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%MIT IAP Radar Course 2011
%Resource: Build a Small Radar System Capable of Sensing Range, Doppler,
%and Synthetic Aperture Radar Imaging
%
%Gregory L. Charvat

%SAR algorithm from:
%Range Migration Algorithm from ch 10 of Spotlight Synthetic Aperture Radar
%Signal Processing Algorithms, Carrara, Goodman, and Majewski

%NOTE: set up-ramp sweep from 2-3.2V to stay within ISM band
%change fstart and fstop bellow when in ISM band

%-----------------------------------------%
%Process raw data here
clear all;
close all;

%read the raw data .wave file here
[Y,FS] = audioread(['towardswarehouse.wav']);

%constants
c = 3E8; %(m/s) speed of light

%radar parameters
Tp = 20E-3; %(s) pulse time
Trp = 0.25; %(s) min range profile time duration
N = Tp*FS; %# of samples per pulse
fstart = 2260E6; %(Hz) LFM start frequency
fstop = 2590E6; %(Hz) LFM stop frequency
%fstart = 2402E6; %(Hz) LFM start frequency for ISM band
%fstop = 2495E6; %(Hz) LFM stop frequency for ISM band
BW = fstop-fstart; %(Hz) transmti bandwidth
f = linspace(fstart, fstop, N/2); %instantaneous transmit frequency

%the input appears to be inverted
trig = -1*Y(:,1);
s = -1*Y(:,2);
clear Y;

%parse data here by position (silence between recorded data)
rpstart = abs(trig)>mean(abs(trig));
count = 0;
Nrp = Trp*FS; %min # samples between range profiles

for ii = Nrp+1:size(rpstart,1)-Nrp
    if rpstart(ii) == 1 & sum(rpstart(ii-Nrp:ii-1)) == 0
        count = count + 1;
        RP(count,:) = s(ii:ii+Nrp-1);
        RPtrig(count,:) = trig(ii:ii+Nrp-1);
    end
end

%parse data by pulse
count = 0;
thresh = 0.08;
clear ii;
for jj = 1:size(RP,1)
    %clear SIF;
    SIF = zeros(N,1);
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    start = (RPtrig(jj,:)> thresh);
    count = 0;
    jj;
    for ii = 12:(size(start,2)-2*N)
        [Y I] =  max(RPtrig(jj,ii:ii+2*N));
        if mean(start(ii-10:ii-2)) == 0 & I == 1
            count = count + 1;
            SIF = RP(jj,ii:ii+N-1)' + SIF;
        end
    end
    %hilbert transform
    q = ifft(SIF/count);
    sif(jj,:) = fft(q(size(q,1)/2+1:size(q,1)));
end
sif(find(isnan(sif))) = 1E-30; %set all Nan values to 0

%SAR data should be ready here
clear s;
s = sif;
save routsidewarehouse2 s; %for image data

%-----------------------------------------%
%load additional varaibles and setup constants for radar here
clear all;
c = 3E8; %(m/s) speed of light

%load IQ converted data here
load routsidewarehouse2 s; %load variable sif %for image data

for ii = 1:size(s,1)
    s(ii,:) = s(ii,:) - mean(s,1);
end

%sif = s-sif_sub; %perform coherent background subtraction
%sif = sif_sub; %image just the background
sif = s; %image without background subtraction
clear s;
clear sif_sub;

%**********************************************************************
%radar parameters
fc = (2590E6 - 2260E6)/2 + 2260E6; %(Hz) center radar frequency
B = (2590E6 - 2260E6); %(hz) bandwidth
cr = B/20E-3; %(Hz/sec) chirp rate
Tp = 20E-3; %(sec) pulse width
%VERY IMPORTANT, change Rs to distance to cal target
Rs = 25*.3048; %(m) y coordinate to scene center (down range), make this value equal to distance to cal target
%Rs = 0;
Xa = 0; %(m) beginning of new aperture length
delta_x = 2*(1/12)*0.3048; %(m) 2 inch antenna spacing
L = delta_x*(size(sif,1)); %(m) aperture length
Xa = linspace(-L/2, L/2, (L/delta_x)); %(m) cross range position of radar on aperture L
Za = 0;
Ya = Rs; %THIS IS VERY IMPORTANT, SEE GEOMETRY FIGURE 10.6
t = linspace(0, Tp, size(sif,2)); %(s) fast time, CHECK SAMPLE RATE
Kr = linspace(((4*pi/c)*(fc - B/2)), ((4*pi/c)*(fc + B/2)), (size(t,2)));

%Save background subtracted and callibrated data
save sif sif delta_x Rs Kr Xa;
%clear all;
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