Signal-to-noise measurement methods in MR imaging

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Purpose

The aim of this educational poster is to provide an overview of the different methods available for to measure signal-to-noise ratio (SNR) in MR images, their applicability and their pitfalls. It provides advice on which methods to use in common applications.

Outline of content

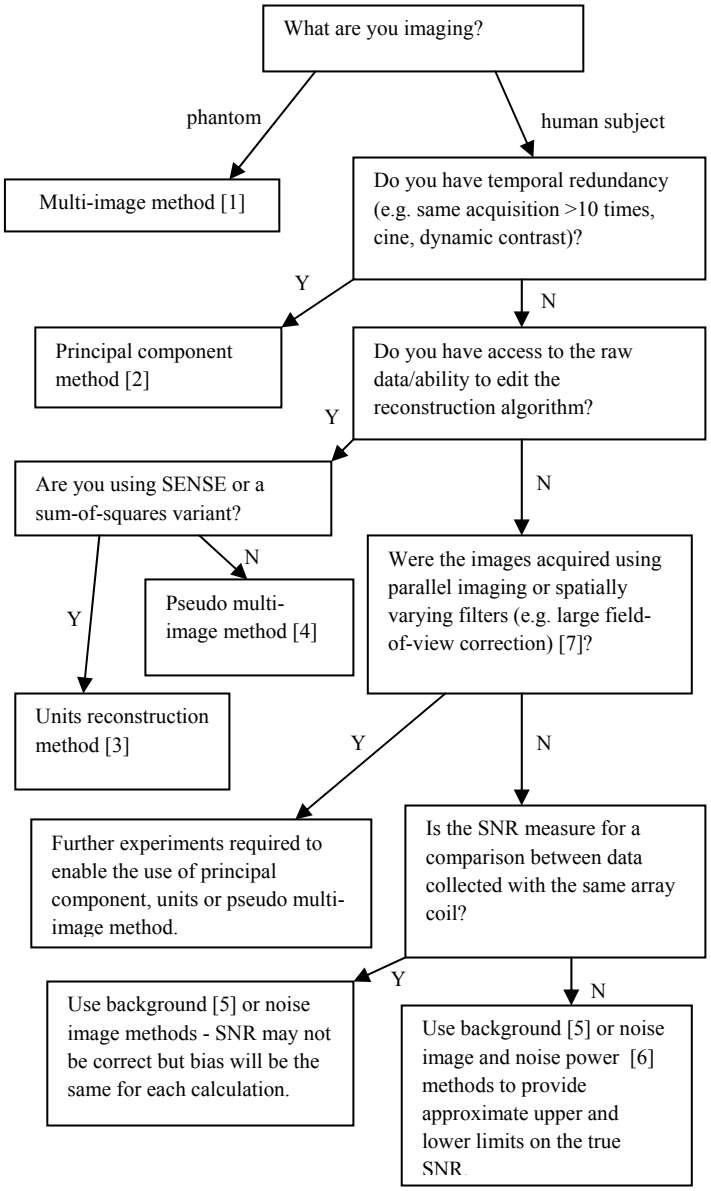
There are myriad SNR methods available in MRI, of varying levels of complexity in terms of implementation and interpretation. The flowchart on the right demonstrates the situations in which the main methods discussed in this poster might be useful.

Multi-image methods involve acquiring two or more successive images [1]. In the case of two images, the difference provides an estimate of the noise over a region of interest (ROI). In a longer time-series, the standard deviation of each pixel, along with its mean, can be used to produce an SNR map.

This approach can be extended to in vivo imaging by the use of principal component analysis and the Marcenko-Pastur distribution, as discussed by Ding et al. [2]. If access to the reconstruction code is available and a noise sample has been acquired, then (depending on the reconstruction method) a units reconstruction [3] or pseudo multi-image approach [4] can be used.

The common approach to SNR involves using a background ROI and applying a correction factor which depends on the number of channels [5]. This can also be carried out by acquiring a noise-only image with the subject still in the scanner, if there is no artefact-free background region. Note that this assumes a perfect array with no correlations between elements and identical noise in each. In practice this is not generally true, and calculating the SNR using a noise power method can give an upper bound as it neglects the impact of correlations between channels on the SNR [6]. Background and noise-only image SNR methods require a consistent noise distribution across the image, a condition which is not fulfilled in the case of parallel imaging or some reconstruction filters [7].

In all methods there is a bias at low SNR when using a magnitude reconstruction. This can be overcome using iterative algorithms [8] or by using a look-up table to correct the measured SNR [3,7].



Summary

The choice of an appropriate SNR method in MRI can be challenging but there are appropriate methods available in most situations.

References

[1] Reeder et al. MRM **54** 748. [2] Ding et al. MRM **63** 782. [3] Kellman & McVeigh MRM **54** 1439. [4] Robson et al. MRM **60** 895. [5] Gilbert JMRI **26** 1678. [6] Constantinides et al. MRM **38** 852. [7] Dietrich et al. MRI **26** 754. [8] Koay & Basser JMR **179** 317.

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