

# ***Interactive comment on “GRAINet: Mapping grain size distributions in river beds from UAV images with convolutional neural networks” by Nico Lang et al.***

## **Anonymous Referee #3**

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### GENERAL COMMENTS

This work by Lang et al. shows an exciting perspective for collecting information about sediment size in streams with coarse bed material. A new approach that combines UAV images and convolutional neural network is proposed. I think that this work could represent a significant and novel contribution, although some key points should be carefully addressed in the revision of the manuscript.

My main concerns about the work are:

1. Introduction. This section is quite weak, it should be improved significantly. Some suggestions for improving this section are given below. L 15-28. This part is not very

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useful. It would be more useful to focus on why grain size data are crucial (e.g. process understanding, modelling). L 38-42. Reference to traditional approaches is very poor. I would avoid the reference to Fehr (1987), maybe a good reference in the German-speaking countries but not worldwide (and in an international journal). I would suggest to look and refer to classical works by Church, Bunte, and many others. For instance, a look to Bunte and Abt (2001, USDA) would be very useful to put this work in the general context of sediment sampling in gravel-bed rivers. L 56. "...is more efficient than traditional field measurements...": I would say that automatic grain size is much less time consuming but it is also, commonly, less accurate. This should be pointed out since it is probably not obvious for readers who are not familiar with sediment sampling. Besides expanding the references considering previous works about sediment sampling, it could be useful to refer to works (e.g. Rice and Church, 2010, Sedimentology) that analyzed lateral and longitudinal variations of sediment size within a single bar. This would be useful to show the great potentials that GRAINet would offer for different purposes (e.g. sediment transport processes, morphodynamic and hydraulic modelling, ecological assessment).

2. Ground truth (see section 3.3). Is this really a ground truth? These measurements of grains are obtained from images not from direct measurements. I understand that this can be the way for training the model, but I would not say that these are ground truth...two different things! This is a key point that should be carefully addressed: the term ground truth is used widely throughout the manuscript.

3. Comparison with field measurements. This is a weak part of the work (see also my previous comment). (i) How field measurements were carried out should be explained in detail (in the Method section). (ii) A better comparison with digital line samples should be carried out: I do not agree that "...overall, no bias exists between the field measurements and the digital line samples" (L 343-344; figure 6). At least for those field measurements of known location, it would be crucial to show the real difference with digital line samples (e.g. if dm is 3-4 cm, difference of 1 cm or more is quite

significant). I think that this is a crucial part of the work that needs to be improved. It is crucial to show how close, or not, are data obtained by GRAINet to those obtained by field measurements.

4. "...Our CNN-based approach makes it possible to robustly estimate grain size distributions and characteristic mean diameters from raw images..." (L 507-508). This conclusion is not sufficiently supported by data (see my previous comments, 2 and 3).

5. Manual component of GRAINet. I have two comments about this aspect. (i) "...Lastly, one could potentially support the still necessary manual annotation process using training-free image processing tools, such as the open source software BASEGRAIN..." (L 553-554). This is a good point that would require further discussion. It is mentioned only in the last section ("Conclusions"). (ii) Comparison with human performance (section 5.4.4). Errors are not so small, see figure 15: further discussion would be useful here. It would be useful to clarify better how much the manual component affects the overall performance of GRAINet.

6. Discussion ("Advantages and limitations of the approach"). What about the presence of fine material? How the presence of fine material would affect the results obtained with GRAINet? This is something that should be discussed.

## SPECIFIC COMMENTS

Section 5.1. It could be moved in the Method section.

L 355. Quantitative analyses were carried out in the field, see for instance Wohl et al. (1996, WRR).

L 502. "...We believe that, in principle, GRAINet could even be used to process airborne imagery from country-wide flight campaigns...". I am quite skeptical about this statement. Commonly country-wide flights have spatial resolution of 20-30 cm (or lower resolution): such resolution seems to be too low to obtain reliable results (see figure 19 and 20).

L 540-541. "...to successfully replace the gold standard line sampling in the field (Fehr, 1987)...": as I pointed out in a previous comment, this is not a good reference for an international audience and journal.

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