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Comment on mr-2021-34

Anonymous Referee #1

Referee comment on "Magnetostatic reciprocity for MR magnet design" by Pedro Freire Silva et al., Magn. Reson. Discuss., https://doi.org/10.5194/mr-2021-34-RC1, 2021

This manuscript describes applications of a reciprocity principle for magnetostatics in the design of permanent magnet systems. The contribution is timely and likely to be of interest to those developing small-scale magnetic resonance systems. The presentation of the work however is much more difficult to follow than it should be. The manuscript should be carefully edited to make it more reader-friendly. As submitted, I feel it is likely to be of use to those who are already expert in these applications, but with some rewriting could be of much broader utility.

Many of my concerns with the manuscript arise from the lack of clear statements of the problem being solved and the lack of clear definitions of assumptions, symbols, constraints etc. It feels as though the authors have a clear vision of what was done and how to do it, but as the manuscript is written, a reader who does not have this same vision struggles to follow.

Some more specific comments:

1) Terms like: anchor magnet, anchor volume, Btarget, minimum discernible thickness, etc, are used without definition. For a reader who is not intimately involved in this kind of design work, clear definitions when these terms are used would help.

2) In section 2.1.1 it would help to refer to Figure 1, and to state clearly what is being contemplated. The way this material is framed, there is a vector potential A, but no words are said about how A is created. It is then a confusing surprise to see B_{rA} which is apparently a remanant field associated with magnetic material that is associated with A. It might be much simpler to frame the problem more symmetrically from the start, perhaps labelling the domains with more descriptive names such as 'sample' and 'external,' or even just 1 and 2. Each of these regions could contain magnetic material and produce fields in the other domain? The 'anchor' could then be defined as a magnet in region 1 for

design and/or fabrication purposes and 2 will contain the finished designed magnet. It is unclear to me why the vector potential is introduced at all here. It is never used, except as a label for one of the domains.

3) On line 81, the introduction of Btarget is unclear. What is B_{target}? Can the origin of the minus sign be explained simply?

4) Line 151: 'zero scaling law' What exactly is meant here?

5) Fig 4A: the coloured figure has many colours in it that aren't in the scale bar?

6) What are the different panels in Fig 4B? What are the x and y axes of these panels?

7) Please state clearly how the control actuation works? There is a hint in Figure 4 that they are moved up and down, though without any sense of scale it is unclear how far. How much force is required to move them and hold them in position?

8) It might help to clearly define the function and requirements of a profiling magnet.

9) Please explain the origin of Eq 8 more clearly and ensure that all quantities in it are clearly defined.

10) What is the dlength scale of T? I found: Due to the zero-scaling of the field profile, all dimensions were normalised to the outer diameter of the available design volume. Maybe a scale bar could go on Figure 4A?

11) I was unable to interpret Table 1. What is d?

12) line 216-217: "found to have a limiting performance" is very vague. Could you be more specific?

13) Fig 5: The upper x axis (eta) is non-monotonic? Evenly spaced tick-marks imply some quantity that is varying smoothly and uniformly. The eta axis is very misleading. It would be helpful to remind the reader what eta is.

14) Fig 5D inset. I don't understand what is being drawn at all.

15) As a non-expert in the work being done here, I found the presentation of the third application to be completely opaque. Only with some difficulty could I even follow the basic idea of what the goal was, and even so was left wondering at the end what the phrase:
"unbound magnetic field strength" (line 54) meant. Is the goal simply to maximize the field strength in that case?

16) Could the authors comment on how the structure in Figure 5 might be fabricated? The abstract does emphasize manufacturability.

17) I think it would help to mention the non-dimensionality of many of the variables much earlier in the paper, before it might cause confusion.

18) Figure 2C is unclear. How do the upper and lower x axes relate to each other? Why does the upper axis increase nonlinearly? Why is the region $1<d_M<1.5$ the interesting region? Isn't $d_M<1$ the region of interest?

19) The caption to Figure 3 suggests that the structures under consideration are those of Fig 2, though Fig 3A appears to simulate an annular ring of magnetic powder rather than the discrete cylinders of Figure 2. 20) It would be helpful to give some sense of the scale of the calculations. Are these things that could be done in a few minutes on a desktop computer, or are they hours on a large cluster?

20) Many additional details could be provided. I do not think enough information is provided in the methods that these results could be reproduced.

I feel the manuscript needs to be edited thoroughly and many pieces re-written so that the paper communicates what is intended in a way that someone who doesn't already know can understand it.