# Joint reconstruction of image and motion in MRI

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MRI is a relatively slow imaging technique consisting of a sequential acquisition of Fourier samples from the imaged subject. Despite recent advances in accelerated MRI, high resolution 3D and dynamic MRI still often necessitate minutes of acquisitions. Patient motion (breathing, heart beating...) is therefore an issue especially in cardiovascular and body application.

The problem of image reconstruction from motion corrupted data can be formulated as a joint optimization problem whereby both the image and the motion are unknown [1] :

$$\min_{(\rho_0,u)} \|E(u)\rho_0 - s\|^2 + \mu\, R(u), \tag{1}$$

with $s$ the acquired data (called k-space), $E$ the forward model describing the MRI acquisition process, $\rho_0$ the motion-corrected image (in some reference motion state) and $u$ the displacement fields at each k-space sample time; $R(u)$ is a regularizer, e.g. $R(u) = \|\nabla u\|^2$.

In this general form the problem is highly underdetermined. Strategies to make the problem more tractable will be described in this presentation, including: i) parameterization of the displacement fields $u$ using motion sensor signals as a prior knowledge (separation of space and time variables in $u$) [1] ; ii) parameterization of the displacement fields using a spatially adaptive mesh (dimensionality reduction) [2]. A method for solving problem (1) under such constraints will be described based on alternating optimization and using a multi-resolution implementation in order to allow large displacements to be estimated. Various applications and extensions of this framework will also be presented [3]–[5].

## References

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