New fast MRSI acquisition method based on an irregular spiral k-t sampling and its application to in vivo spectroscopic imaging of phosphorus metabolites

Proposed Approach

- Implementation of spiral sampling:
  - Spiral encoding in MRSI: one temporal point acquired for each k-space
  - Spatial and temporal interleaving in order to sample the k-space and the spectroscopic signal with the desired spatial and temporal resolution (Fig. 1).

- New spiral acquisition method based on a temporal under-sampling with a known sparse support spectrum

- Temporal under-sampling Decreases of the SNR

- Sparse reconstruction by Least-Square (LS) and noise minimization using Sequential Backward Selection of the samples (SBS)

- Role of the Sequential Backward Selection of the samples (SBS) [3]: minimize the noise amplification

  \[
  E(\| \mathbf{x}_{\text{b}} - \mathbf{x}_t \|^2) = \sigma^2 \text{tr}((\mathbf{A}^* \mathbf{A})^{-1})
  \]

- Acquisition parameters
  - Anatomic image : T2 fat sat, spatial resolution 256*256, FOV 40 cm
  - Spectroscopic image : CSI 32*32 with the phase encoding method, FOV 25cm, length time of 35minutes: data used for numerical phantom simulation, with spiral sampling

Results

- Signal Reconstruction to Error Ratio (SRER) (std noise 10% PCR)

  \[
  \text{SRER} = 20 \log_2(\frac{|| \text{original spectrum} ||_2}{|| \text{reconstructed spectrum} ||_2})
  \]

- Acquision time reduced by a factor 2

Discussion and Conclusion

- New fast irregular acquisition method with the use of Compressed Sensing demonstrated with a Least Square reconstruction and the SBS algorithm

References


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