Prospective Cardiac Motion Self-Gating Technique for Magnetic Resonance Imaging

SUMMARY

UCLA researchers from the Department of Radiology have developed a novel method for accurate and robust cardiac motion self-gating in magnetic resonance imaging without the need for electrocardiograph gating.

BACKGROUND

In cardiac magnetic resonance imaging (MRI) applications, electrocardiograph (ECG) is the current clinical gold standard used to monitor the cardiac motion and provide the synchronization (gating) signal to the imaging system. However, the ECG-gated signal is problematic in several aspects: (1) the ECG signal is often interfered by the strong and fast varying magnetic field of the MRI scanner, thus corrupting the synchronization, leading to unsuccessful imaging; (2) additional time is required to setup the ECG monitoring system, increasing the cost of cardiac MRI scans; and (3) ECG-gating is unstable for some patient populations (e.g. patients with abnormal chest or cardiovascular geometry) and inaccessible for fetal cardiac scans.

Current self-gating cardiac MRI techniques are limited by extended acquisition time or limited to only radial acquisition, which is susceptible to eddy-current induced image artifacts. In addition, current techniques are retrospectively gated, which requires copying data to a separate computer for post-processing in order to get the image.

INNOVATION

Researchers from UCLA’s Department of Radiology have developed a novel technique for prospective cardiac self-gating to be incorporated in standard cardiac MRI pulse sequences capable of real-time image acquisition. The technique combines a modified cardiac MRI pulse sequence running on the scanner and real-time signal processing software running on the online image reconstruction computer, and is thus easily implementable on any commercial MRI system without the need for additional hardware. The self-gating technique utilizes machine learning to process the self-gating signal from multiple coil arrays to better estimate the cardiac motion in real-time. By utilizing prospective self-gating, this method reduces setup time for cardiac MRI patients, avoids interference from the magnetic field, and has the capability of acquiring cardiac cine images on previously inaccessible populations segments (patients with abnormal chest or cardiovascular geometries and fetal patients).

APPLICATIONS

- Cardiac-gated MRI
- Fetal cardiac imaging
- Respiratory-gated MRI
- Cardiac-respiratory-dual-gated MRI

ADVANTAGES

- Reduced setup time for cardiac MRI patients
- More efficient and less expensive cardiac MRI scans
- Avoids interference by the magnetic field of the MRI scanner
- Compatible with high field MRI (7 Tesla scanners)
- Capability to conduct high quality time resolved fetal cardiac MRI scanning
- Prospectively gated sequence allowing for better image efficiency and real-time acquisition

STATE OF DEVELOPMENT

Working prototype is currently available on a Siemens MRI Imaging System. Method of the invention has been validated in a preliminary study containing 4 volunteers providing cardiac CINE images of similar quality to ECG-gated ones.

PATENT STATUS

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ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

▶ Improved Cardiac Late Gadolinium Enhancement MRI for Patients with Cardiac Devices
▶ High Spatial and Temporal Resolution Dynamic Contrast-Enhanced Magnetic Resonance Imaging
▶ A Novel MR Angiography Technique
▶ An Accelerated Phase-Contrast MRI Technique
▶ An Improved Phase-Contrast MRI Technique