Absolute Temperature Measurement Using Magnetic Susceptibility MRI

Technology #2018-474

Magnetic resonance imaging (MRI) is a widely used tool to generate detailed images of diverse body parts including organs, soft tissue, and bone. Quantitative parametric MRI enables comparison of images across multiple sites, greater objectivity, and application of sophisticated analysis techniques such as artificial intelligence and deep learning. Quantitative parametric imaging requires calibration and validation of MR scanners with a quantitative calibration standard (aka “phantom”) in order to compare images across different timepoints and at different institutions.

Even with an appropriate phantom, there are still challenges because the values of most parameters being mimicked by the phantom (T1, T2, diffusion, CEST effect, MT ratio) are a function of temperature. This means that accurate knowledge of temperature is critical for the calibration process. Current techniques are either not sensitive enough in typical clinical instruments (e.g., proton shift technique) or are so sensitive that calibration must be performed in spectroscopy mode – a highly unsatisfactory practice for most clinicians.

Absolute Temperature Measurement Using Magnetic Susceptibility MRI

This technology uses a thermometer comprised of paramagnetic ions to accurately determine the temperature in MR imaging based on bulk magnetic susceptibility. The technique provides temperature estimates as measured using a methyl resonance shift of 0.09 ppm/°C, providing an accuracy of ± 0.15 °C. Notably, this yields sub-degree temperature measurements, which are critical to the success of most quantitative imaging techniques. Ultimately, this will permit more accurate estimation of multiple parameters involved in parametric quantitative imaging, a critical need for this rapidly growing industry.

Applications

· MRI phantom for temperature measurement

· Calibration for quantitative parametric MRI

Advantages

· Sub-degree accuracy, precise

· Suitable for clinically relevant instruments (i.e., magnet strengths)

· Does not require utilization of spectroscopy mode (in contrast to the Tm-DOTMA technique)

Inventors

Scott D. Swanson, PhD