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%%%%%%%%%%%%%%% Problem 1  %%%%%%%%%%%%%%%%%%%%%
%% 1a) read test_pattern and generate k-space
%%%% Read the test pattern
fname = 'test_pattern.png';
temp = imread(fname);
im_orig = double(temp);

% for kicks show original test image
imshow(im_orig,[]);colorbar;axis on;truesize
title('mag (original)','FontSize',14,'FontWeight','bold')

% reconstruct the image with proper k-space centering
IM_FT = fftshift(fft2(fftshift(im_orig)));

% show the magnitude of k-space
imshow(log(abs(IM_FT)),[]); colorbar;axis on;truesize
title('log(mag(IM_FT))','FontSize',14,'FontWeight','bold')
 % show the phase of the image
imshow(angle(IM_FT),[]); colorbar;truesize;axis on
title('phase(IM_FT)','FontSize',14,'FontWeight','bold')
 % For kicks: show the real channel of k-space
imshow(log(abs(real(IM_FT))),[]); colorbar; truesize;axis on
title('log(mag(real(IM_FT)))','FontSize',14,'FontWeight','bold')
 % For kicks: show the imaginary channel of k-space
imshow(log(abs(imag(IM_FT))+1),[]); colorbar; truesize;axis on
title('log(mag(imag(IM_FT)))','FontSize',14,'FontWeight','bold')

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% reconstruct the image (should take us back to where we started)
im_recon_full = fftshift(ifft2(fftshift(IM_FT)));
 % show the magnitude of the image
imshow(abs(im_recon_full),[]);colorbar;axis on;truesize
title('mag (im_recon_full)','FontSize',14,'FontWeight','bold')
% show the phase of the image
imshow(angle(im_recon_full),[]);colorbar;axis on;truesize
title('angle (im_recon_full)'','FontSize',14,'FontWeight','bold')

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%% 1b) partialM Fourier - REDUCE ky max
%%%% Now simulate reduced spatial resolution in ky
[Ny,Nx]=size(IM_FT);
IM_FT_LR = IM_FT(Ny/4+1:3*Ny/4,:);
% show the magnitude of k-space
imshow(log(abs(IM_FT_LR)),[]); colorbar;axis on;truesize
title('log(mag(IM_FT_LR))','FontSize',14,'FontWeight','bold')



% reconstruct the image
im_lr = fftshift(ifft2(fftshift(IM_FT_LR)));
 % show the magnitude of the image
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imshow(abs(im_lr),[]);colorbar; truesize;axis on
title('magnitude (im partialFour))','FontSize',14,'FontWeight','bold')
% show the phase of the image
imshow(angle(im_lr),[]);colorbar;truesize;axis on
title('phase (im partialFour))','FontSize',14,'FontWeight','bold')



%%%% 1c zero-fill to get aspect ratio right
[Ny,Nx]=size(IM_FT);
IM_FT_LR_ZF = zeros(Ny,Nx);
IM_FT_LR_ZF(Ny/4+1:3*Ny/4,:) = IM_FT_LR;
imshow(log(abs(IM_FT_LR_ZF+1)),[]); colorbar;axis on;truesize
%%% little trick here: avoid log(0) by adding 1
title('log(mag(IM FT LR ZF + 1))','FontSize',14,'FontWeight','bold')

% reconstruct the image
im_lr_zf = fftshift(ifft2(fftshift(IM_FT_LR_ZF)));
 % show the magnitude of the image
imshow(abs(im_lr_zf),[]);colorbar; truesize;axis on
title('magnitude (im partialFour zf))','FontSize',14,'FontWeight','bold')

%%%% 1d create a lowpass filtered version to reduce Gibbs ringing
%%      start with 1-dimensional Hanning windows and extend to 2D matrix

w = hann(300);
plot (w); title('Hanning window central 300 points 1-dim','FontSize',↙
14,'FontWeight','bold')
xlabel('y-position','FontSize',14,'FontWeight','bold');
xlabel('weight','FontSize',14,'FontWeight','bold');

LP_HANN = zeros(Ny,Nx);
LP_HANN(Ny/4+1:3*Ny/4,:) = repmat(w,1,Nx);
imshow(abs(LP_HANN),[]); colorbar;axis on;truesize
%%% little trick here: avoid log(0) by adding 1
title('abs(Hanning Window)','FontSize',14,'FontWeight','bold')

% reconstruct the image
im_lr_hann = fftshift(ifft2(fftshift(IM_FT_LR_ZF.*LP_HANN)));
 % show the magnitude of the image
imshow(abs(im_lr_hann),[]);colorbar; truesize;axis on
title('magnitude (im partialFour hann))','FontSize',14,'FontWeight','bold')

%%% Profile plots for comparison
%% from the original image
plot(abs(im_orig(:,306)),'k'); hold on;
%% from the partial Fourier image + zero-filling
plot(abs(im_lr_zf(:,306)),'r');
%% from the partial Fourier image + zero-filling + Hanning window
plot(abs(im_lr_hann(:,306)),'b');
title('Line Profile of column 306','FontSize',14,'FontWeight','bold')
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xlabel('y-position','FontSize',14,'FontWeight','bold');
xlabel('Signal','FontSize',14,'FontWeight','bold');
legend('original','zero-filled','hanning')

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%% 1e Reduce delta ky
[Ny,Nx]=size(IM_FT);
IM_FT_DKY = IM_FT(1:2:Ny,:);


% reconstruct the image
im_dky = fftshift(ifft2(fftshift(IM_FT_DKY)));
 % show the magnitude of the image
imshow(abs(im_dky),[]);colorbar; truesize;axis on
title('magnitude (im alternate k-y))','FontSize',14,'FontWeight','bold')




 %% Read raw data from file: 512x512, NEX = 1
in = 'RAW_512_512.mri';
Nx = 512;
Ny = 512;
IM_FT = read_raw(in,Nx,Ny,1);
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