Problem 2.24 Skolnik

October 9, 2016

0.1 Problem a) and b)

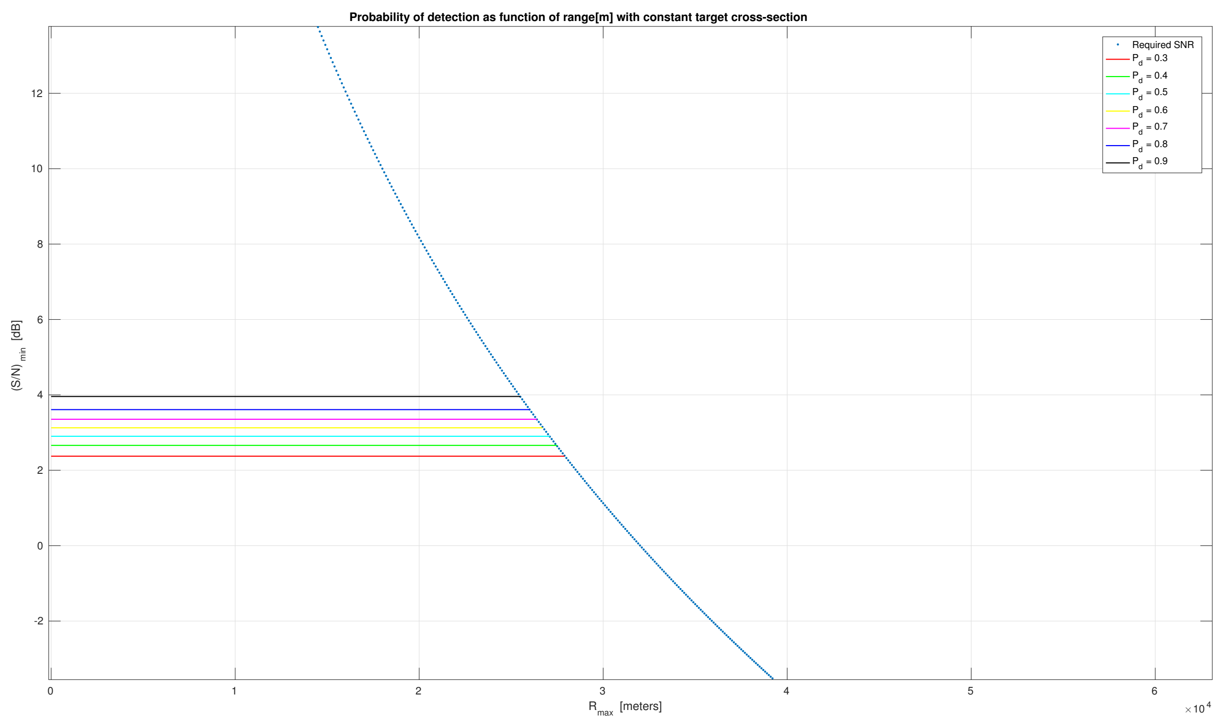

Figure 1: Probability of detection as function of range[m] with constant target cross-section

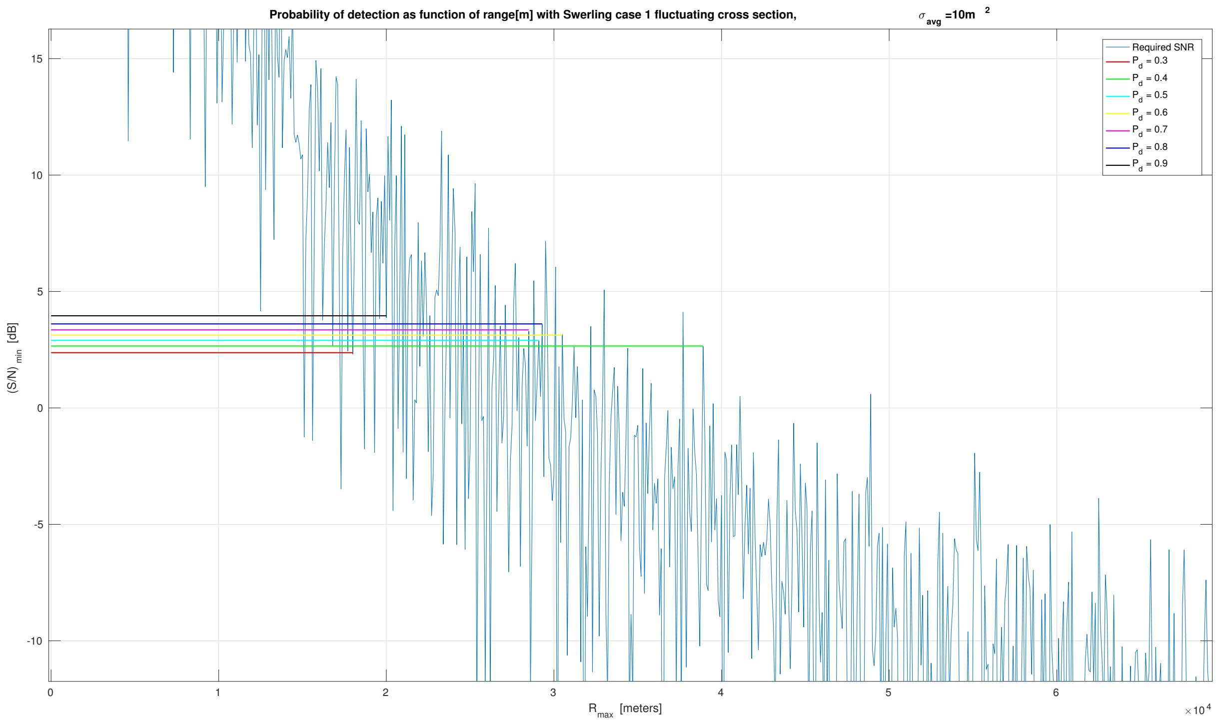

Figure 2: Probability of detection as function of range[m] with Swerling case 1 fluctuating cross section, $\sigma_{avg} = 10m^2$

0.2 Problem c)

The R_{max} in case of a $P_d = 0.9$ and constant cross-section is around 25 km, which is not much in case of long distance marine surveillance. I would assume the average power needs to be higher for this purpose. For the Swerling case 1 fluctuating target, the R_{max} for a $P_d = 0.9$ is only 20 km.

0.3 Problem d)

Remove sea clutter.

```matlab
function pb224(swerling)


% Exercise 2, Problem 2.24
% Henning Schei
%close all
f = 9400e6;

% Antenna properties:

verticalBeamWith = .8; % degrees
gain_dB          = 33; % dB
gain = 10^(gain_dB/10);
azimuth_rotation_rate = 20; %rpm




Pt   = 25e3;
ppr  = 4000;
R_nf = 5; %dB
R_BW = 15e6; %Hz
system_loss = 12; %dB
T_fa = 4*60*60; %seconds
P_fa = 1/(T_fa*R_BW);
sigma = 10;
n=26;
Ae = 1;
Fn_dB = 5;
Fn = 10^(Fn_dB/10);

r = 1e3:1e2:1e6;
Pd = 0.3:0.1:0.9;

% Finding the corresponding SNR to each Pd from 0.3:0.9
for i = 1:numel(Pd)
    SNR_dB(i) = calcSNR(Pd(i),P_fa,n);
end






% Part b)

% According to Swerling case 1, the target cross sections
% fluctuates exponential distrubiated

% Using inverse transform samling to obtaion exponential distrubiated
```

```
% numers


% Trying different implementations
figure;
switch swerling
    case 'stationary'
        % Calculate required SNR for different ranges, the points where
            they
        % intersect will correspond to the maximum range for different
            Pd's


        SNR_req = (Pt*gain*Ae*sigma)./(power(4*pi,2) *1.38e-23 *
            290*R_BW*Fn*power(r,4));
        SNR_req_dB = 10*log10(SNR_req);

        a = plot(r,SNR_req_dB,'.');
        grid on
        hold on

        xlabel 'R_{max} [meters]'
        ylabel '(S/N)_{min} [dB]'
        title 'Probability of detection as function of range[m] with
            constant target cross-section'



        dz = 0.1;
        i = 1;
        colors = ['r','g','c','y', 'm', 'b', 'k'];
        for j = SNR_dB,
            z = SNR_req_dB(SNR_req_dB < j + dz & SNR_req_dB > j -dz);
            if numel(z) > 1
                z = med(z);
            end
            z = find(abs(SNR_req_dB -z) < 0.001);
            line([0, 1e3+z*1e2-100], [j, j], 'Color', colors(i),
                'LineWidth', 1);
            i=i+1;


        end

        legend('Required SNR', 'P_d = 0.3', 'P_d = 0.4', 'P_d = 0.5',
            'P_d = 0.6', 'P_d = 0.7', 'P_d = 0.8','P_d = 0.9' );
        axis([0 8e4 1 8]);
        hold off

    case 'case1'
```

```
    N = numel(r); % Number of random points
    sigma = [];
    sigma_avg=10;
    for j = 1:N
        sigma = [sigma ; exprnd(sigma_avg)];
    end

    SNR_req = (Pt.*gain.*Ae.*sigma')./(power(4*pi,2) .*1.38e-23 .*
        290.*R_BW.*Fn.*power(r,4));
    SNR_req_dB = 10*log10(SNR_req);
    a = plot(r,SNR_req_dB);
    grid on
    hold on

    xlabel 'R_{max} [meters]'
    ylabel '(S/N)_{min} [dB]'
    title 'Probability of detection as function of range[m] with
        Swerling case 1 fluctuating cross section,
        \sigma_{avg}=10m^2'

    dz = 0.1;
    i = 1;
    colors = ['r','g','c','y', 'm', 'b', 'k'];
    i=1;
    for j = SNR_dB,
        z = SNR_req_dB(SNR_req_dB < j + dz & SNR_req_dB > j -dz);
        if numel(z) > 1
            z = med(z);
        end
        z = find(abs(SNR_req_dB -z) < 0.001);
        line([0, 1e3+z*1e2-100], [j, j], 'Color', colors(i),
            'LineWidth', 1);
        i=i+1;


    end
    legend('Required SNR', 'P_d = 0.3', 'P_d = 0.4', 'P_d = 0.5',
        'P_d = 0.6', 'P_d = 0.7', 'P_d = 0.8','P_d = 0.9' );
    axis([0 9e4 1 10]);
    hold off

end
```