correction factor that depend on the environment (refer table.1)
- C= correction factor (refer table 1)

Environment	$a(h_m)$	C
Open		$-4.78[log_{10}(f_c)]^2 + 18.33 log_{10}(f_c) - 40.98$
Suburban	$[1.1 log_{10}(f_c) - 0.7]h_m - [1.56 log_{10}(f_c) - 0.8]$	$-2[log_{10}(f_c/28)]^2 - 5.4$
Small/medium city		0
Metropolitan ($f_c \leq 200\ MHz$)	$8.29[log_{10}(1.54h_m)]^2 - 1.1$	0
Metropolitan ($f_c > 200\ MHz$)	$3.2[log_{10}(11.75h_m)]^2 - 4.92$	0

Table 1 Parameters of

Hata Model for Urban Areas is formulated as:

$$L_U = 69.55 + 26.16 log f - 13.82 log h_B - C_H + (44.9 - 6.55 log h_B) log d$$

For small or medium size cities (antenna height not more than 10m),

$$C_H = 0.8 + (1.1 log f - 0.7)h_M - 1.56 log f$$

For large cities,

$$C_H = \begin{cases} 8.29(\log(1.54 h_M))^2 - 1.1, & for\ 150MHz \leq f \leq 200MHz \\ 3.2(\log(11.75 h_M))^2 - 4.97, & for\ 200MHz \leq f \leq 1500MHz \end{cases}$$

Where,

L_U= Path loss in Urban Areas

h_B= Height of base station antenna in meters (m)

h_M= Height of mobile station antenna in meters (m)

f= Frequency of Transmission in megahertz (MHz).

C_H= Antenna height correction factor

d= Distance between the base and mobile stations in kilometers (km).

PROCEDURE

1. Install Matlab Software.
2. Study and understand the given matlab code for Okumura/hata model.
3. Choose suitable values for height of transmitting antenna and height of receiving antenna and mention them.
4. Choose a suitable frequency for transmission and link distance and mention them.
5. Obtain figures loss in urban/suburban/rural areas and compare the differences.

Matlab code

```
clc;  close all; clear all;
hte=  __;   %Include value for hte= height of transmitting antenna
hre = __;   %Include value for hre= height of receiving antenna
fc= __ ;    %Include value for frequency  (MHz)
d=8         %Include different value for distance
t= 1        %loss of t=1 for urban environment
loss = zeros(1,4)
k=1;        % a = ch
for fc= 100:500:1600
if (t==1) % urban area city
a= (1.1*log(fc)-0.7)*hre-(1.56*log(fc)-0.8); % Antenna height correction factor
else if (fc <200)
a = 8.29*power(log(1.54*hre)^2)-1.1;
else
a=3.2*(log(11.574*hre)^2)-4.97;
end
end
lurban=69.55+26.16*log(fc)-13.86*log(hte)-a+(44.9-6.55*log(hte))*log(d);
```

```
loss_lurban(k)= lurban
lsub= lurban-2*(log(fc/28)^2)-5.4;
% for suburban area
loss_lsub(k)= lsub
% for rural area
lrural = lurban - 4.78*power(log(fc),2)+18.33*log(fc)-40.94;
loss_lrural(k)= lrural
k=k+1;
end
%plot between freq and loss
fc= 100:500:1600
% plot for urban area 6

figure
plot(fc,loss_lurban)
xlabel('Frequency')
ylabel('Loss in Urban area')
title('Hata-Okumura Model_Urban')
figure
plot(fc,loss_lsub)
xlabel('Frequency')
ylabel('Loss in Suburban area')
title('Hata-Okumura Model_Suburban')
figure
plot(fc,loss_lrural)
xlabel('Frequency')
ylabel('Loss in Rural area')
title('Hata-Okumura Model_Rural ')
```

DISCUSSION

1. Briefly explain out door propagation.
2. Brief comparison between large scale propagation models vs small scale propagation models.
3. What are the factors A, B, C depend on in the path loss expression.
4. Brief discussion about Hata-okumura model.

5. Give reasons to values you choose for height of transmitting antenna, height of receiving antenna, frequency for transmission and link distance (Hint: Hata-okumura model parameters).