Experiment 3: To Analyse Free Space and 2 Ray Propagation Models

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Aim:

To study the Path loss models and estimate the path loss

Algorithm:

i. Calculate the constant from the given values in the question.
ii. Now make an array for the distance from 100 to 2000 with 100 step size.
iii. Make an array of zeros with length of the array of distance.
iv. Now using the formula for Path Loss and Received power calculate them using a for loop.

Problem statement 1:

Estimate the received power and the corresponding path loss using Free Space Propagation Model. Also plot:

i. Distance Vs. Received power and
ii. Distance Vs. Path loss

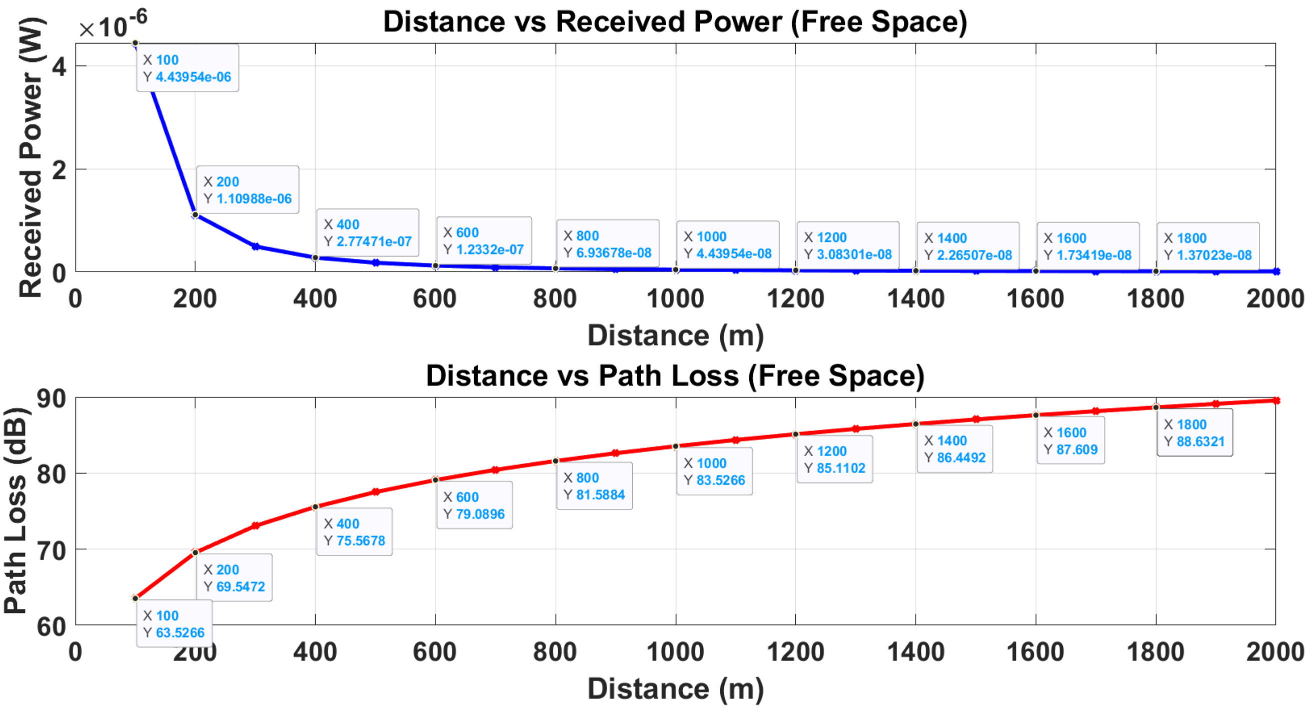
Use the following values:

i. Frequency of operation = 900 MHz
ii. Transmit Power = 10W
iii. Gain of the transmitting antenna = 5 dB
iv. Gain of the receiving antenna = 3 dB
v. Assume the system loss factor L = 1
vi. Distance d = 100:100:2000 m
vii. Cell radius = 500m

Code:

```
clc
clear all
close all
frequency = 900 * 1e6;
Pt = 10;
Gt = 10^(5 / 10);
Gr = 10^(3 / 10);
ht = 40;
hr = 3;
L = 1;
d = 100:100:2000;
c = 3e8;
lambda = c / frequency;
Pr = (Pt * Gt * Gr * (lambda.^2)) ./ ((4 * pi * d).^2 * L);
PL = 10 * log10(Pt ./ Pr);
figure;
subplot(2,1,1);
plot(d, Pr, 'b-', 'LineWidth', 3, 'Marker','x');
set(gca,'FontSize',20,'FontWeight','bold');
xlabel('Distance (m)');
ylabel('Received Power (W)');
title('Distance vs Received Power (Free Space)');
grid on;
subplot(2,1,2);
plot(d, PL, 'r-', 'LineWidth', 3, 'Marker','x');
set(gca,'FontSize',20,'FontWeight','bold');
xlabel('Distance (m)');
ylabel('Path Loss (dB)');
title('Distance vs Path Loss (Free Space)');
grid on;
```

Output:



Inference:

i. Received Power decreases with an increase in distance
ii. Path loss increases with an increase in distance

Problem statement 2:

Estimate the received power and the corresponding path loss using Two-ray Model. Also plot:

i. Distance Vs. Received power and
ii. Distance Vs. Path loss

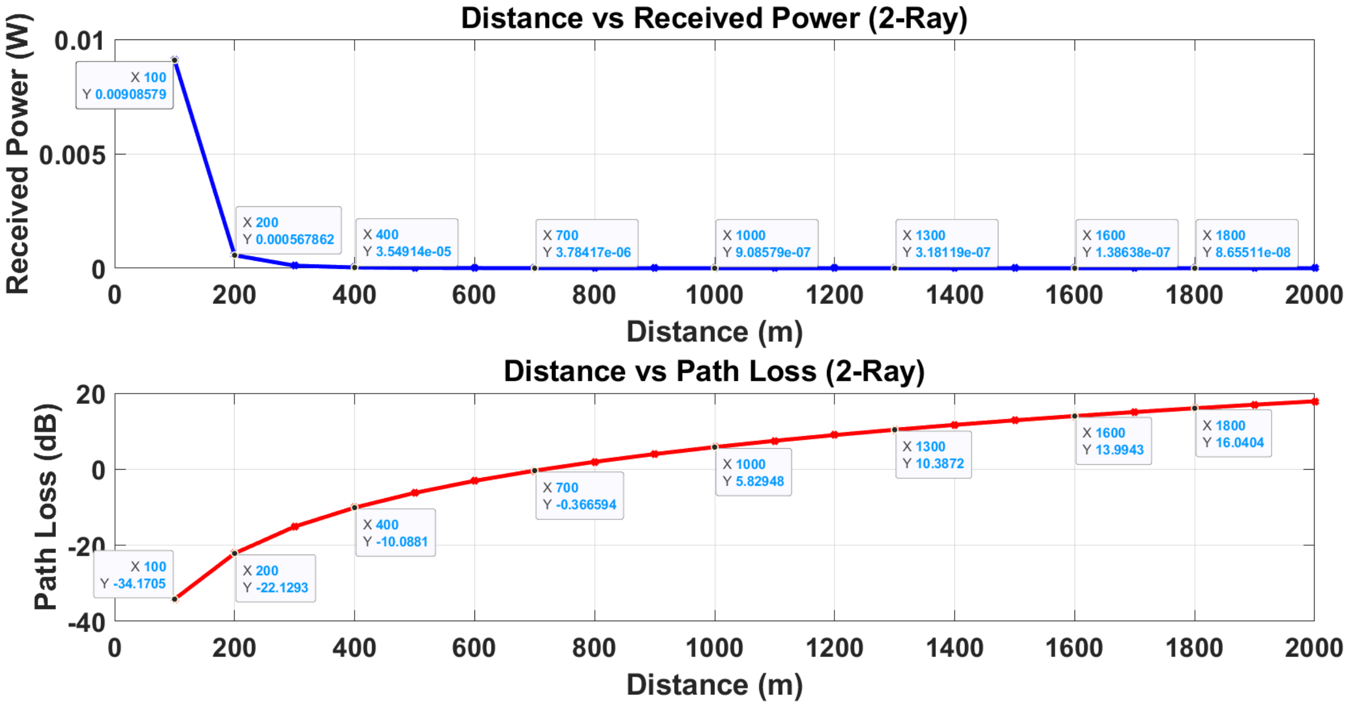
Use the following values:

i. Frequency of operation = 900 MHz
ii. Transmit Power = 10W
iii. Gain of the transmitting antenna = 5 dB
iv. Gain of the receiving antenna = 3 dB
v. ht=40 m, hr = 3 m;
vi. Distance d = 100:100:2000 m

Code:

```
clc
clear all
close all
frequency = 900 * 1e6;
Pt = 10;
Gt = 10^(5 / 10);
Gr = 10^(3 / 10);
ht = 40;
hr = 3;
d = 100:100:2000;
c = 3e8;
lambda = c / frequency;
Pr = (Pt * Gt * Gr * ht.^2 *hr.^2) ./ ((d).^4);
PL = 40 * log10(d)-(10*log(Gt)+10*log(Gr)+20*log(ht)+20*log(hr));
figure;
subplot(2,1,1);
plot(d, Pr, 'b-', 'LineWidth', 3, 'Marker','x');
set(gca,'FontSize',20,'FontWeight','bold');
xlabel('Distance (m)');
ylabel('Received Power (W)');
title('Distance vs Received Power (2-Ray)');
grid on;
subplot(2,1,2);
plot(d, PL, 'r-', 'LineWidth', 3, 'Marker','x');
set(gca,'FontSize',20,'FontWeight','bold');
xlabel('Distance (m)');
ylabel('Path Loss (dB)');
title('Distance vs Path Loss (2-Ray)');
grid on;
```

Output:



Inference:

i. Received Power decreases with an increase in distance
ii. Path loss increases with an increase in distance

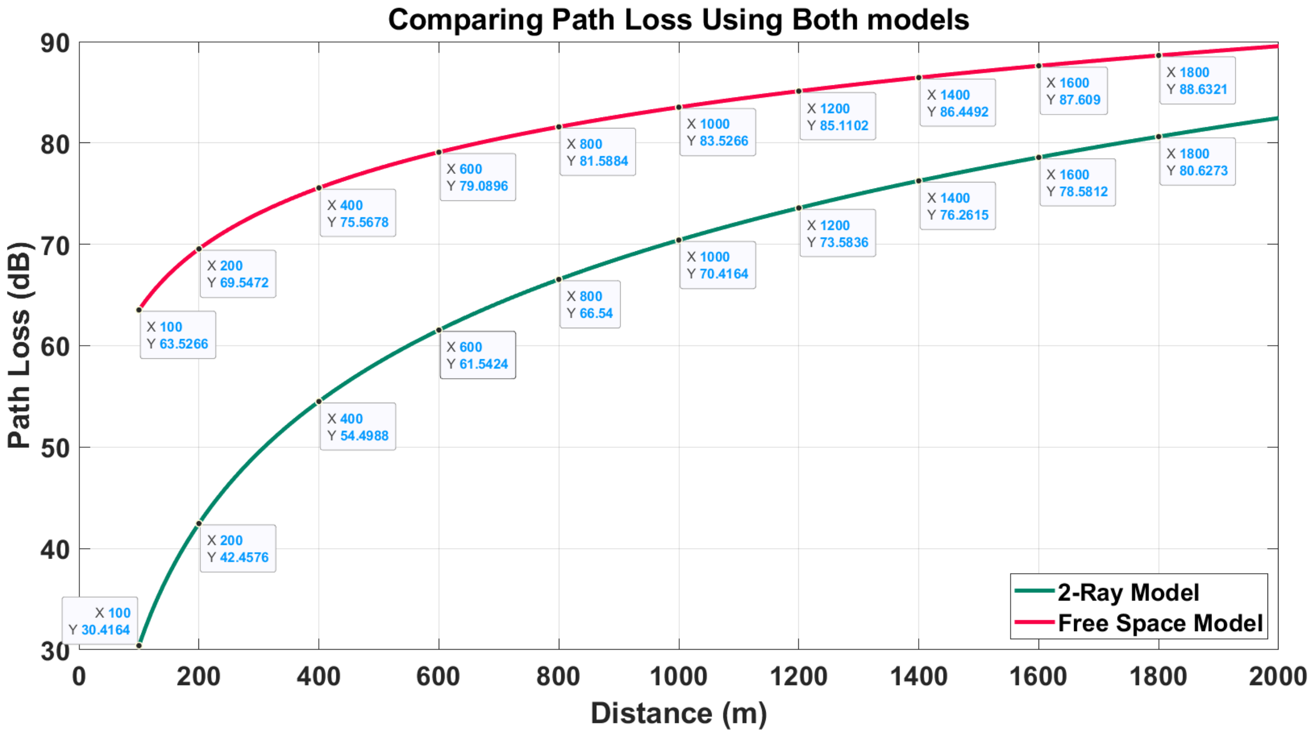
Problem statement 3:

C. Consider any one distance value and compare the path loss estimated using both the models.

Code:

```
clc
clear all
close all
f = 900*10^6;
pt = 10;
gt = 10^(0.5);
gr = 10^(0.3);
lamda = (3*10^8)/f;
pi = 3.14159;
L = 1;
ht = 40;
hr = 3;
d = 100:10:2000;
for i=1:length(d)
    pr(i) = (pt*gt*gr*((lamda^2)/(((4*pi)^2)*L)))./(d(i)^2);
    pr1(i) = (pt*gt*gr*((ht^2)*(hr^2)))/(d(i)^4);
end
pl = 10*log10(pt./pr);
pl1 = 10*log10(pt./pr1);
figure;
plot(d,pl1,'Color','#008568', 'LineWidth', 3);
hold on;
plot(d,pl,'Color','#F90046', 'LineWidth', 3);
hold off;
title('Comparing Path Loss Using Both models');
legend('2-Ray Model','Free Space Model','Location','SouthEast');
xlabel('Distance (m)','FontWeight','Bold');
ylabel('Path Loss (dB)','FontWeight','Bold');
set(gca,'FontSize',20,'FontWeight','bold');
grid on;
```

Output:



Inference:

Path loss for 2 Ray Model is comparatively less as compared to free space propagation model for same distance. However, for larger values of distance, the path loss values tend to come close to each other.

Output Verification:

Wireless Date: 4/2/25

Exp3: To analyse Free Space and 2 Ray Propagation Models

Aim: To study the path loss models and estimate the path loss

Problem Statement:

A. Estimate the ~~path loss models and obtain~~ received power and the corresponding path loss using Free Space Propagation model

1. Plot distance vs Received power
2. Distance Vs Path loss

Use the following values:

i Freq of operation = 900 MHz

ii Transmit power = 10 W

iii Gain of Tx antenna = 5 dB

iv Assume the system loss factor L = 1

v Gain of Rx antenna = 3 dB

vi Distance d = 100:100:2000 m

B. Estimate the received power and corresponding path loss using 2 ray model

1. Plot distance vs Received power
2. Distance vs path loss

Use the following values:

i Freq of operation = 900 MHz

ii Transmit power = 10 W

iii Gain of Tx antenna = 5 dB

iv Gain of Rx antenna = 3 dB

v $h_t = 40$ m $h_r = 3$ m

vi Distance d = 100:100:2000 m

Path loss:

$40\log(400) - 10\log(3.16) + 10\log(1.44) + 20\log(40) + 20\log(3) = 68.60$

C. Consider any one distance value and compare the path loss estimated using both models.

Calculations:

Free Space

$$P_r = 10 \times 10^{5/10} \times 10^{3/10} \left(\frac{0.33}{4\pi \times 200}\right)^2 = 1.089 \times 10^{-6}\,W$$

$$\text{Path loss} = 10\log\left(\frac{10}{1.089 \times 10^{-6}}\right) = 69.6297\,dB$$

2-Ray

$$P_r = \frac{10 \times 3.16 \times 2 \times (40)^2 \times (3)^2}{(200)^2} = 5.688 \times 10^{-4}\,W$$

$$\text{Path loss} = 40\log(200) - [10\log(3.16) + 10\log(2) + 20\log(40) + 20\log(3)] = 42.45\,dB$$

Observation and Result:

Hence, the graphs of received power and path loss with respect to distance were observed, calculated as well successfully and verified it with manual calculations, for the Free Space propagation model as well as the Two Ray propagation model.