School of Engineering and Applied Science (SEAS)
Ahmedabad University

BTech(ICT) Semester V: Wireless Communication (ECE311)

Laboratory Assignment-5

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1. Solution Problem-1

   (a) Matlab Script:

```matlab
close all;
clear all;
clc;
SNR=[-20:5];
%converting SNR to linear
SNRLin = 10.^(SNR./10);

L = 100;                                          % sample size
Pf = 0.01;                                        %Pf=igamma(u,threshold./2)./gamma(u)

% Analytical expression
threshold = (sqrt(2).* erfcinv(2.* Pf)./sqrt(L)) + 1; %lambda~threshold
theoryPd = 0.5.* erfc(((threshold-(SNRLin+1)).*L)./sqrt(2.*L.*(SNRLin+1).^2)/sqrt(2));

% Simulation
for i = 1:length(SNR)
    detect = 0;
    % Monte Carlo Loop
    for ii = 1:10000
        noise = randn(1,L); % white gaussian noise, 0dB variance
        signal = sqrt(SNRLin(i)).*randn(1,L);
        rec_sig = signal + noise;
        energy = sum(real(rec_sig).^2 + imag(rec_sig).^2);
        test = (1/L).*sum(energy);
        threshold(i) = (sqrt(2).* erfcinv(2.* Pf)./sqrt(L)) + 1;
        if(test >= threshold(i))
            detect = detect + 1;
        end
    end
    simPd(i) = (detect/10000);
end

% Plots
close all
figure
plot(SNR, theoryPd, 'cmo-', 'LineWidth', 3);
hold on;
plot(SNR, simPd, 'b^', 'LineWidth', 3);
grid on
legend('Theory', 'Simulation');
xlabel('SNR (dB)');
ylabel('Probability of Detection');
title('P_d vs SNR  for P_f = 0.01');
```

   (b) Simulation Output:

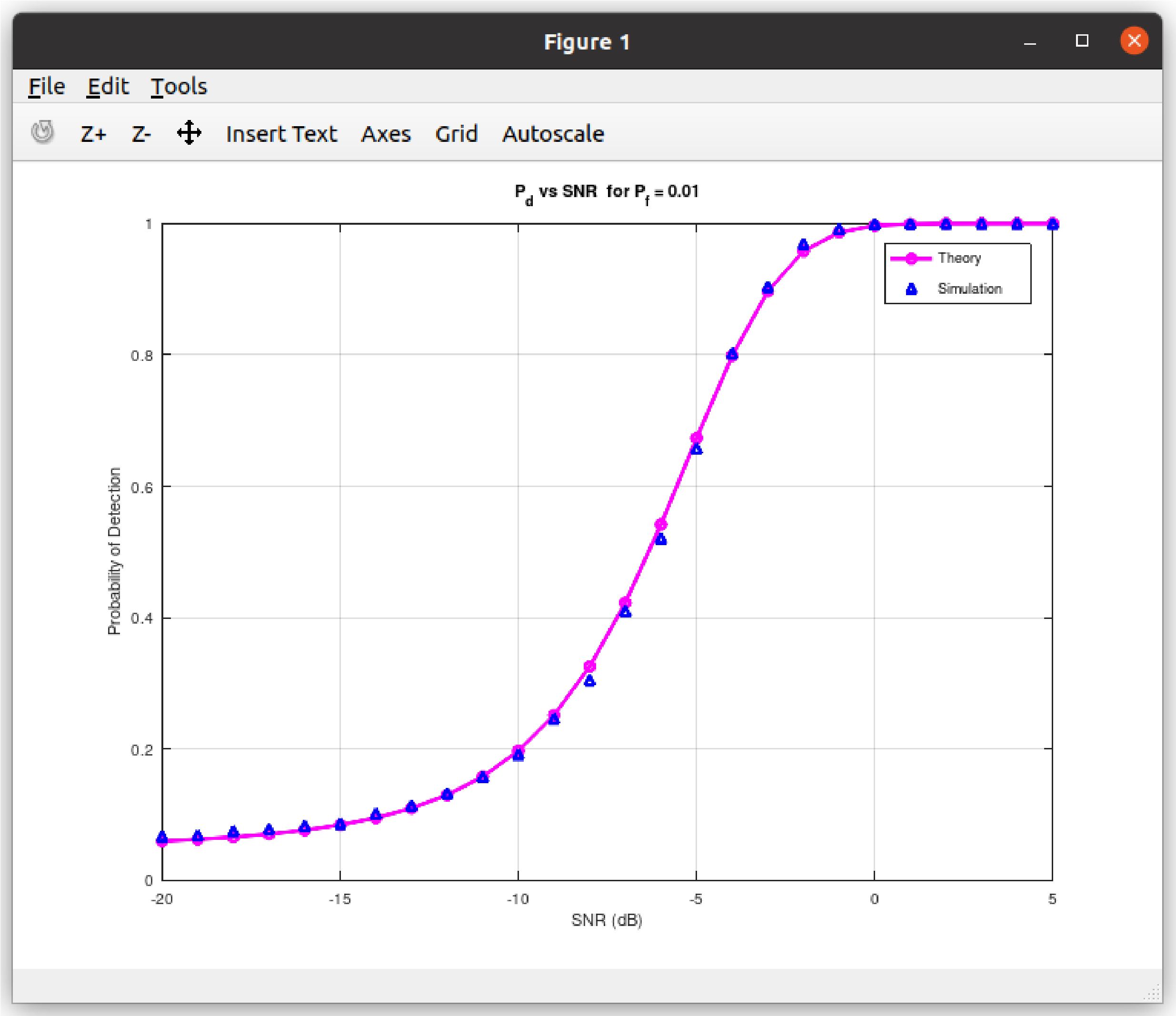

Fig 1:Plot of P$_d$ $v/s\ SNR\ for\ P_f = 0.01$

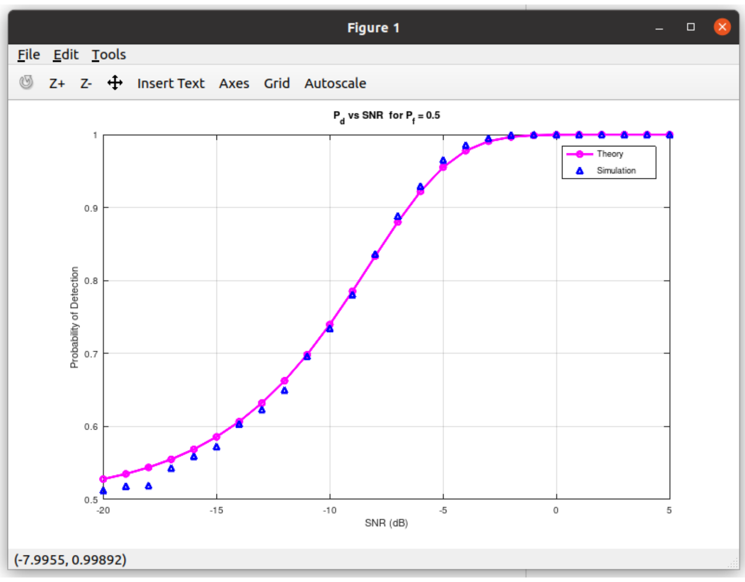

Fig 2:Plot of P$_d$ $v/s\ SNR\ for\ P_f = 0.5$

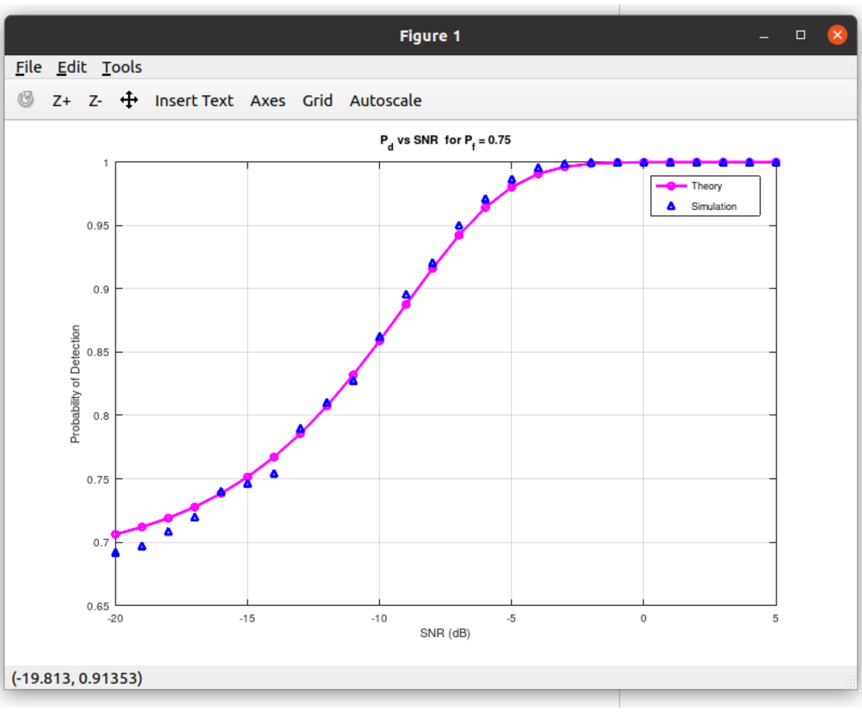

Fig 3:Plot of P$_d$ v/s SNR for $P_f = 0.75$

(c) Inference:

1) If we plot P_d vs P_f , graph displays that most convenient point for Secondary User is when least probability of false alarm at some value of SNR .

2) In this assignment we're plotting P_d vs SNR at constant value of $P_f = 0.01$ .If we take $P_f > 0.01$ increasing line will be straight.At low value of SNR detection Probability is very less nearly 0.01 which means, SU considers PU is not present [Poor channel].As increasing SNR , P_d increases significantly . a certain SNR threshold,at least one of the error probabilities can be come worse than1/2.We call this sort of failure a lack of robustness in the detector.The nominal SNR threshold below which this phenomenon manifests are called the SNR wall for the detector.

3) So,
⋆ **SNR Value must be as high as possible to better detection of PU is present for spectrum sharing.**
⋆ **And probability of detection tend to increase with probabilty of False alarm**