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과정 번호: ENE 1015

전공: 융합전자공학과

주제: FADING CHANNEL (DENT'S MODEL) FOR MULTIPLE UNCORRELATED SIGNALS

JAKES FADING MODEL REVISTED (DENT'S MODEL)

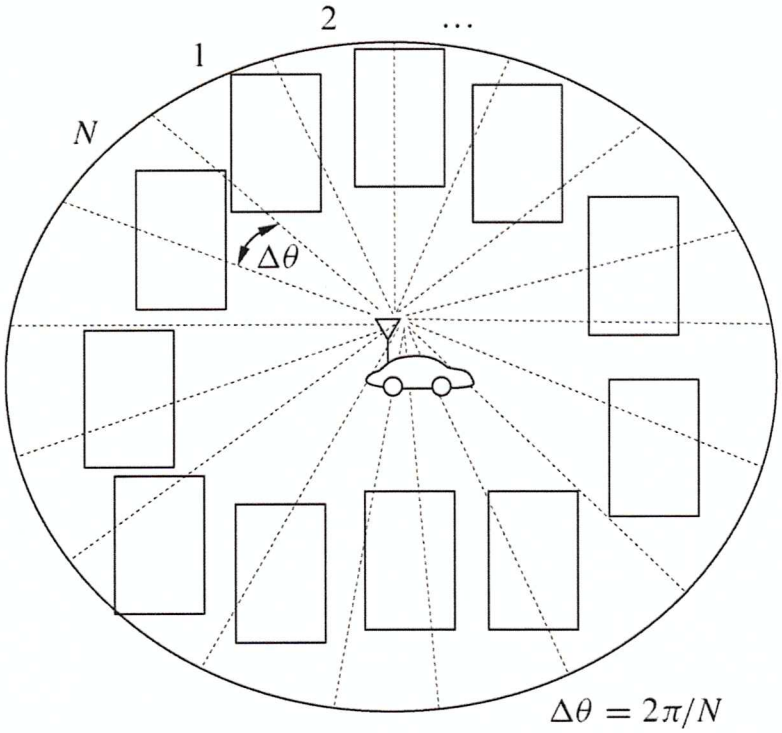


FIG 1: Dense Scattering Environment

MODEL POSTULATION

In this model., the channel consists of many scatters densely packed with respect to their angles of arrival as shown in fig 1 above. Angle of elevation is ignored since it is a 2-dimensional model. In the model proposed by Jakes and and modified by Dent, in a uniform scattering model we assume N (LoS and multi-path) signal components with angles of arrival $\theta i = i\Delta\theta$, i = 0, . . ., N − 1, where $\Delta\theta = 2\pi/N$. Also signal component has the same received power.

Based on the proposed model, the graph of the zeroth order Bessel function (theoretical computation) shows the relationship between the signal autocorrelation function and the Doppler frequency with respect to the time lags ($f_D \tau$). This figure will be similar to that of the simulated and theoretical figure in the next page.

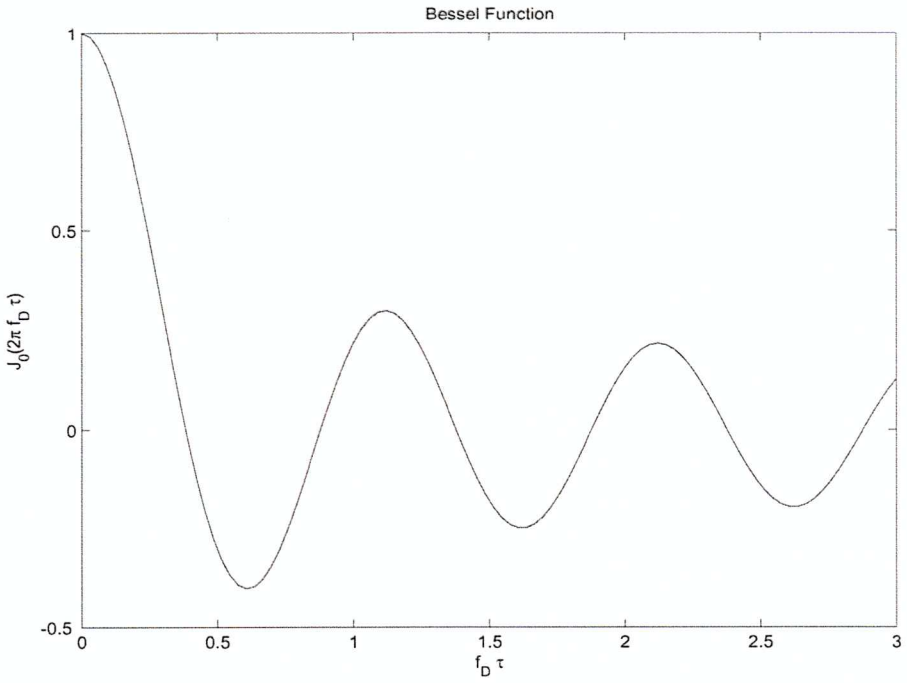


FIG 1: Bessel function versus $f_D \tau$

SIMULATION ANALYSIS AND CONCLUSION

Proposed model equation of fading channel for multiple uncorrelated signals

$$T(k) = \sqrt{\frac{2}{N_o}} * \sum_{n=1}^{n=N_o} A_j(n) * (\cos\beta_n + j sin\beta_n)[\cos\omega_n t + \theta_n].$$

Where

$\omega_n = \omega_m \cos\alpha_n$

α_n = Arrival angle of the impeding rays of signal on the mobile

$\omega_m = \frac{2\pi * fv}{c}$ In the simulation $\frac{fv}{c} = 83$, hence $\omega_m = 2\pi(83)$

N = Number of equal strength incident Ray

$N_o = \frac{N}{4}$, Number of oscillators

The angle θ_n is randomised over the entire circumference 2π.

A_j =Hadamard Matrix of size $(N_o * N_o)$

A simulation analysis was ran across different values of N, { N = 16, 64, 256, 512} to compare the Autocorrelation function of the signals against the Doppler frequency to the theoretical Bessel function. The result showed that the theory is a replica of the simulated values as the value of N increases progressively. Thus it is suffice to say that based on the model as the number of equal strength incident ray increases progressively the Autocorrelation of the signals coincides with that of the theoretical Bessel function. Also, the simulation showed that when the Power density function

(PDF) of the distribution was conducted the resulting distribution graph was similar to that of the Rayleigh distribution.

SOURCE CODE (MATLAB)

```
%%%%%%%%%%%%%%%%%%%%%%%% JAKES MODEL REVISITED (DENT MODEL) %%%%%%%%%%%%%%%%
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%                       학번: 2022151222
%                       전공: 융합전자공학과
%                       과정 제목: 무선 통신
%                       주제: FADING CHANNEL (MULTIPLE UNCORRELATED SIGNAL)
%                       교수: 문회찬 교수님
%                       날짜: 2022 년 03 월 30 일
%                       과정 번호: ENE 1015
%%%%%%%%%%%%%%%%%%%%%%%% DECLARATION OF
VARIABLES %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
N_equal_strength_Ray = 1024;
Number_of_wave  = 2;
sampling_interval = 383.5e-6;
Number_of_samples = 1e6;
Number_of_oscillators = N_equal_strength_Ray/4;
Normalization_factor = sqrt(2/Number_of_oscillators);
n = 1:Number_of_oscillators;
arrival_angle = (2*pi*(n-0.5))/N_equal_strength_Ray;
Beta = (pi*n)/Number_of_oscillators;
Maximum_doppler_shift = 2*pi*83;
Hadamard_matrices = hadamard(Number_of_oscillators);
theta_n = rand(1, length(n))*2*pi; % Random oscillator phase
t=0:sampling_interval:(Number_of_samples-1)*sampling_interval;
```

```
% APPLYING VECTORIZED ALGEBRA

T_k = Normalization_factor .* Hadamard_matrices(Number_of_wave,:).*
(exp(-1i*Beta))* transpose(cos((transpose(Maximum_doppler_shift.* t) *
cos(arrival_angle)) + theta_n));


%%%%%%%%%%%%%%%%%%%% PLOTS AND
DISPLAY %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

figure(1)

[Auto_Corr_Value, tau] = xcorr(T_k, 'normalized');

Auto_Corr_Value = real(Auto_Corr_Value);

idx0 = find(tau==0);

tau = tau * sampling_interval;

plot(tau, Auto_Corr_Value, 'ob');

xlim([tau(idx0) tau(idx0+5000)]);

xlabel('\omega_m\tau');

ylabel('Re[Autocorrelation]');

title('Autocorrelation graph for a fading channel');

grid on

hold on

J0 = besselj(0, Maximum_doppler_shift*tau);

plot(tau, J0, 'r')

hold off

legend('Simulated', 'theoretical')

figure(2)

Abs_T = abs(T_k);

Histogram = histogram(Abs_T, 'Normalization','pdf', 'DisplayStyle','bar',
'EdgeColor','auto');

hold on;

ax = gca;

x = linspace(ax.XLim(1), ax.XLim(2), 1000);

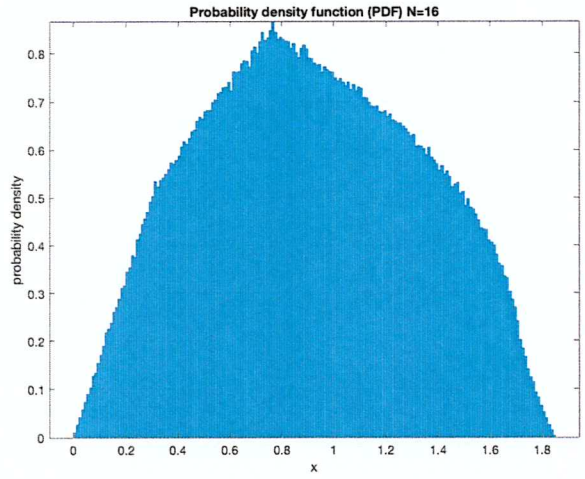
plot(x, Histogram, 'LineWidth', 2)

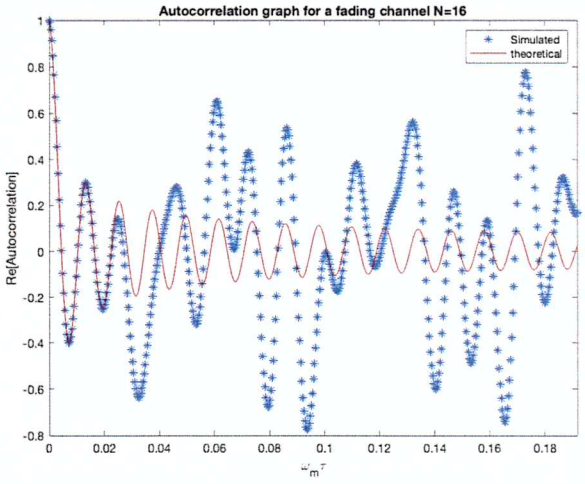
xlabel('x');

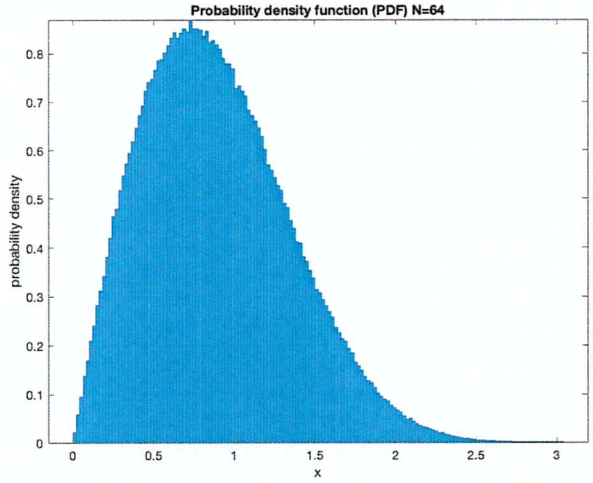
ylabel('probability density');
```

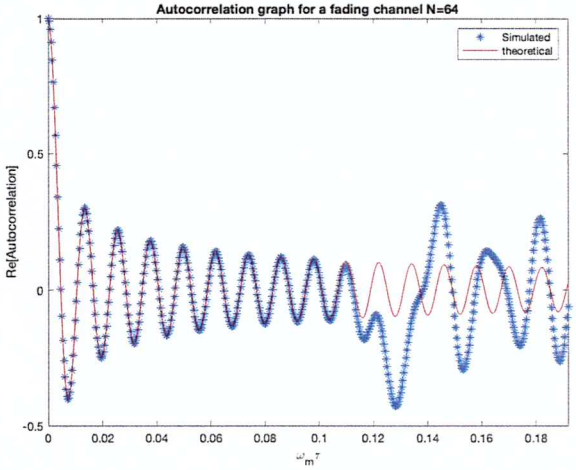
```
title('Probability density function (PDF)');
axis tight
grid on
```

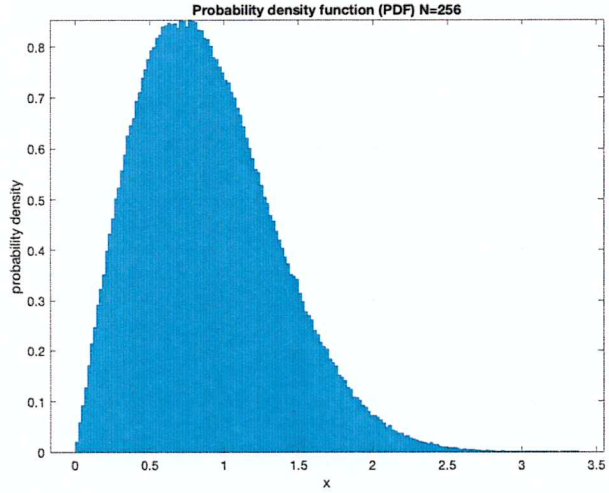
SIMULATED FIGURES AND PLOTS

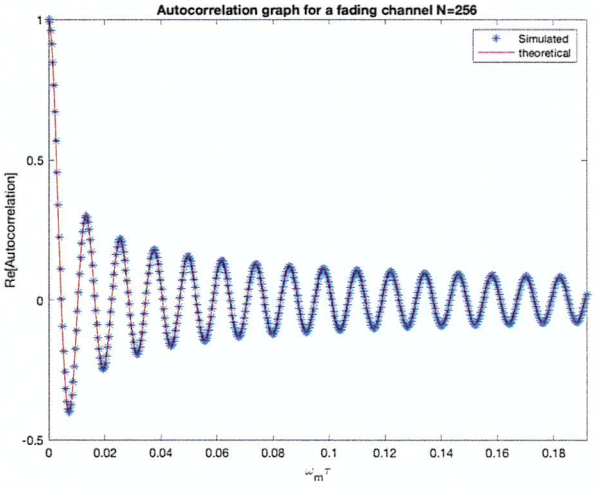












Autocorrelation Graph when N = 512 (Limit of display taken into consideration for clarity)

