

The purpose of this project is to implement different interference in FMCW RADAR detection and mitigation algorithms, techniques and methods.

Weighted Envelop Normalization ( WEN) and its advanced version ( AWEN) are implemented as two different MATLAB functions, and then tested on a synthetic data

This MATLAB project can be only used for rsearch porposes. Please contact me if you have any issue with scripts or have dificulties to understand some parts of the code

Developed by Abderrahim BELISSAOUI  
Signal processing & control system engineer  
Email: abd.belissaoui@gmail.com

Table of Contents

RADAR parameters.....1  
Chirp parameters.....2  
CFAR parameters.....2  
target 1.....2  
target 2.....2  
beat signal.....2  
    Detection Based FFT.....3  
CFAR detector.....3  
adding interference.....3  
Total signal.....4  
Detection based FFT.....4  
CFAR detector.....4  
WEN.....5  
Detection based FFT.....5

Clear varibales and workspace

```
clear all
close all
clc
```

RADAR parameters

```
c=3e8 ;
Bw= 540e6;
R_max=125; %m
```

```
Vmax= 60*(1000/3600) ;
d_res=c/(2*Bw) ;
```

## Chirp parameters

```
Tc= 45e-6 ; %125m / 45 us
S= Bw/Tc ;

fb_max= 10e6 ; %% 10 MHz
fs= 2.2*10e6 ;

% 2*S*R_max/c ; % R_max=(Fs*c)/(2*S) ; Sampling frequency f_IF= 2*(S*d)/c ;
d_res=c/(2*Bw) ;
t= (0:1/fs:Tc-1/fs) ;
```

## CFAR parameters

```
refLength=6;
guardLength=1;
offset=4;
```

## target 1

```
A1=0.1 ;
R1= 40 ; % target 1 Range
V1=0; % m/s
f_IF1= 2*(S*R1)/c;
S_T1=A1*cos(2*pi*f_IF1*t) ;
```

## target 2

```
A2=0.02 ;
R2= 70 ; % target 2 range
V2=0 ; % m/s
f_IF2= 2*(S*R2)/c ;
S_T2=A2*cos(2*pi*f_IF2*t) ;
S_IF_targets= (S_T1+S_T2) ;
```

## beat signal

```
S_IF_targets=awgn(S_IF_targets,40) ; % total beat frequency signal
L=length(S_IF_targets) ;
```

## Detection Based FFT

```
Y = fft(S_IF_targets);
B2 = abs(Y/L);
B1 = B2(1:L/2+1);
B1(2:end-1) = 2*B1(2:end-1);
B1=pow2db(B1) ;
f = fs*(0:(L/2))/L;
%
Rng= (f*c)/(2*S);
```

## CFAR detector

```
cfarThreshold = CA_CFAR(B1, refLength,guardLength,offset) ;
```

```
figure
subplot(3,1,1)
plot(t, S_IF_targets,'r')
axis([0 max(t) -1 1])
title('Noisy Beat Signal: No interference ')
xlabel('time (s)')
ylabel('Amplitude(V)')
subplot(3,1,2)
plot(Rng,B1,'r')
axis([0 R_max -40 0]);
title('Range FFT- No interference ')
xlabel('Range (m)')
ylabel('Power Spectrum(db)')
subplot(3,1,3)
plot(Rng,B1,'r');
axis([0 R_max -40 0]);
hold on,plot(Rng,cfarThreshold,'-.b')
legend('Range FFT','CFAR Threshold')
```

## adding interference

```
PL = 0.4*Tc * fb_max;
tS = (0:PL-1)*(1/fb_max); % Time vector
halfIdx = round(PL/2);
sFreq1=0.4*fb_max ;
sFreq2=0.7*fb_max ;
```

```
[S2_P1,phiEnd] = ChirpGenerate(sFreq1, sFreq2, t(1:halfIdx),90);
[S2_P2,phiEnd] = ChirpGenerate(sFreq2, sFreq1, t(1:halfIdx),phiEnd);
S2_P3= zeros(1,L-PL) ;
S2 = [S2_P3,S2_P1, S2_P2];
S2 = 0.2*S2 ;
```

## Total signal

```
S_IF= (S_T1+S_T2)+S2 ;
S_IF=awgn(S_IF,40);
% figure
% snr(S_IF)
% title("snr of total beat signal")
```

## Detection based FFT

```
Y = fft(S_IF);
Q2 = abs(Y/L);
Q1 = Q2(1:L/2+1);
Q1(2:end-1) = 2*Q1(2:end-1);
Q1=pow2db(Q1) ;
f = fs*(0:(L/2))/L;
Rng= (f*c)/(2*S);
%
```

## CFAR detector

```
cfarThreshold = CA_CFAR(Q1, refLength,guardLength,offset) ;
```

```
figure
subplot(3,1,1)
plot(t, S_IF,'r') ;
axis([0 max(t) -1 1])
title('Noisy Beat Signal wih interference ')
xlabel('time (s)')
ylabel('Amplitude(V)')
subplot(3,1,2)
plot(Rng,Q1,'r')
axis([0 R_max -40 0]);
title('Range FFT - with mutual interference')
xlabel('Range (m)')
ylabel('Power Spectrum(db)')
subplot(3,1,3)
plot(Rng,Q1,'r');
```

```
axis([0 R_max -40 0]);
hold on,plot(Rng,cfarThreshold,'-.b')
legend('Range FFT','CFAR Threshold')
xlabel('Range (m)')
ylabel('Power Spectrum(db)')
```

## WEN

```
[mlmax_F,mlmax_B,r,m_new] = WEN(S_IF,80) ;
```

## Detection based FFT

```
Y = fft(m_new);
P2 = abs(Y/L);
P1 = P2(1:L/2+1);
P1(2:end-1) = 2*P1(2:end-1);
P1=pow2db(P1) ;
f = fs*(0:(L/2))/L;
Rng= (f*c)/(2*S);
%
```

```
cfarThreshold = CA_CFAR(P1, refLength,guardLength,offset) ;
```

```
figure
subplot(3,1,1)
plot(t, m_new,'r') ;
axis([0 max(t) -1 1])
title('WEN signal ')
xlabel('time (s)')
ylabel('Amplitude(V)')
subplot(3,1,2)
plot(Rng,P1,'r')
axis([0 R_max -40 0]);
title('Range FFT - WEN spectrum')
xlabel('Range (m)')
ylabel('Power Spectrum(db)')
subplot(3,1,3)
plot(Rng,P1,'r');
axis([0 R_max -40 0]);
title('Detection - Proposed Algorithm')
hold on,plot(Rng,cfarThreshold,'-.b') ;
legend('Range FFT','CFAR Threshold')
xlabel('Range (m)')
ylabel('Power Spectrum(db)')
```

