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%ECE458 - Senior Design
%Michael Benker
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%% FALSE DETECTION RATES %%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
clf;clear all; clc; close all;
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samples=10000;
T_h_begin = 1.5; %Begin and end for parameter sweep of threshold
    numbers
T_h_end = 6;
T_m_begin = 3;
T_m_end = 9;
T_l_begin = 8;
T_l_end = 24;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%
%VARIABLES
Ave2sec = 0;      %2-second average
T_high = 4;       %standard deviations for high sensitivity setting
T_med = 8;        %standard deviations for medium sensitivity setting
T_low = 12;       %standard deviations for low sensitivity setting
Data20sec = zeros(200,1);
history = zeros(100,1);

RI_med = zeros(100,1); %1 if real interrupt, 0 if false interrupt
RI_high = zeros(100,1);
RI_low = zeros(100,1);
ID_low = zeros(100,1); %1 if interrupt detected, 0 if interrupt not
    detected
ID_med = zeros(100,1);
ID_high = zeros(100,1);
TID_low = zeros(100,1); %1 if ID = RI = 1, 0 otherwise
TID_med = zeros(100,1);
TID_high = zeros(100,1);
FD_low = zeros(100,1); %1 if ID = 1 & RI = 0, 0 otherwise
FD_med = zeros(100,1);
FD_high = zeros(100,1);
FN_low = zeros(100,1); %1 if ID = 0 & RI = 1, 0 otherwise
FN_med = zeros(100,1);
FN_high = zeros(100,1);
FDR_low = 0; %probability of false interrupt given interrupt
    detection
FDR_med = 0;
FDR_high = 0;
FDR_low_array = zeros(samples,1);
FDR_med_array = zeros(samples,1);
FDR_high_array = zeros(samples,1);

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T_high_array = zeros(samples,1);      %standard deviations for high
    sensitivity setting
T_med_array = zeros(samples,1);      %standard deviations for medium
    sensitivity setting
T_low_array = zeros(samples,1);      %standard deviations for low
    sensitivity setting
FN_low_array = zeros(samples,1);
FN_med_array = zeros(samples,1);
FN_high_array = zeros(samples,1);
Opti_low = zeros(samples,1);
Opti_med = zeros(samples,1);
Opti_high = zeros(samples,1);

%IMPORT DATA
SoundData1 = 'Book2.xlsx'; %Read excel file in folder
DataMat = zeros(30,4); %Predefine Data Matrix
Ambients = xlsread(SoundData1, 'A2:A31'); %Ambient 1st col
Quiets = xlsread(SoundData1, 'B2:B31'); %Quiet is 2nd col
Mediums = xlsread(SoundData1, 'C2:C31'); %Medium is 3rd col
Louds = xlsread(SoundData1, 'D2:D31'); %Loud is 4th col
[k,DataLoc] = xlsread(SoundData1, 'E1:E1');

%Define past 20 seconds (ambients)

for s=1:samples
    T_high=T_h_begin+s*(T_h_end-T_h_begin)/samples;
    T_med=T_m_begin+s*(T_m_end-T_m_begin)/samples;
    T_low=T_l_begin+s*(T_l_end-T_l_begin)/samples;

    T_high_array(s,1)=T_high;
    T_med_array(s,1)=T_med;
    T_low_array(s,1)=T_low;

    RI_med = zeros(100,1); %1 if real interrupt, 0 if false interrupt
    RI_high = zeros(100,1);
    RI_low = zeros(100,1);
    ID_low = zeros(100,1); %1 if interrupt detected, 0 if interrupt
    not detected
    ID_med = zeros(100,1);
    ID_high = zeros(100,1);
    TID_low = zeros(100,1); %1 if ID = RI = 1, 0 otherwise
    TID_med = zeros(100,1);
    TID_high = zeros(100,1);
    FD_low = zeros(100,1); %1 if ID = 1 & RI = 0, 0 otherwise
    FD_med = zeros(100,1);
    FD_high = zeros(100,1);
    FN_low = zeros(100,1); %1 if ID = 0 & RI = 1, 0 otherwise
    FN_med = zeros(100,1);
    FN_high = zeros(100,1);

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for c = 1:200
    Data20sec(c,1) = Ambients(randi([1 30],1,1),1);

end
Ave20sec = mean(Data20sec);
Std20sec = std(Data20sec);
RT_high = Ave20sec+Std20sec*T_high; %Running threshold level (high
    sens)
RT_med = Ave20sec+Std20sec*T_med; %Running threshold level (med sens)
RT_low = Ave20sec+Std20sec*T_low; %Running threshold level (low sens)

for c=1:25
    new = Ambients(randi([1 30],1,1),1);
    history(c,1)=new;

    if new>RT_high
        ID_high(c,1)=1;
        FD_high(c,1)=1;
    end
    if new>RT_med
        ID_med(c,1)=1;
        FD_med(c,1)=1;
    end
    if new>RT_low
        ID_low(c,1)=1;
        FD_low(c,1)=1;
    end

end

%Quiet interrupts
%Only high sensitivity should activate interrupt
for c=26:50
    new = Quiets(randi([1 30],1,1),1);
    history(c,1)=new;
    RI_high(c,1)=1;
    if new>RT_high
        ID_high(c,1)=1;
        TID_high(c,1)=1;
    else
        FN_high(c,1)=1;
    end
    if new>RT_med
        ID_med(c,1)=1;
        FD_med(c,1)=1;
    end
    if new>RT_low
        ID_low(c,1)=1;
        FD_low(c,1)=1;
    end

end

end

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%medium interrupts
%Only high and medium sensitivity should activate interrupt
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for c=51:75
    new = Mediums(randi([1 30],1,1),1);
    history(c,1)=new;
    RI_high(c,1)=1;
    RI_med(c,1)=1;
    if new>RT_high
        ID_high(c,1)=1;
        TID_high(c,1)=1;
    else
        FN_high(c,1)=1;
    end
    if new>RT_med
        ID_med(c,1)=1;
        TID_med(c,1)=1;
    else
        FN_med(c,1)=1;
    end
    if new>RT_low
        ID_low(c,1)=1;
        FD_low(c,1)=1;
    end
end

end
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%loud interrupts
%all activate interrupt
for c=76:100
    new = Louds(randi([1 30],1,1),1);
    history(c,1)=new;
    RI_high(c,1)=1;
    RI_med(c,1)=1;
    RI_low(c,1)=1;
    if new>RT_high
        ID_high(c,1)=1;
        TID_high(c,1)=1;
    else
        FN_high(c,1)=1;
    end
    if new>RT_med
        ID_med(c,1)=1;
        TID_med(c,1)=1;
    else
        FN_med(c,1)=1;
    end
    if new>RT_low
        ID_low(c,1)=1;
        TID_low(c,1)=1;
    else
        FN_low(c,1)=1;
    end
end
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        end

    end

    %False Interrupt Detection Rate - Print all
    %FDR_low = sum(FD_low, 'all')/sum(ID_low, 'all');    %probability of
        false interrupt given interrupt detection
    %FDR_med = sum(FD_med, 'all')/sum(ID_med, 'all');
    %FDR_high = sum(FD_high, 'all')/sum(ID_high, 'all');
    FDR_low = sum(FD_low, 'all')/sum(ID_low, 'all');    %probability of
        false interrupt given interrupt detection
    FDR_med = sum(FD_med, 'all')/sum(ID_med, 'all');
    FDR_high = sum(FD_high, 'all')/sum(ID_high, 'all');

    FDR_low_array(s,1) = FDR_low;
    FDR_med_array(s,1) = FDR_med;
    FDR_high_array(s,1) = FDR_high;

    FN_low_array(s,1)=sum(FN_low, 'all')/100;
    FN_med_array(s,1)=sum(FN_med, 'all')/100;
    FN_high_array(s,1)=sum(FN_high, 'all')/100;

    Opti_low(s,1)= FDR_low_array(s,1)+FN_low_array(s,1);
    Opti_med(s,1)=FDR_med_array(s,1)+FN_med_array(s,1);
    Opti_high(s,1)=FDR_high_array(s,1)+FN_high_array(s,1);

    end

    %!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!

    %FDRfit_high = fit( T_high_array,FDR_high_array,
        'poly3','normalize','on');
    %FNfit_high = fit( T_high_array,
        FN_high_array,'poly3','normalize','on');

    %FDRfit_med = fit( T_med_array,
        FDR_med_array,'poly3','normalize','on');
    %FNfit_med = fit( T_med_array, FN_med_array,'poly3','normalize','on');

    %FDRfit_low =
        fit( T_low_array,FDR_low_array,'poly3','normalize','on' );
    %FNfit_low = fit( T_low_array,FN_low_array,'poly3','normalize','on' );

    DataLoc = char(DataLoc);
    figure(1)
    subplot(2,1,1)
    plot(T_low_array,FDR_low_array)
    title('False Detection Rate: Low Sensitivity, %s')
    xlabel('# of Threshold Standard Deviations, T')
    ylabel('FDR')
    grid on
    subplot(2,1,2)

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plot(T_low_array,FN_low_array)
title('False Negatives: Low Sensitivity,')
xlabel('# of Threshold Standard Deviations, T')
ylabel('FN')
suptitle(DataLoc)
grid on

figure(2)
subplot(2,1,1)
plot(T_med_array,FDR_med_array)
title('False Detection Rate: Medium Sensitivity,')
xlabel('# of Threshold Standard Deviations, T')
ylabel('FDR')
grid on
subplot(2,1,2)
plot(T_med_array,FN_med_array)
title('False Negatives: Medium Sensitivity,')
xlabel('# of Threshold Standard Deviations, T')
ylabel('FN/100')
suptitle(DataLoc)
grid on

figure(3)
subplot(2,1,1)
plot(T_high_array,FDR_high_array)
title('False Detection Rate: High Sensitivity,')
xlabel('# of Threshold Standard Deviations, T')
ylabel('FDR')
grid on
subplot(2,1,2)
plot(T_high_array,FN_high_array)
title('False Negatives: High Sensitivity,')
xlabel('# of Threshold Standard Deviations, T')
ylabel('FN/100')
suptitle(DataLoc)
grid on

%fit_high = fit( T_high_array,Opti_high, 'poly3','normalize','on');
%fit_med = fit( T_med_array, Opti_med,'poly3','normalize','on');
%fit_low = fit( T_low_array,Opti_low,'poly3','normalize','on' );

figure(4)
subplot(3,1,1)
plot(T_high_array,Opti_high)
%fit_high( 0.01 );
title('FDR+False Negatives: High Sensitivity,')
xlabel('Threshold stdev')
ylabel('Pr')
grid on

subplot(3,1,2)
plot(T_med_array,Opti_med)

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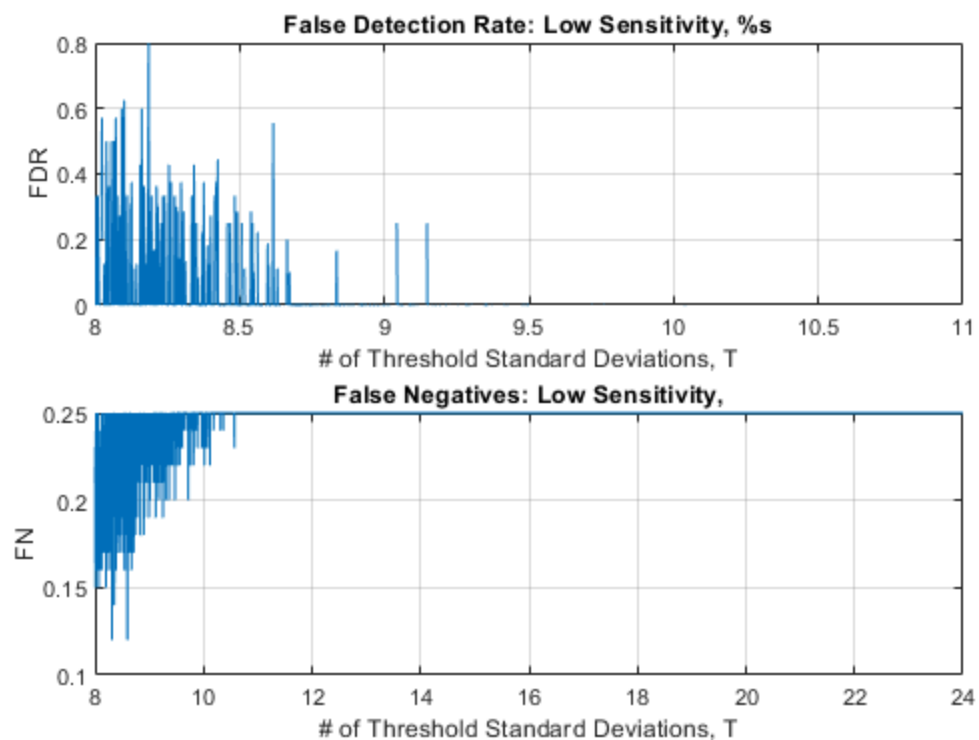
```

%fit_med( 0.01 );
title('FDR+False Negatives: Med Sensitivity,')
xlabel('Threshold stdev')
ylabel('Pr')
grid on

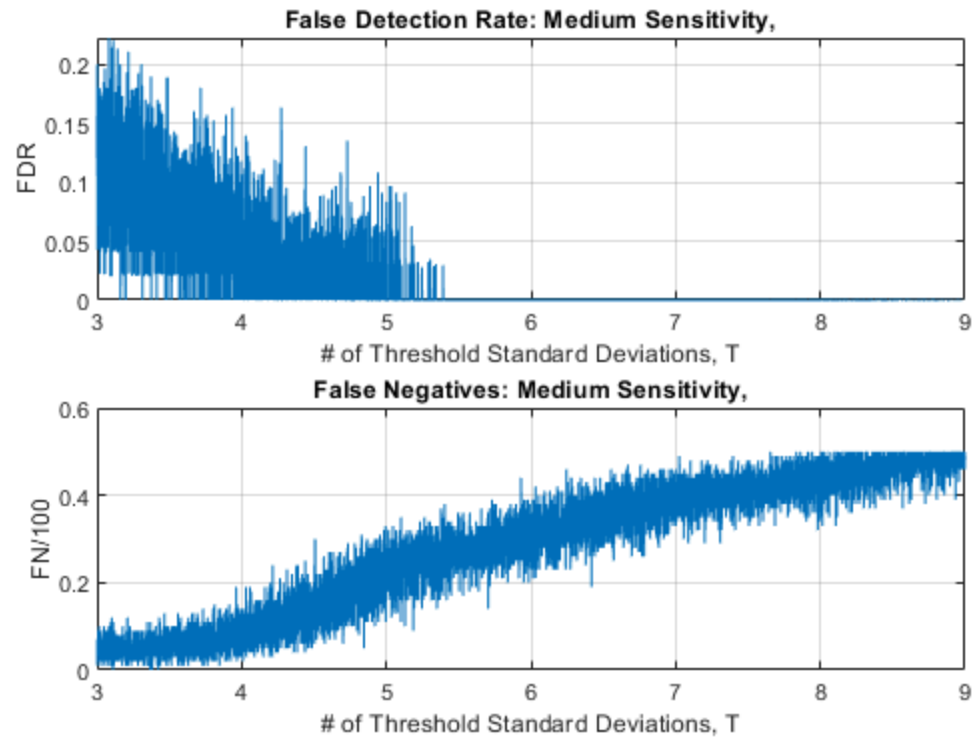
subplot(3,1,3)
plot(T_low_array,Opti_low)
%fit_low( 0.01 );
title('FDR+False Negatives: Low Sensitivity, ')
xlabel('Threshold stdev')
ylabel('Pr')
suptitle(DataLoc)
grid on

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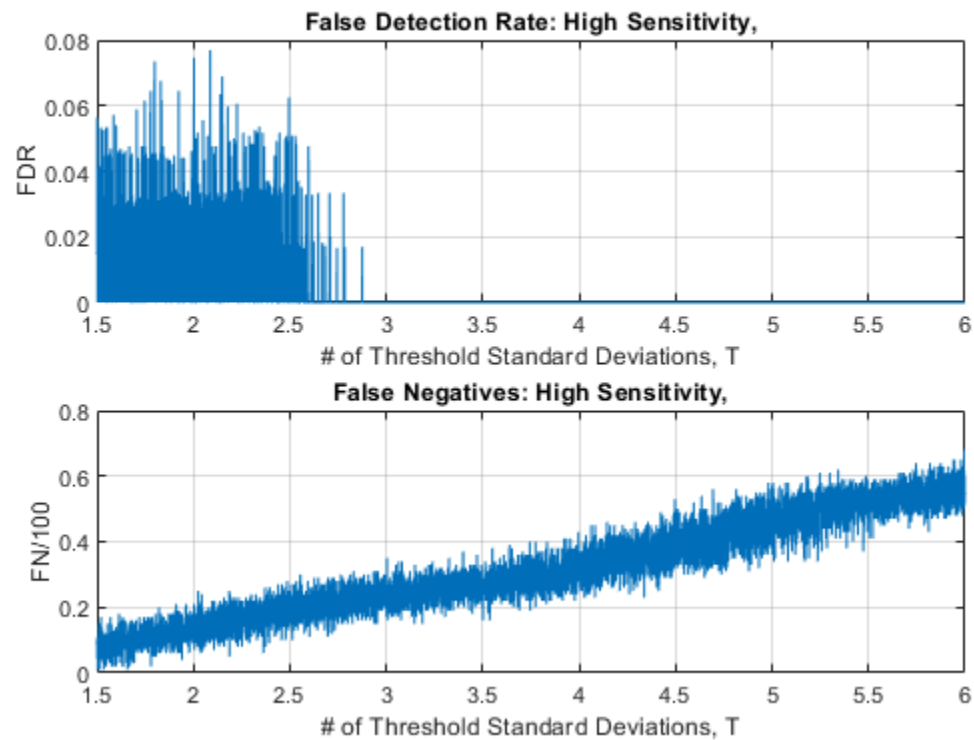
SENG Near On the Go with TV on



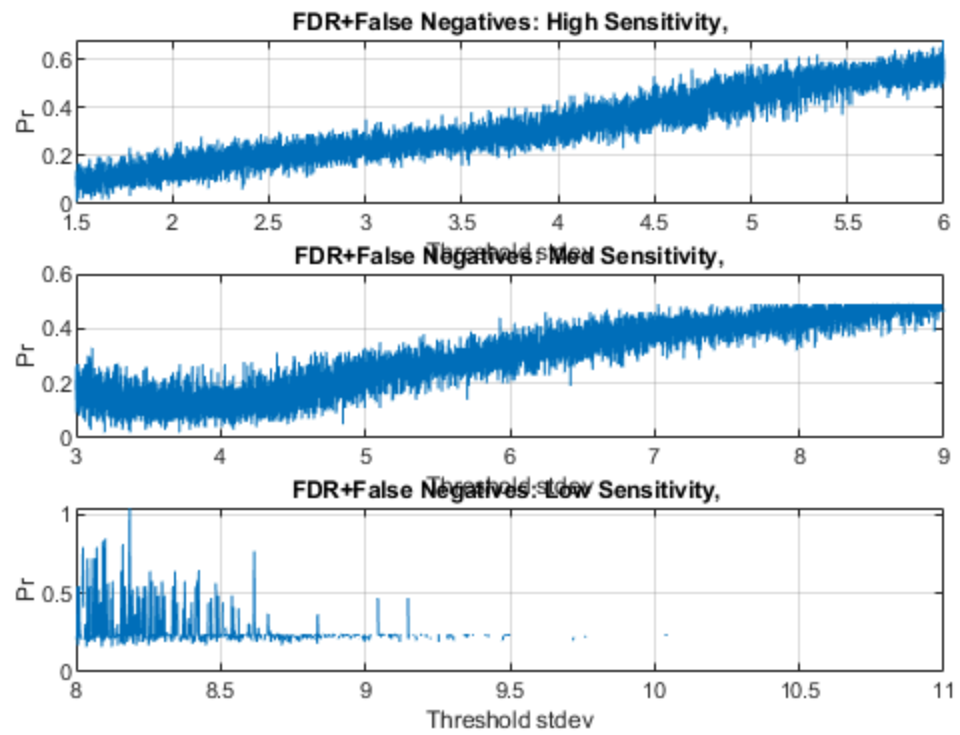
SENG Near On the Go with TV on



SENG Near On the Go with TV on



SENG Near On the Go with TV on



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