

MR Systems Engineering/Overview of the MRI System

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Highlights:

- A modern MRI system can be designed from the patient outwards.
- The RF and DAS subsystems have undergone the largest evolutionary steps in recent years.
- There are many more considerations in the design of a MRI system beyond the MRI physics.

Target audience:

Engineers, physicists, clinicians and anyone interested to understand the fundamental building blocks of a clinical MRI system, how they fit together, the rationale behind the requirements, the constraints and the present state-of-the-art.

OUTCOME/Objectives:

Provide a broad overview of the system architecture, subsystems and design constraints for a modern clinical MRI system.

METHODS:

A traditional overview of the MRI system typically starts with the magnet. This is understandable both from the pure NMR perspective, B₀ being one of the fundamental enablers for MRI, and the hardware cost perspective. The magnet is typically the most expensive component of an MRI system. However, as MRI has matured as a technology, and proliferated as a clinical imaging modality, the boundary conditions that define a modern clinical MRI system have expanded to include aspects of the patient, the operator and other clients (e.g. site environment, hospital network, PACS, service & maintenance etc.). The advancements in the technology and cost optimization of the many components of a modern MRI system mean that, in many cases, the requirements towards the patient, operator and other clients take greater priority. In simple terms, the magnet is no longer the primary starting point for a MRI system architecture. This review will approach the subject of "Overview of the MRI System" from the patient outwards.

RESULTS:

The "inside-out" starting points for design of a modern clinical MRI system are the space occupied by the patient, the workflow around handling the receive coils and peripherals on the patient, the clinical application requirements on various aspects of the involved magnetic fields, the data acquisition/management requirements and the economic requirements of installing, maintaining and operating the system. Patient and operator safety are leading in all relevant boundary conditions.

DISCUSSION/CONCLUSION:

The attributes that define a modern clinical MRI system go far beyond its ability to produce an MR image. Patient comfort, ease of use, technology maturity and cost are just a few of the parameters to be balanced together with constant improvements in functionality, reliability and robustness. The need to deliver robust and meaningful clinical performance, in the context of these requirements, has driven much of the system level innovation in recent years.

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