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Definizione dei parametri

```
% frequenza radar, velocità luce e fattore lambda
fc = 77e9;
c = 3e8;
lambda = c/fc;

% massimo range e sweep time (fattore medio 5.5)
range_max = 1000
tm = 5.5*range2time(range_max,c);

% sweep slope sulla base della risoluzione
range_res = 1;
bw = rangeres2bw(range_res,c);
sweep_slope = bw/tm;

% frequenza calcolata sulla base del range massimo
fr_max = range2beat(range_max,sweep_slope,c);

% velocità massima oggetto di 300 km/h
v_max_kmh = 350
v_max = v_max_kmh*1000/3600;
fd_max = speed2dop(2*v_max,lambda);
fb_max = fr_max+fd_max;

% sample rate pari al doppio della massima beat frequency
fs = max(2*fb_max,bw);
```

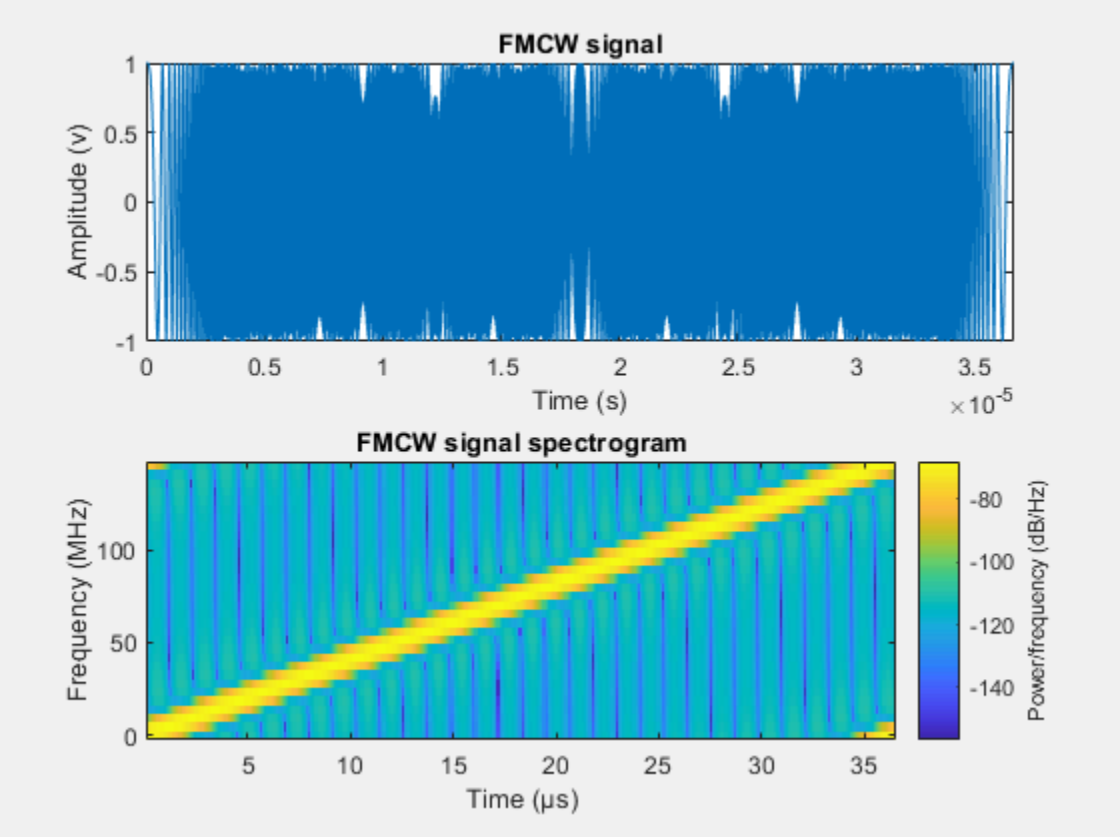
```
range_max =

        1000
```

```
v_max_kmh =

   350
```

Simulazione della forma d'onda FMCW

```
% definizione della forma d'onda
```

```
waveform = phased.FMCWWaveform('SweepTime',tm,'SweepBandwidth',bw,...
    'SampleRate',fs);

% plot rispetto a tempo e frequenza
sig = waveform();
subplot(211); plot(0:1/fs:tm-1/fs,real(sig));
xlabel('Time (s)'); ylabel('Amplitude (v)');
title('FMCW signal'); axis tight;
subplot(212); spectrogram(sig,32,16,32,fs,'yaxis');
title('FMCW signal spectrogram');
```



Costruzione del modello dell'oggetto da individuare

```
% parametri oggetto (distanza e velocità)
obj_dist = 700
obj_speed_kmh = 300
obj_speed = obj_speed_kmh*1000/3600;
obj_rcs = db2pow(min(10*log10(obj_dist)+5,20));

% costruzione target
objtarget = phased.RadarTarget('MeanRCS',obj_rcs,'PropagationSpeed',c,...
    'OperatingFrequency',fc);
objmotion = phased.Platform('InitialPosition',[obj_dist;0;0.5],...
    'Velocity',[obj_speed;0;0]);
```

```
% canale assunto free space
channel = phased.FreeSpace('PropagationSpeed',c,...
    'OperatingFrequency',fc,'SampleRate',fs,'TwoWayPropagation',true);
```

```
obj_dist =

   700
```

```
obj_speed_kmh =

   300
```

Setup sistema radar FMCW

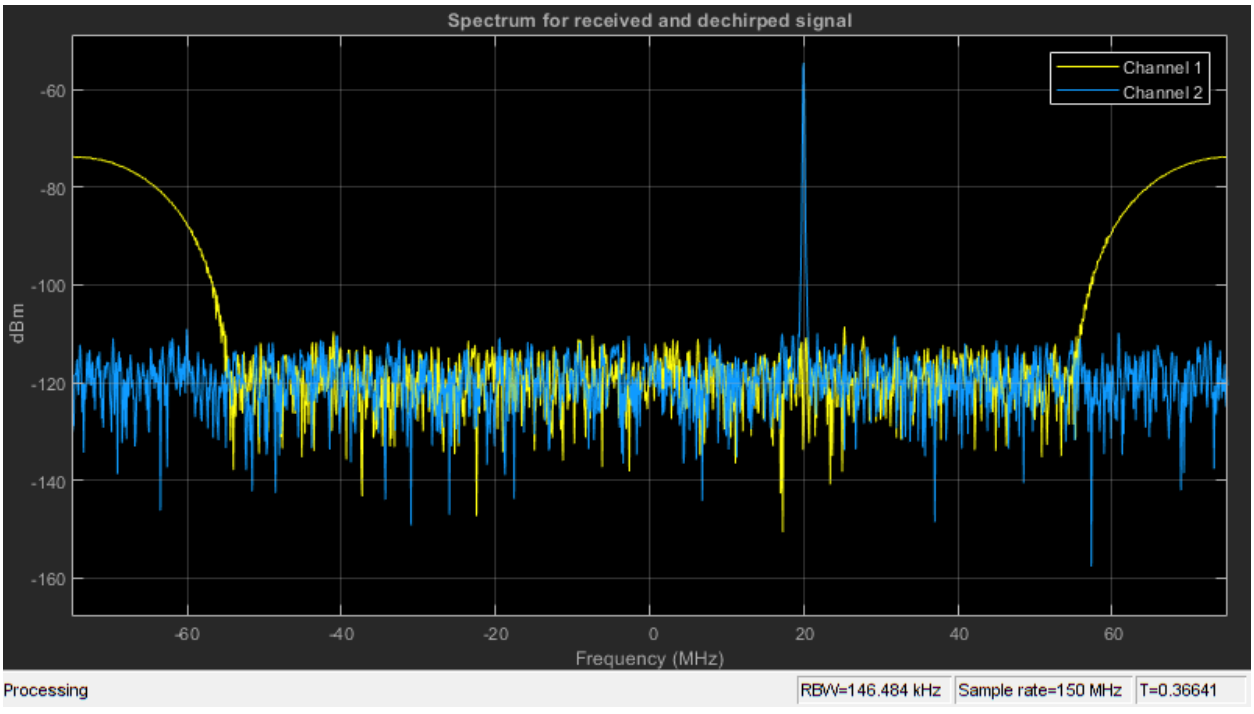
```
% set parametri trasmettitore e ricevitore
ant_aperture = 6.06e-2;                          % in square meter
ant_gain = aperture2gain(ant_aperture,lambda);  % in dB

tx_ppower = db2pow(5)*1e-3;                      % in watts
tx_gain = 9+ant_gain;                            % in dB

rx_gain = 15+ant_gain;                           % in dB
rx_nf = 4.5;                                     % in dB

% definizione di trasmettitore e ricevitore
transmitter = phased.Transmitter('PeakPower',tx_ppower,'Gain',tx_gain);
receiver = phased.ReceiverPreamp('Gain',rx_gain,'NoiseFigure',rx_nf,...
    'SampleRate',fs);

% velocità dispositivo su cui il radar è montato
radar_speed_kmh = 5
radar_speed = -radar_speed_kmh*1000/3600;
radarmotion = phased.Platform('InitialPosition',[0;0;0.5],...
    'Velocity',[radar_speed;0;0]);
```

```
radar_speed_kmh =

     5
```

Simulazione sistema radar

```
% analisi spettro segnale ricevuto
specanalyzer = dsp.SpectrumAnalyzer('SampleRate',fs,...
    'PlotAsTwoSidedSpectrum',true,...
    'Title','Spectrum for received and dechirped signal',...
    'ShowLegend',true);
```

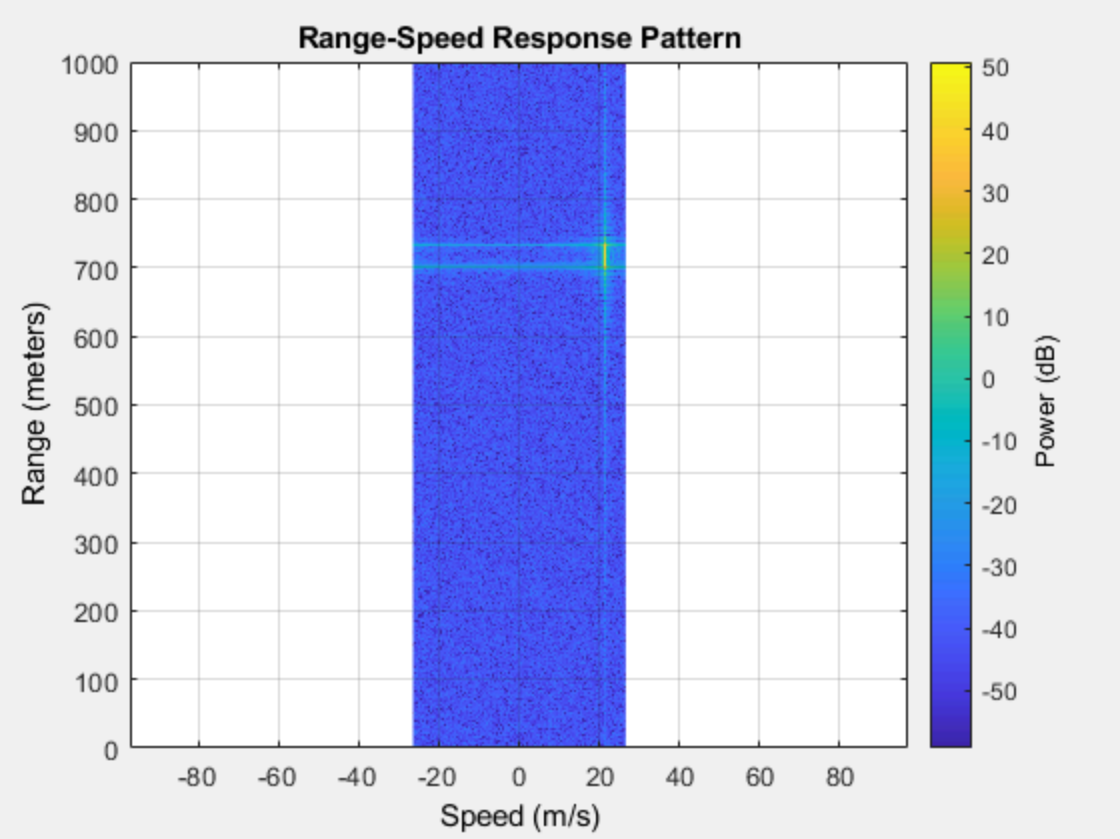
```
rng(2012);
Nsweep = 10000;
xr = complex(zeros(waveform.SampleRate*waveform.SweepTime,Nsweep));

% loop simulazione
for m = 1:Nsweep
    % Update radar and target positions
    [radar_pos,radar_vel] = radarmotion(waveform.SweepTime);
    [tgt_pos,tgt_vel] = objmotion(waveform.SweepTime);

    % Transmit FMCW waveform
    sig = waveform();
    txsig = transmitter(sig);

    % Propagate the signal and reflect off the target
    txsig = channel(txsig,radar_pos,tgt_pos,radar_vel,tgt_vel);
    txsig = objtarget(txsig);

    % Dechirp the received radar return
    txsig = receiver(txsig);
    dechirpsig = dechirp(txsig,sig);

    % Visualize the spectrum
    specanalyzer([txsig dechirpsig]);

    xr(:,m) = dechirpsig;
end
```



Stima distanza oggetto in movimento

```
% analisi risposta doppler
rngdopresp = phased.RangeDopplerResponse('PropagationSpeed',c,...
    'DopplerOutput','Speed','OperatingFrequency',fc,'SampleRate',fs,...
    'RangeMethod','FFT','SweepSlope',sweep_slope,...
    'RangeFFTLengthSource','Property','RangeFFTLength',2048,...
    'DopplerFFTLengthSource','Property','DopplerFFTLength',256);

clf;
plotResponse(rngdopresp,xr);                    % Plot range Doppler map
axis([-v_max v_max 0 range_max])
clim = caxis;

% ottimizzazione frequenza campionamento post-ricezione
Dn = fix(fs/(2*fb_max));
for m = size(xr,2):-1:1
    xr_d(:,m) = decimate(xr(:,m),Dn,'FIR');
end
fs_d = fs/Dn;

% stima distanza
fb_rng = rootmusic(pulsint(xr_d,'coherent'),1,fs_d);
rng_est = beat2range(fb_rng,sweep_slope,c)

% calcolo accuracy
accuracy = rng_est/obj_dist
```

```
rng_est =

  636.2822


accuracy =

    0.9090
```



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