



In-vivo MRI Radiofrequency Pulses Robust against Respiration Induced Errors (20140236, Dr. Kamil Ugurbil)

Technology No. 20140236

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MRI Errors from Physiological Motion during Respiratory Cycle

Radiofrequency (RF) pulses for in-vivo magnetic resonance imaging (MRI) are prone to errors due to physiological motion of organs in the torso during the respiratory cycle. Two different strategies mitigate these errors and obtain solutions robust against respiratory changes within an imaging scan or between different scans. Both methods require calibration scans (B1+ and DeltaB0 maps) performed at three different respiratory positions (exhale, half-inhale and inhale). Each calibration scan is acquired together with a navigator scan capable of measuring the actual position of the diaphragm, which determines the phase in the respiratory cycle.

1. **B1+ shim solution obtained simultaneously from three scans.** This strategy obtains a B1+ shimming solution (or designs a pTX RF pulse) from simultaneously using the calibration scans obtained for the three respiratory positions.
2. **B1+ shim solution calculated individually from each scan.** This strategy calculates an individual B1+ shim solution (or pTX RF pulse) for each of the three respiratory positions. Prior to the final imaging scan, a fast navigator scan determines the current respiratory position and then applies the B1+ shim solution (or pTX RF pulse) corresponding to this measured navigator position for the subsequent acquisition.

Temporal Variations of Deltab0 and B1+ Maps

MR scanners operating at a higher main magnetic field strength (B0) provide higher signal-to-noise ratio (SNR) and better acceleration performances in parallel imaging techniques, allowing for higher spatial resolution images and/or shorter acquisition times. Higher magnetic fields also provide stronger tissue contrast in a variety of applications. Despite these advantages, physiological motion during higher B0 scans can alter DeltaB0 and radio-frequency field (B1+) maps, which can lead to significant image artifacts (e.g., shading), and is

one of the main reasons higher fidelity 3T MR scanners are not used more often for body imaging. In addition, most torso imaging requires breath-holds rather than free-breathing, which increases scan time and difficulty for the patient. This new technology focuses on organs in the torso subject to motion during the respiratory cycle, resulting in temporal variations of DeltaB0 and B1+ maps. Besides cardiac imaging, this approach may enhance liver imaging and pediatric imaging as well. This technology can be readily implemented on clinical scanners with minimal impact on scan time.

BENEFITS AND FEATURES:

- Robust against errors from physiological motion during respiratory cycle
- B1+ shim solution obtained simultaneously from three scans or calculated individually from each scan
- MR scanner or software upgrade
- Improved cardiac imaging/diagnostic capabilities
- May enable 3T scanners to be used widely for cardiac imaging, which would improve diagnostic capabilities due to higher fidelity images
- Allows free-breathing torso imaging; improved patient comfort and faster scan times
- Cardiac imaging, liver imaging and pediatric imaging

APPLICATIONS:

- Magnetic resonance imaging (MRI)
- Multichannel transmit MRI
- Parallel transmit MRI
- Cardiac MRI
- Imaging areas susceptible to physiological motion (e.g., cardiac imaging, liver imaging, pediatric imaging)
- MR scanner or software upgrade
- Imaging at 3T, 7T and beyond
- MRI of cardiac anatomy and function
- MR angiography of coronary arteries and aorta
- Cardiac MR spectroscopy
- Periodic changes that impact spatial B1+ and DeltaB0 distributions, such as cardiac motion or pulsatile blood flow

Phase of Development - Prototype development; Pilot Scale demonstrated

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