

Magnetic Resonance Imaging

Lecture 3; Section 4: Random motion artefacts

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Section 4

Random motion artefacts

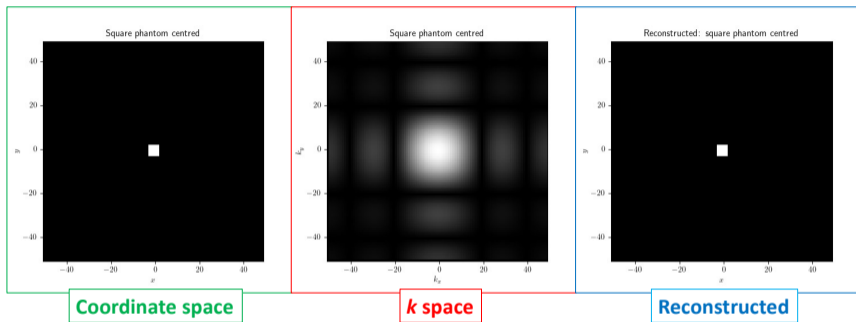
Motion artefacts; general comments

Motion artefacts most commonly observed in the phase-encoding direction

This is because:

- Motion along any field gradient results in the abnormal integration of phase, which is then incorrectly mapped onto the phase-encoding direction
- Frequency encoding is performed while G_x gradient pulse is on; typically for around 10 ms. Only very modest displacements can occur in such a short time. The result is that random displacements in the frequency-encoding direction lead to blur
- By contrast, displacements due to motion can build up between phase-encoding pulses, G_y , as these occur at intervals of TR ... and TR can range from, e.g. 500 ms to a second or so

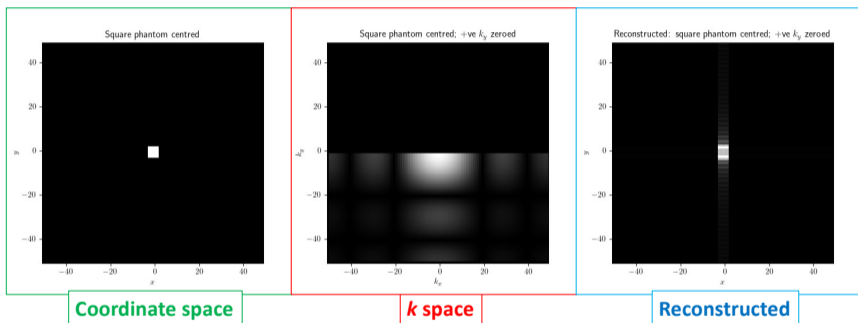
Square phantom at the centre of the field in coordinate space



Fourier transform of a 2D real function yields is Hermitian, so, component at k_i is the complex conjugate of the component at $-k_i$.

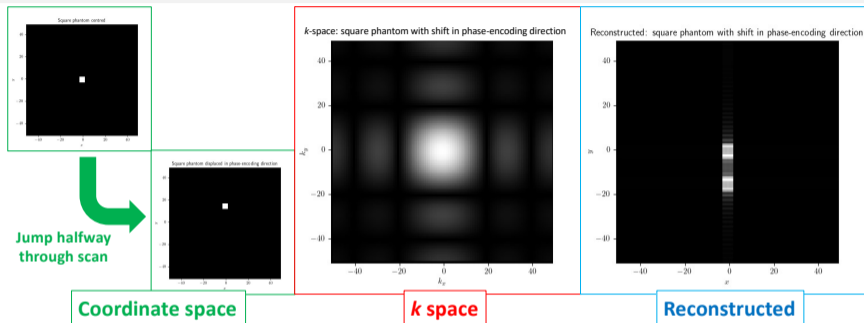
This means there is no information in quadrant $(-k_x, -k_y)$ that is not in quadrant (k_x, k_y) and the information content of quadrants $(-k_x, k_y)$ and $(k_x, -k_y)$ is the also the same

Loss of half of phase-encoding in k space



Loss of information in “second half” of phase-encoding cycle leads to loss of definition/banding in the phase-encoding direction

Effect of sudden displacement in phase-encoding direction

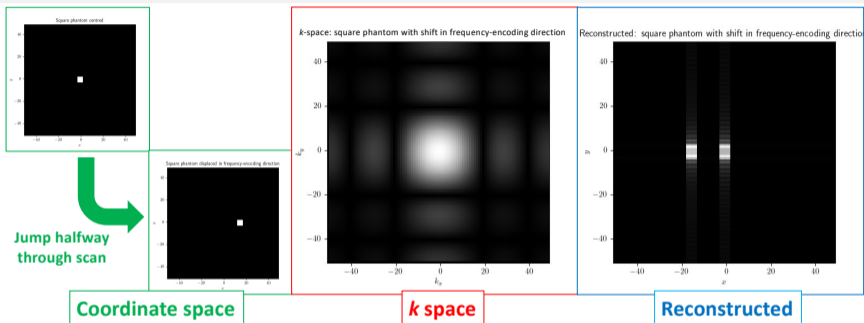


Consider that square phantom jumped as shown halfway through the cycle

The “bottom half” of k -space arises from the original position, the “top half” from the new position

The result multiple images and ghosting in the phase-encoding direction

Effect of sudden displacement in frequency-encoding direction

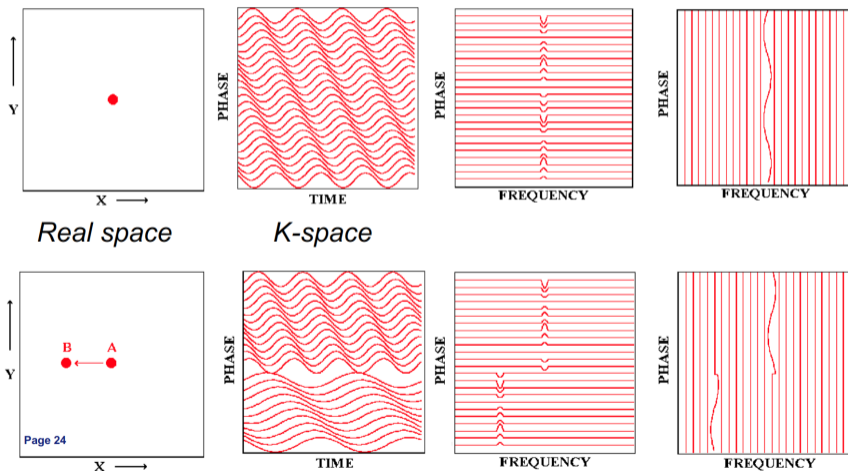


Consider that square phantom jumped as shown halfway through the cycle

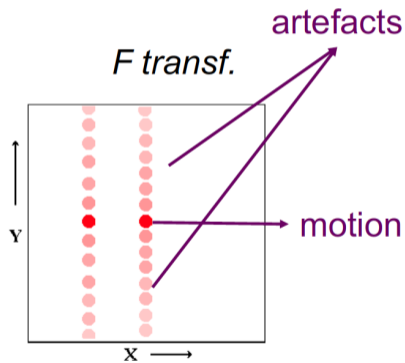
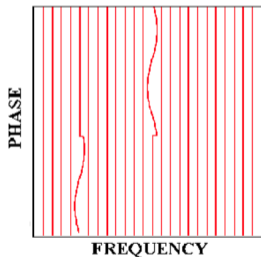
Again, the “bottom half” of k -space arises from the original position, the “top half” from the new position

The result multiple images and ghosting in the frequency-encoding direction

Another way of looking at displacement along the frequency-encoding direction

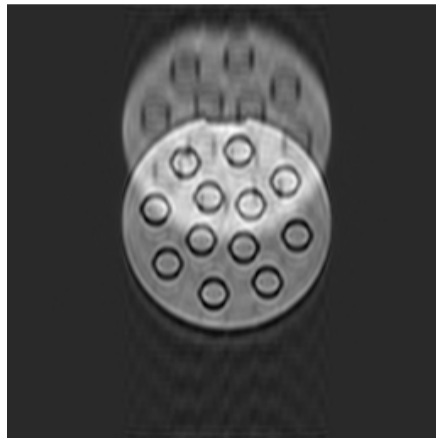


Another way of looking at displacement along the frequency-encoding direction



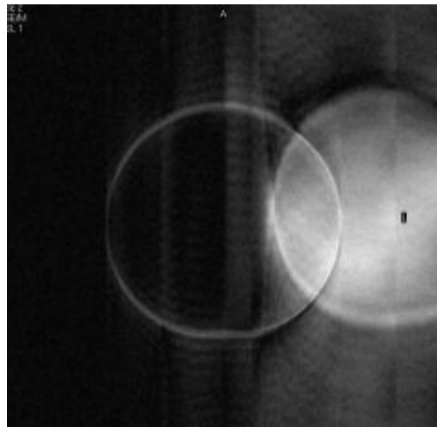
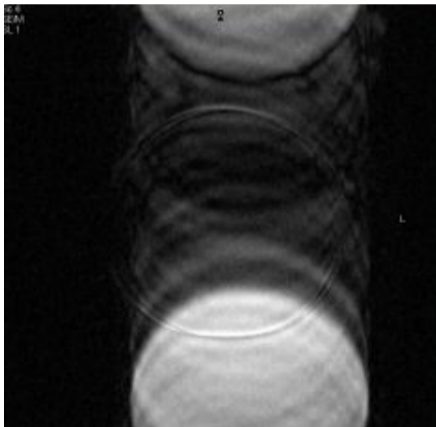
Displacement artefacts: questions 1

What causes the artefacts seen in the following images?



Displacement artefacts: questions 2

What causes the artefacts seen in the following images?



Summary of section 4

Random motion causes:

- Since frequency-encoding happens rapidly, most often motion in frequency-encoding causes blur
- Gross sudden movements in frequency-encoding direction can lead to multiple images and ghosting
- Phase encoding builds up over many cycles, so, motion in phase-encoding direction often leads to multiple images and ghosting