

Magnetic Resonance in Medicine - Decision on Manuscript # MRM-22-23039

Date: Tue, 5 Jul 2022 20:18:35 +0000 (05.07.2022 22:18:35)

From: Magnetic Resonance in Medicine <onbehalf@manuscriptcentral.com>

Reply-To: mrm@ismrm.org

To: mrm@ismrm.org

05-Jul-2022

Dear Author(s):

We write you in regard to the manuscript # MRM-22-23039 entitled "Stack-of-Radial Echo Planar Imaging with Locally Low Rank Regularized Subspace Reconstruction for Fast High-Resolution Brain MRI," which you submitted to Magnetic Resonance in Medicine.

Your manuscript has been reviewed by Referees who are knowledgeable about this topic. Unfortunately, in view of the overall comments and scores found below, we must reject your manuscript at this time. Despite raising a number of major issues, the Referees did find value in your manuscript and provide guidance about how it can be improved. Consequently, if you can provide a substantially revised manuscript that addresses the concerns of the Referees and Editors, we invite you to resubmit this work to Magnetic Resonance in Medicine. In order for the resubmitted manuscript to be acceptable for Magn Reson Med, however, some of its scores will need to improve significantly. Additional explanation is provided in the editorial comment below.

The resubmission would be treated as a new manuscript and receive a new submission date. Please reference the current manuscript number MRM-22-23039 in your cover letter. In general, the resubmission may be reviewed by the same Referees. Please resubmit your manuscript without revision markings. Instead, we ask that you provide a point-by-point response to the Referees in a separate file, and submit that file as supplemental material for review. We should mention that as an alternative to a resubmission to Magnetic Resonance in Medicine, at this time you are free to submit your work to a different journal instead, should you prefer.

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Thank you for considering Magnetic Resonance in Medicine for the publication of your research.

Sincerely,

Joshua Trzasko, Ph.D., Deputy Editor
Peter Jezzard, Ph.D. (he/him), Editor-in-Chief

Magnetic Resonance in Medicine
mrm@ismrm.org

Editor's Comments to the Author:

Thank you for submitting to Magn Reson Med. Apologies for the delay in getting you a review outcome. Your paper was sent initially to two expert referees, but their opinions on the merits of the paper diverged. We therefore needed to recruit a 3rd arbitrating referee, which delayed the review process for which we apologise. Ultimately, I am afraid, the third reviewer also recommends rejection of the paper. Overall, I regret that we cannot proceed with the current paper. However, we would allow a future resubmission if you wished to undertake the considerable work outlined by the reviewers, but we will need to see a substantial improvement in reviewer enthusiasm and accompanying scores. Alternatively, you would be at liberty at this juncture to submit elsewhere.

Deputy Editor: Trzasko, Joshua

Comments to Author:

Thank you for submitting your work to MRM. As previously noted, given a discrepancy in the original two reviewers assessment, a third arbitrating reviewer was brought in. Unfortunately that reviewer expressed concerns in line with Reviewer 1, toward that the manuscript is in need of improved motivation and result quality (to justify technique). This said, all three reviewer noted the work as "interesting" and of potential interest to MRM readership. Although addressing these concerns will require significant modification -- such that this current version can no longer be considered for publication -- we would welcome a revision which thoroughly addresses the reviewer concerns as a New Submission. At that time, we would expect these highlighted areas to be remedied and overall scores raised closer to the average journal acceptance rate (4.0). Of course, you are also free to submit this paper to another journal at this stage.

Referee(s)' Comments to the Author:

Referee: 1

Comments to the Author

This work proposed a modified volumetric radial EPI acquisition (stack-of-radial) with subspace reconstruction for efficient volumetric imaging. Although the innovation of this work is moderate, focusing on the optimization of the radial EPI encoding and its combination with the subspace reconstruction, the content could be of interest to MRM readers. However, two major limitations of this work are: i) the lack of clear motivation and advantage of the work compared to previous radial and Cartesian methods, and ii) the quality of the results/images is relatively

low with strong image artifacts that should be further improved. Please see below for more detailed comments.

1. The motivation of the proposed method is not very clear. One advantage of radial EPI is that it's more robust to distortion, however, the efficiency of the proposed radial EPI for fMRI or dMRI is not high, as the >1 minute acquisition is not fast compared to multi-shot EPI or other non-Cartesian trajectories such as spiral. For fMRI or dMRI, a much shorter volume TR (much less than 1 minute) is needed. Please clarify the purpose/advantage (distortion, motion, or efficiency?) and appropriate application of the approach in introduction and discussion.

2. There are other variants of volumetric radial EPI, which can be efficient with small echo spacing/blip size, such as 3D hybrid radial-Cartesian sampling scheme (Graedel, Nadine N., et al. MRM 2017) or 3D planes-on-a-paddlewheel (Stäb, Daniel, et al. NMR in Biomedicine 2017). What is the advantage of the proposed trajectory compared to these radial EPI methods?

3. The structure of the 2nd paragraph could be further improved. For example, one motivation of using EPTI is distortion free which is not clearly described, and the citation of 3D EPTI is not accurate here. Also, at the end of this paragraph the author mentioned shot-to-shot B0 variation in cartesian sampling, how does the proposed method address potential shot-to-shot B0 variation compared to EPI or EPTI?

4. The subspace method used in this work models the B0 phase evolution with a large number of subspace bases, avoiding the need of reference scan, however, leading to sub-optimal conditioning. The author mentioned the image quality could be further improved by including proper reference scan. Please consider compare the reconstruction with and without reference scan to show if a reference scan is helpful to improve the image quality.

5. Following the last comment, the results shown in the work still contain substantial image artifacts, and the image quality is not very satisfying compared to the previous radial EPI works. Further optimization of the methods and results (such as reference scan, reconstruction parameters) is recommended.

6. The lack of fat saturation could be a source of artifacts since the high frequency cannot be reconstructed well by the subspace model. Please consider include fat-saturation to improve the image quality and investigate if fat-saturation is necessary for the sequence (inversion recovery or CHES), or include more discussion about this point considering the space limit.

7. More results to compare the image quality to other radial or Cartesian EPI methods at same spatial resolution and acquisition time is recommended, including SNR, resolution, level of artifacts, and geometric distortion.

8. It's hard to evaluate the quality of the phase maps in Figure 5, a different color map and tissue phase map or SWI would help.

Referee: 2

Comments to the Author

The Authors present a stack-of-radial echo planar acquisition combined with a linear subspace reconstruction with locally low-rank regularization. I consider this to be a very good example of a trend in MR toward combining advanced acquisition and reconstruction techniques to push the boundaries of MR technology. The findings are impressive, with the technique achieving whole-brain coverage at 1 mm isotropic resolution in 1.3 minutes. The explanation of how the subspace method interfaces with the technique are insightful.

I recommend acceptance with minor revision.

Comments:

1) The signal model presented in Equation (1) is noise-free, whereas the objective in Expression (3) includes data fidelity and regularization terms implying noise-contaminated measurements. I recommend updating Equation 1 to include noise.

2) In Figure 1(B), 15 coefficients were used respective to the 50 Hz dictionary to attempt matching of the 100 Hz case, whereas Figure 1(A) indicates 21 coefficients were required for 100 Hz to achieve tolerance. Readers unfamiliar with the technique may ask whether more coefficients from 50Hz could represent the 100 Hz dictionary. Explaining that work for Figure 1(B) followed tolerances set for work in Figure 1(A) should rectify this.

3) Regarding LLR, there are foundational works additional to References 22 and 23 which should be cited, e.g. archive.ismrm.org/2011/4371.html or DOI 10.1109/TSP.2013.2270464. At least some more information (~one sentence) should provide details of the LLR implementation beyond indicating use of soft singular value thresholding (thus LLR as a proximal operator). Were blocks (of what dimensionality?) overlapping (maximally or partially) and then averaged, or non-overlapping but cycled?

4) There are several examples of writing which in my opinion impede technical exposition. Examples:

-Line 9 of Abstract in Methods: do you mean "flow flip angle," or "low flip angle" ?

-Line 48 in 'Linear Subspace Reconstruction: "there different slices" or "three different slices" ?

-Line 59: "cerebral venous" or "cerebral vasculature" or "cerebral vessels" ?

-Line 7 of Discussion: "Adequate number of subspace coefficients presents accuracy approximation of the MGRE signal." What?

-Please capitalize the first letter of the first word in the second sentence of line 38.

-Line 56, "logic" or "logical" ?

Referee: 3

Comments to the Author

The authors propose a combination of 3D stack-of-stars sampling with a radial EPI in-plane acquisition in order to provide volumetric, fast, and high-resolution brain imaging. The reconstruction of this type of data is carried out using an iterative subspace approach which requires a pre-designed dictionary and exploits local low-rank constraints. Even though the paper provides a methodology which might be interesting for MRM readers, there are important issues that should be improved for this paper to be published. Please find my major and minor comments below.

Major comments:

1) The main issue for this reviewer is the low-quality of the results shown in Fig. 5. In this reviewer opinion these images should represent one of the main results by showing how successful the proposed methodology is. However, these images show severe streaking artifacts which are not explained nor analyzed in detail. The authors only provide a vague hypothetical solution in the Discussion section. It is also hard to infer from the information provided in the paper why these artifacts may occur and what can be done or changed in the formulation in order to account for them.

2) There is also a lack of explanation for the method proposed in the paper. The authors are using a subspace approach with a local low-rank constraint, however, the reasons for this choice are not elaborated. For instance, the local low-rank constraint is playing an important role in the formulation, but the intuition behind is not explained. Readers might benefit from what are the principles behind the reconstruction techniques employed in the paper. Even though this is a technical note, this reviewer believes that there is room in the paper to elaborate more on these ideas.

3) The organization of the paper is also confusing. I would recommend including a Theory section to introduce the model and reconstruction approach, and this should be done before the Methods section where the experiments are explained. The current format starts with a description of the data and the theory is explained afterwards. This flow can be confusing for some readers. The description of the experiments in the Results section also needs improvement. For example, the Results section begins with an explanation of the simulation results, however, the experiment was not explained before, and the reader has to infer from the images the experiment that was run.

Minor comments:

1) After Equation 3 it is indicated that α has dimensions $[N_x, N_y, K]$, however, this does not make sense when, a few lines below, it is written that $\rho = \hat{U}\alpha$.

2) The phase format in Fig. 5 is hard to interpret.

3) Could you explain how the ranges for $T2^*$ and f_{B0} were selected? What are the consequences in the reconstruction if these ranges do not represent the acquired data properly?

Referee(s)' Responses to the Questionnaire:

Referee: 1

Originality of content: 3 – Good

Referee: 2

Originality of content: 4 – Very good

Referee: 3

Originality of content: 3 – Good

Referee: 1

Soundness of conclusions: 2.5

Referee: 2

Soundness of conclusions: 5 – Outstanding

Referee: 3

Soundness of conclusions: 2 – Fair

Referee: 1

Importance (significance of results, potential implication on other work, reader interest): 3.5

Referee: 2

Importance (significance of results, potential implication on other work, reader interest): 5 – Outstanding

Referee: 3

Importance (significance of results, potential implication on other work, reader interest): 2.5

Referee: 1

Quality (quality of methodology and data, clarity of presentation): 2 – Fair

Referee: 2

Quality (quality of methodology and data, clarity of presentation): 4 – Very good

Referee: 3

Quality (quality of methodology and data, clarity of presentation): 2 – Fair

Referee: 1

Is the manuscript in the appropriate category? : Yes

Referee: 2

Is the manuscript in the appropriate category? : Yes

Referee: 3

Is the manuscript in the appropriate category? : Yes

Referee: 1

If no, please indicate appropriate category:

Referee: 2

If no, please indicate appropriate category:

Referee: 3

If no, please indicate appropriate category:

Referee: 1

Can manuscript be shortened without compromising intended message? : No

Referee: 2

Can manuscript be shortened without compromising intended message? : No

Referee: 3

Can manuscript be shortened without compromising intended message? : No

Referee: 1

Accuracy (are there substantive errors?) : No

Referee: 2

Accuracy (are there substantive errors?) : No

Referee: 3

Accuracy (are there substantive errors?) : No

Referee: 1

Do the figures, tables, abstract, and overall organization adhere to the MRM Style Guide? (If not, please elaborate in the written comments): Yes

Referee: 2

Do the figures, tables, abstract, and overall organization adhere to the MRM Style Guide? (If not, please elaborate in the written comments): Yes

Referee: 3

Do the figures, tables, abstract, and overall organization adhere to the MRM Style Guide? (If not, please elaborate in the written comments): Yes

Referee: 1

Needs linguistic editing for English? : No

Referee: 2

Needs linguistic editing for English? : No

Referee: 3

Needs linguistic editing for English? : No

Referee: 1

Is there a figure that justifies consideration for MRM's cover: No

Referee: 2

Is there a figure that justifies consideration for MRM's cover: No

Referee: 3

Is there a figure that justifies consideration for MRM's cover: No

Referee: 1

Please indicate if you think that the authors have gone to special efforts to provide data or code in support of MRM's Reproducible Research goal: Yes

Referee: 2

Please indicate if you think that the authors have gone to special efforts to provide data or code in support of MRM's Reproducible Research goal: Yes

Referee: 3

Please indicate if you think that the authors have gone to special efforts to provide data or code in support of MRM's Reproducible Research goal: Yes

Referee: 1

Is MRM the appropriate journal? : Yes

Referee: 2

Is MRM the appropriate journal? : Yes

Referee: 3

Is MRM the appropriate journal? : Yes

Referee: 1

If no, please suggest an alternative journal:

Referee: 2

If no, please suggest an alternative journal:

Referee: 3

If no, please suggest an alternative journal: