**Echo Planar Imaging Nyquist Ghost Correction using Structured Low-Rank Matrix Modeling**

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**Introduction**

Echo Planar Imaging (EPI) is an ultrafast imaging technique used in different MRI applications:
- Diffusion Imaging
- Neurofunctional brain mapping
- Cardiac Imaging

Multiple lines of data are acquired alternately at a high speed ⇒ Misalignment between lines

<table>
<thead>
<tr>
<th>Ideal</th>
<th>Real</th>
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<tbody>
<tr>
<td>2k_1</td>
<td>2k_2</td>
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<tr>
<td>2k_3</td>
<td>2k_4</td>
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</tbody>
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**Proposed method using the LORAKS framework**

Fourier data is separated and two channels are reconstructed. There exists a correlation between channels!

LORAKS missing entries are filled using structured low-rank matrix modeling and side information

Two reconstructed images (different phase)

Final image after combination of two channels

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**LORAKS using side information**

- Low rank modeling of local k-space neighborhoods (LORAKS) is a powerful MRI reconstruction framework
- K-space data (Fourier domain) is carefully embedded in Toeplitz/Hankel matrices
- Based on MR images typical characteristics it can be proven that these matrices are low-rank! [1,2]

\[ \hat{k} = \arg \min_k J_f (C(k) \lambda_c C(k_{ACS}^c)) + \lambda_s J_f (S(k)) \]

s.t. strict data consistency

A nonconvex low-rank matrix recovery problem is solved

Ill-posed problem if side information is not used [3]

Robust method against possible imperfections in the side information

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**Brain Multi-coil EPI data**

Data acquired with multiple coils and highly accelerated (1 sampled line every 6 lines)

ACS (RO⁺) ACS (RO⁻) Uncorrected DPG MUSSELS Proposed

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**Cardiac Multi-coil Unaccelerated EPI data**

ACS (RO⁺) ACS (RO⁻) Uncorrected DPG MUSSELS Proposed

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**Conclusion**

- LORAKS using side information is a powerful approach to EPI ghost correction
- Broadly applicable across a range of different application contexts
- Successful results where conventional methods frequently fail (e.g. accelerated data, cardiac imaging)

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**References**

1. Haldar, IEEE TMI, 2014
3. Lobos et al., ISMRM, 2017
4. Lobos et al., arXiv: 1708.05095, 2017