Author's response to the reviewer's comments

Manuscript number:	2015JOE001805
Title:	Low Complexity Adaptive Sonar Imaging
Authors:	Buskenes, J.I., Hansen, R.E., Austeng, A.

We would like to thank the associate editor for his efforts and for his speedy replies to queries from the authors, and reviewers for their thorough and highly relevant comments. The following sections mentions some general changes and the reviewer's comments are answered in detail in the next pages. We quote in *italic* statements from the reviewers, and provide our replies in ordinary print.

1 Figure changes

1. Fig 3. Caption changed to indicate that the size 40x40 pixels was chosen for sufficient statistics to make the histogram look well. Also added a sentence explaining that the steering is relative to broadside for all pixels, since each of them are pre-delayed into focus.

2. Fig 8 is new. It was added to provide details on how the steering bound $\phi_{3\text{dB}}$ is affected by the number of elements M and the element spacing relative to the wavelength $\frac{d}{\lambda}$.

2 Other changes

1. The steering bound $\phi_{3\text{dB}}$ depends on not just β, but also on the number of elements M and the element spacing relative to the wavelength $\frac{d}{\lambda}$.

   (a) We have supplied additional info on how the steering is affected by these parameters in appendix A.

   (b) Equations (12) and (14) only gave the correct results for our system configuration, and were not very intuitive. Appendix C now replace and extends these equations, so removed them in hope this will make the article easier to read.

2. Various spelling flaws corrected.

3. Appendix C added. Contains information of where source code and media files can be located. Before the article goes to publishing we will make sure that this link is permanent.

4. Reference to Synnevåg's proceedings article from 2008, "A low-complexity data-dependent beamformer" is replaced with his 2011 journal article with the same name. This was an error from our side, we never intended to reference the proceedings article since this work extends his journal version.

3 Answer to reviewer 1

General

The paper is well written and addresses an actual problem. The solution however, is barely innovative. Still the results are interesting enough for publication. Some minors details.

We appreciate the reviewer's view and would like to thank him for this time and patience reviewing this article.

Specifics

Introduction

1. *The authors show no evidence that bats use adaptive processing, remove this example.*

   Very true. We have reworded the example to say that the bats have a sophisticated sonar instead. The term adaptive sonar is now only used on human made systems. We hope this change is satisfactory.

2. *It is not clear whether LCA is really an adaptive method that adapts weights on the fly or a method that a posteriori decides which window shows best results.*

   We appreciate the remark. We are using a system level definition of adaptivity that includes any kind of dynamic and data dependent behavior, hence feel that both beamformers fall in that category. Both methods process the pixels in a data dependent manner, resulting in non linear image. We have tried to emphasize with improved clarity that the LCA solution space is merely a sampled version of that of MVDR, hence can not be considered a fully adaptive (yet heavily constrained) method such as MVDR.

3. *The use of non-SI units like cm is discouraged.*

   We agree that non-SI units should be avoided, however had the belief that cm being a prefixed SI unit was valid? In the IEEE Styles Manual this unit is used several times as an example: `http://www.ieee.org/publications_standards/publications/journmag/online_style_manual-10292015.pdf` (e.g. on page 24 paragraph "The En, Em, or Two-Em Dash", and several times on page 25 paragraph "Math" bullet point 16). Will leave it as is for now pending clarification.

4 Answer to reviewer 3

General

Although the topic is potentially interesting for all readers, due to many specific terms used in the text, in the present form the article would probably only be highly appreciated by expert readers. I would recommend some minor changes in order to widen the frame of potential readers.

We thank the reviewer for the thorough review and very constructive remarks. We believe in this philosophy and attempt to make changes accordingly.

Specific points

Abstract

1. *"the array's spatial covariance matrix" might be a bit shocking for the non-expert Reader → The formulation in the Introduction might fit better "the influence of noise ..."*

   This is a good point. We have reformulated the sentence to speak of computing the spatial statistics instead.

Page 2

2. *"6 of which were micro-steered" → a short explanation or reference might help to understand what is meant by "micro-steered"*

   Another good point. This wording is now changed and a sentence elaborating on its meaning is added.

3. *"it was not clear how how many" → delete 1 x "how"*

   Thank you. Corrected.

4. *"with an element beamwidth" → what is meant by element beamwidth? Maybe an additional figure could be used to explain this.*

   Good remark. We meant the -3dB opening angle of the elements. We have reworded this the two places it was mentioned.

Page 3, after (1)

5. *"Applying a window that trails off .... Minimum variance distortion-less response (MVDR) beamformer." → real and complex Windows? The introduction should be more formal: x ist introduced as delayed data, weights or delays to change, or both is explained later. → The difference between noise and sidelobes should be pointed out.*

   Good observations. We realize this was ambiguous and have now rewritten this paragraph in hopes it will be clearerr.

Page 5, equation (5)

6. *The lateral correlation and the reason why equation (5) is a good choice should be better explained.*

   Indeed. We have rewritten the paragraph slightly, but the technique is mentioned mostly for completeness. It wasn't used.

Page 6, last row

7. *"they are optimal for any value" → optimal in which sense?*

   Thank you. This was mentioned earlier in the same paragraph, just after (8). Is this insufficient?

Fig 3

8. *why is a 40x40 pixel group a good choice? could the associated broadside direction be made visible in the figure, too?*

   This is an excellent question. This should perhaps be related to the detail level in the image, which in turn depends on the array's imaging performance. We took an ad-hoc approach to this and selected 40x40 pixels to get sufficient statistics for a visually good looking histogram. We have now written this into the caption of Fig. 3.

Page 8

9. *reference to Fig.1 → could the sequence of figures be changes to have Fig. 1 closer to this paragraph*

   We agree this would be better. In our two column print the figure is on the page before its first reference. We assume this will be placed properly when processed for publishing.

Page 11

10. *where is the synthetic aperture needed/applied in this work, or is it just the name of the array? how does the work on LCA/MVDR Change the Quality of synthetic aperture? What exactly is the sectorscan mode?*

    The reviewer is quite right, it is a system designed for SAS imaging, but we only create image sectors for its data. That is, the images are from single ping, rather than synthesized from several pings. We agree this was worded in an ambiguous way and have rewritten it for improved clarify, as well as elaborated on the meaning of sectorscan imaging.