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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Bathymetry observations of inland water bodies using a tethered single-beam sonar controlled by an Unmanned Aerial Vehicle" *by* Filippo Bandini et al.

Anonymous Referee #1

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"Bathymetry observations of inland water bodies using a tethered single-beam sonar controlled by an Unmanned Aerial Vehicle"

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November 29, 2017

General comments:

This manuscript describes an innovative approach to measuring bathymetry: using

an Unmanned Aerial Vehicle (UAV) with a tether to deploy a compact sonar system. This idea is a simple one but has not, to my knowledge, been explored previously and is worth investigating. The authors effectively summarize the advantages of this new approach relative to conventional methods of surveying water bodies, such as depth retrieval from passive optical image data, boat-based sonar measurements, and wading surveys. The UAV-sonar combination allows for data collection in inaccessible and/or non-navigable waterways and does not suffer from the same turbidity-related constraints as other remote sensing methods and thus can obtain bathymetric data from far greater depths. The description of the new system is thorough but not too detailed and the methods used to obtain the sonar position from the drone's GNSS receiver and an offset calculation are explained reasonably well. Two case studies are used to quantify the accuracy of this approach, with encouraging results. The tables comparing various ground-based and remote sensing methods and their costs are useful additions to the manuscript. Overall, I believe this paper makes a nice methodological contribution and can be published with only a few minor revisions. I have made a number of comments and (mostly minor) edits on a PDF document uploaded separately and refer the authors to that document for detailed line-by-line corrections, but a few more substantive comments are highlighted here.

Specific comments:

1. In several cases, obscure and unnecessary references are included while in other places relevant citations are omitted, or used inappropriately – please see detailed comments in the PDF.

2. Page 2, line 3: need to clarify that you are talking about bathymetric lidar sensors with green laser wavelengths. Near-infrared lasers are absorbed by water.

3. Page 3, line 10 (and throughout): I think the large beam angle of the Deeper sonar is an important limitation you need to acknowledge more explicitly. Even at 1 m depth, the footprint is 26 cm, so at greater depths this system will have very poor spatial

resolution and you will not be able to detect small-scale differences in depth. I think the beam angle might be the most important source of the bias you discuss later in the paper as well.

4. Page 3, line 16: Does the sonar have a minimum depth?

5. Page 5, line 7 (and throughout): Be careful with the term geographical coordinates, which implies longitude and latitude, whereas a truly Cartesian frame of reference requires a map projection. I recommend using the term spatial or real-world rather than geographical throughout the paper to avoid any confusion on this point.

6. Page 6, line 17: I'm confused about the camera alignment – how is it oriented on the UAV? An additional figure could help here.

7. Page 9, line 17: The supplementary data you mention appear to be missing.

8. Page 10, line 5: I think it would actually be more informative to not use the absolute value so that you know which of the two sonars is reading a greater depth. As long as you clearly define what is being plotted, e.g. SS510 - Deeper, then you'll know whether positive or negative corresponds to a deeper reading by one sonar vs. the other. With absolute value, that information is lost.

9. Table 3: It would be helpful to clearly define how the various statistics included in this table were calculated, just to avoid confusion. Make things explicit when you can.

10. Page 12, line 13: The bias associated with shallow points in a large footprint is an important issue that will become more problematic as depth increases. The wide beam angle of the Deeper sonar is a major limitation of this sensor.

11. Figure 9: This data set is rather sparse, far less continuous than the boat-based data shown in Figures 6 and 7. Can the UAV-based system provide more continuous coverage like you'd get from a boat, or are only widely spaced point measurements possible? If you can only obtain a few points, the advantage of the UAV would not be nearly as great. Please comment on this in your revision.

12. Page 14, line 2: You need to explain how this bias factor is defined and was computed.

13. Page 14, line 2: This bias does not appear to be very pronounced, and Figures 10 and 11 are nearly identical. Don't exaggerate this effect.

14. Page 16, line 24: I don't see how having a waterproof UAV connects to the operator not being in the area. Is it so the UAV can crash into the water without being destroyed? Please elaborate a bit in your revised manuscript.

15. Page 16, line 36: I think the geometry of the bed (i.e., steep side slopes) and the beam angle of the sonar are more important factors contributing to the bias.

16. Table B1: Be consistent with number formatting. On the previous line you used , but here you're using '. I think , is more common, so please use that throughout.

Technical corrections:

Please see the PDF for detailed line-by-line edits, which are extensive and need to be incorporated into a revised manuscript.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2017-625/hess-2017-625-RC1-supplement.pdf

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