From Pulse Sequence to Clinical Applications in the Brain / Fast & Super-Fast Imaging

Daniel K. Sodickson, MD, PhD Daniel.Sodickson@med.nyu.edu

Highlights

- Imaging speed is a primary concern whenever time is of the essence – in other words, in nearly all branches of clinical and research imaging.
- The tools of the trade in rapid MR imaging have traditionally included streamlined pulse sequences, high magnetic fields, strong and rapidly-switching field gradients, many-element RF coil arrays, and appropriately tailored image reconstruction algorithms.
- Increasingly, we are moving into an era characterized by three additional tools: incoherent acquisitions, sparsity-enforcing image reconstructions, and efficient uses of dynamic information.
- Combinations of compressed sensing, parallel imaging, and robust continuous acquisition strategies are poised to play an important role in defining a new paradigm of efficient and information-rich imaging.

Title: Fast & Super-Fast Imaging

Target audience: Clinicians and basic scientists interested in the operation and application of rapid imaging techniques

OUTCOME/Objectives: To review the history and basic principles of rapid MR imaging, and to highlight emerging trends and promising new applications

PURPOSE: This presentation will review recent advances in rapid magnetic resonance imaging, in historical context and with an eye towards how these advances promise to change the way day-to-day imaging is performed and interpreted.

METHODS: Particular emphasis will be placed on the burgeoning new field of compressed sensing for rapid medical imaging. In essence, compressed sensing represents a form of "pre-compression," which allows dramatic reductions in the number of data points required to generate a complete image. Rather than devoting precious scan time to the acquisition of a traditionally defined complete dataset in order to create images whose inconsequential features would only be discarded by a faithful image compression algorithm, compressed sensing techniques take advantage of the knowledge that nearly all images in medicine (and, for that matter, in nature) may be faithfully represented by a number of parameters smaller than the number of voxels. This knowledge, combined with appropriate irregular sampling and nonlinear reconstruction strategies, enables reconstruction of images from highly undersampled, and hence highly accelerated, datasets. Unlike other constrained or model-based image reconstruction approaches, compressed sensing techniques do not ever presuppose which are the most important image features, and they can therefore be remarkably successful in preserving true image content in a largely unbiased fashion.

RESULTS: In the presentation, basic principles of compressed sensing will be reviewed, productive combinations with parallel imaging in suitable detector arrays will be discussed, and various practical methods and applications (in neuroimaging and elsewhere) will be surveyed.

DISCUSSION AND CONCLUSION: The presentation will conclude with an exploration of how, in addition to providing access to new spatial and temporal scales, modern rapid imaging techniques such as compressed sensing may change the way clinicians and researchers look at images, and may even require re-evaluation of what we mean by an "image."