CogSci 260: Introduction to Diffusion Tensor Imaging
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Week 4 Problem Set

Problem 1

Consider the Fourier Transform of an acquired 2D MR image that has spatial frequencies $\{-k_{x,max}, \ldots, -2\Delta k, -\Delta k, 0, \Delta k, 2\Delta k, \ldots, k_{x,max}\}$ and the similarly in y.

Problem 1a Starting from the center of the Fourier Transform of an acquired MR image, the spatial frequences increase or decrease as you move away from the origin (ie, the center point)?

Problem 1b What are the x and y resolutions of the MR image in terms of the above k values?

Problem 1c What is the x and y fields of view (FOV) the MR image in terms of the above k values?

Problem 2

Consider a localized field inhomogeneity δB_0 an EPI image that is acquired with a time τ between data samples and a time Δ between echos.

Problem 2a What is the bandwith W_x in the read direction in terms of these timing parameters?

Problem 2b What is the bandwith W_y in the blip (ie phase encoding) direction in terms of these timing parameters?

Problem 2c How far is a pixel shifted in the x (read) direction due to this field inhomogeneity in terms of the bandwidth W_x and the field of view F_x?

Problem 2d How far is the pixel shifted in the y (phase encoding) direction in terms of W_y and the field of view F_y?

Problem 2e Which shift is bigger, and why?

Problem 3

A Western movie shows a rapidly traveling wagon.

Problem 3a If the wagon wheels have 8 equally spaced spokes, and the camera captures frames at 24 frames/sec, how fast does one of the wagon wheels have to turn before it appears to be traveling backwards?

Problem 3b If a standard spin warp MRI is acquired with a phase encoding step every 100 ms and there is a large cylindrical blood vessel perpedicula to the plane of the slice that alters the brightness of its MR signal with a period of 200ms, where does the blood vessel appear to be in the final image?