clc

close all

clear all

L = 50;

snr\_dB = -10; % SNR in decibels

snr = 10.^(snr\_dB./10); % Linear Value of SNR

Pf = 0.01:0.01:1; % Pf = Probability of False Alarm

%% Simulation to plot Probability of Detection (Pd) vs. Probability of False Alarm (Pf)

for m = 1:length(Pf)

m

i = 0;

for kk=1:10000 % Number of Monte Caarlo Simulations

n = randn(1,L); %AWGN noise with mean 0 and variance 1

sig(kk) =var(n);

s = sqrt(snr).\*randn(1,L); % Real valued Gaussina Primary User Signal

y = s + n; % Received signal at SU

P =var(y);

energy = abs(y).^2; % Energy of received signal over N samples

fin =(1/L).\*sum(energy); % Test Statistic

thresh(m) = (qfuncinv(Pf(m))./sqrt(L))+ 1; % Theoretical value of Threshold

if(fin >= thresh(m))

i = i+1;

end

end

Pd(m) = i/kk;

end

thou=100;

l=thou:1:10000;

c1=P/2.\*((P+sig.^2).\*sig.^2);

c2=0.5.\*log(sig.^2/P+sig.^2);

sum5=0;

for r=thou:l+1

% zeta=abs(((l+2-r).\*c2)/c1);

sum5=sum5+[gammainc(50,50)]./(gamma(l+2-r)/2);

end

sum6=0;

for j=thou:l

for r=thou:j

sum6=sum6+[gammainc(0.5,0.5)]./(gamma(j-r+1)/2);

% sum6=sum6+[gammainc((j-r+1)/2),zeta/2\*P(l)+sig(l)^2]/(gamma(j-r+1)/2)

sum7=prod(sum6);

end

end

Pd1=(1-sum5).\*(sum7);

sum8=0;

for l=thou:10000

sum8=abs(sum8)+abs(Pd1);

end

%analytical

subplot(1,3,1)

plot(Pf, Pd)

hold on

%% Theroretical ecpression of Probability of Detection; refer above reference.

thresh = (qfuncinv(Pf)./sqrt(L))+ 1;

Pd\_the = qfunc(((thresh - (snr + 1)).\*sqrt(L))./(sqrt(2).\*(snr + 1)));

subplot(1,3,1)

plot(Pf, Pd\_the, 'r')

% numerical

title('thou+20');

xlabel('Pf');

ylabel('Pd');

legend('analytical','numerical');

hold off

L = 200;

snr\_dB = -10; % SNR in decibels

snr = 10.^(snr\_dB./10); % Linear Value of SNR

Pf1 = 0.01:0.01:1; % Pf = Probability of False Alarm

%% Simulation to plot Probability of Detection (Pd) vs. Probability of False Alarm (Pf)

for m = 1:length(Pf1)

m

i = 0;

for kk=1:10000 % Number of Monte Caarlo Simulations

n = randn(1,L); %AWGN noise with mean 0 and variance 1

s = sqrt(snr).\*randn(1,L); % Real valued Gaussina Primary User Signal

y = s + n; % Received signal at SU

energy = abs(y).^2; % Energy of received signal over N samples

fin =(1/L).\*sum(energy); % Test Statistic

thresh(m) = (qfuncinv(Pf1(m))./sqrt(L))+ 1; % Theoretical value of Threshold

if(fin >= thresh(m))

i = i+1;

end

end

Pd(m) = i/kk;

end

%analytical

subplot(1,3,2)

plot(Pf1, Pd)

hold on

%% Theroretical ecpression of Probability of Detection; refer above reference.

thresh = (qfuncinv(Pf1)./sqrt(L))+ 1;

Pd\_the = qfunc(((thresh - (snr + 1)).\*sqrt(L))./(sqrt(2).\*(snr + 1)));

subplot(1,3,2)

plot(Pf1, Pd\_the, 'r')

% numerical

title('thou+40');

xlabel('Pf');

ylabel('Pd');

legend('analytical','numerical');

hold off

L = 1000;

snr\_dB = -10; % SNR in decibels

snr = 10.^(snr\_dB./10); % Linear Value of SNR

Pf2 = 0.01:0.01:1; % Pf = Probability of False Alarm

%% Simulation to plot Probability of Detection (Pd) vs. Probability of False Alarm (Pf)

for m = 1:length(Pf2)

m

i = 0;

for kk=1:10000 % Number of Monte Caarlo Simulations

n = randn(1,L); %AWGN noise with mean 0 and variance 1

s = sqrt(snr).\*randn(1,L); % Real valued Gaussina Primary User Signal

y = s + n; % Received signal at SU

energy = abs(y).^2; % Energy of received signal over N samples

fin =(1/L).\*sum(energy); % Test Statistic

thresh(m) = (qfuncinv(Pf2(m))./sqrt(L))+ 1; % Theoretical value of Threshold

if(fin >= thresh(m))

i = i+1;

end

end

Pd(m) = i/kk;

end

%analytical

subplot(1,3,3)

plot(Pf2, Pd)

hold on

%% Theroretical ecpression of Probability of Detection; refer above reference.

thresh = (qfuncinv(Pf1)./sqrt(L))+ 1;

Pd\_the = qfunc(((thresh - (snr + 1)).\*sqrt(L))./(sqrt(2).\*(snr + 1)));

subplot(1,3,3)

plot(Pf2, Pd\_the, 'r')

% numerical

title('thou+60');

xlabel('Pf');

ylabel('Pd');

legend('analytical','numerical');

hold

L = 5;

snr\_dB = 3; % SNR in decibels

snr = 10.^(snr\_dB./10); % Linear Value of SNR

Pf3 = 0.01:0.01:1; % Pf = Probability of False Alarm

%% Simulation to plot Probability of Detection (Pd) vs. Probability of False Alarm (Pf)

for m = 1:length(Pf3)

m

i = 0;

for kk=1:10000 % Number of Monte Caarlo Simulations

n = randn(1,L); %AWGN noise with mean 0 and variance 1

s = sqrt(snr).\*randn(1,L); % Real valued Gaussina Primary User Signal

y = s + n; % Received signal at SU

energy = abs(y).^2; % Energy of received signal over N samples

fin =(1/L).\*sum(energy); % Test Statistic

thresh(m) = (qfuncinv(Pf3(m))./sqrt(L))+ 1; % Theoretical value of Threshold

if(fin >= thresh(m))

i = i+1;

end

end

Pd(m) = i/kk;

end

%analytical

figure,

subplot(1,3,1)

plot(Pf3, Pd)

hold on

%% Theroretical ecpression of Probability of Detection; refer above reference.

thresh = (qfuncinv(Pf3)./sqrt(L))+ 1;

Pd\_the = qfunc(((thresh - (snr + 1)).\*sqrt(L))./(sqrt(2).\*(snr + 1)));

subplot(1,3,1)

plot(Pf3, Pd\_the, 'r')

% numerical

title('thou+20');

xlabel('Pf');

ylabel('Pd');

legend('analytical','numerical');

hold off

L = 10;

snr\_dB = 3; % SNR in decibels

snr = 10.^(snr\_dB./10); % Linear Value of SNR

Pf3 = 0.01:0.01:1; % Pf = Probability of False Alarm

%% Simulation to plot Probability of Detection (Pd) vs. Probability of False Alarm (Pf)

for m = 1:length(Pf3)

m

i = 0;

for kk=1:10000 % Number of Monte Caarlo Simulations

n = randn(1,L); %AWGN noise with mean 0 and variance 1

s = sqrt(snr).\*randn(1,L); % Real valued Gaussina Primary User Signal

y = s + n; % Received signal at SU

energy = abs(y).^2; % Energy of received signal over N samples

fin =(1/L).\*sum(energy); % Test Statistic

thresh(m) = (qfuncinv(Pf3(m))./sqrt(L))+ 1; % Theoretical value of Threshold

if(fin >= thresh(m))

i = i+1;

end

end

Pd(m) = i/kk;

end

%analytical

subplot(1,3,2)

plot(Pf3, Pd)

hold on

%% Theroretical ecpression of Probability of Detection; refer above reference.

thresh = (qfuncinv(Pf3)./sqrt(L))+ 1;

Pd\_the = qfunc(((thresh - (snr + 1)).\*sqrt(L))./(sqrt(2).\*(snr + 1)));

subplot(1,3,2)

plot(Pf3, Pd\_the, 'r')

% numerical

title('thou+40');

xlabel('Pf');

ylabel('Pd');

legend('analytical','numerical');

hold off

L = 100;

snr\_dB = 3; % SNR in decibels

snr = 10.^(snr\_dB./10); % Linear Value of SNR

Pf3 = 0.01:0.01:1; % Pf = Probability of False Alarm

%% Simulation to plot Probability of Detection (Pd) vs. Probability of False Alarm (Pf)

for m = 1:length(Pf3)

m

i = 0;

for kk=1:10000 % Number of Monte Caarlo Simulations

n = randn(1,L); %AWGN noise with mean 0 and variance 1

s = sqrt(snr).\*randn(1,L); % Real valued Gaussina Primary User Signal

y = s + n; % Received signal at SU

energy = abs(y).^2; % Energy of received signal over N samples

fin =(1/L).\*sum(energy); % Test Statistic

thresh(m) = (qfuncinv(Pf3(m))./sqrt(L))+ 1; % Theoretical value of Threshold

if(fin >= thresh(m))

i = i+1;

end

end

Pd(m) = i/kk;

end

%analytical

subplot(1,3,3)

plot(Pf3, Pd)

hold on

%% Theroretical ecpression of Probability of Detection; refer above reference.

thresh = (qfuncinv(Pf3)./sqrt(L))+ 1;

Pd\_the = qfunc(((thresh - (snr + 1)).\*sqrt(L))./(sqrt(2).\*(snr + 1)));

subplot(1,3,3)

plot(Pf3, Pd\_the, 'r')

% numerical

title('thou+60');

xlabel('Pf');

ylabel('Pd');

legend('analytical','numerical');

hold on