New Approach to Spatial Encoding in MRI Can Greatly Reduce Scan Time

New Haven, CT: Two researchers at Yale University have developed an approach to dramatically reduce the amount of time it takes to obtain a Magnetic Resonance Image (MRI). While traditional MRI uses many lines of data, each acquired under a static magnetic field that varies linearly in space, this work used dynamic and curved magnetic fields to encode an entire image with a single line of data. The work, by Todd Constable and Gigi Galiana, both in Diagnostic Radiology in the School of Medicine, allows a complete image to be obtained in approximately 4ms. This could enable better temporal resolution for cardiac and fMRI applications, and most importantly reduced exam times for standard clinical MRI.

Unlike CT or X-ray scanning MRI has traditionally been quite slow because the data for an image is acquired line-by-line and anywhere from 64 to 512 lines of data are needed for a high quality clinical MR image. Typical study times for a clinical exam are on the order of an hour, with individual scans requiring several minutes.

In a paper published in PlosOne (http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0086008) by Yale University scientists, a new approach is presented that allows a complete image to be obtained from only a single line of data that can be acquired in less than 10ms.

The technique abandons the traditional Fourier transform based encoding method that is the most common encoding method on modern scanners today, and instead approaches spatial encoding as a general linear model. From this perspective, the researchers sought methods that assigned a unique code to each voxel in an image such that only a single line of data is needed to form an image.

“We endeavored to develop a technique wherein each pixel in an image is assigned a unique model signature,” says Dr. Constable. “The encoding is designed in a manner that ensures any non-unique codes are well separated spatially such that parallel receiver arrays can distinguish these components.”

The approach is general and can be applied to any imaging sequence or any contrast mechanism. At this time however most MR imaging systems cannot generate the curved magnetic fields required to perform acquisitions this rapidly and these gradient field capabilities need to be built into the next generation of magnets.

“Such accelerations in spatial encoding in MRI may shorten study times for patients increasing comfort, increasing throughput, leading to decreased cost and increased accessibility of MRI,” says Dr. Constable.

The unprecedented temporal resolution achievable with this approach may open up new applications in diagnostic MR and enhance existing dynamic studies such as perfusion, or cardiac imaging applications. Fast scan times may also reduce the need

for sedation of patients in pain and/or of children who can't stay still long enough for conventional MR imaging studies and may also expand the use of MRI in emergency medical situations.

Program Area: Diagnostic Radiology, Magnetic Resonance Imaging, Engineering, MR physics, ultra-fast MRI, parallel imaging.

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