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Comment on gchron-2022-12

Simon Nachtergaele (Referee)

Referee comment on "Technical note: colab_zirc_dims: a Google Colab-compatible toolset for automated and semi-automated measurement of mineral grains in laser ablation–inductively coupled plasma–mass spectrometry images using deep learning models" by Michael C. Sitar and Ryan J. Leary, Geochronology Discuss., https://doi.org/10.5194/gchron-2022-12-RC1, 2022

Review of ***"Technical Note: calib_zirc_dims: a Google-Colab-based Toolset for Automated and Semi-automated measurement of mineral grains in LA-ICP-MS images using deep learning models"*** *by Sitar and Leary submitted to Geochronology*

As a junior researcher interested in the combination of geology and artificial intelligence, I must admit that I read this article with great pleasure. The work of MC Sitar and RJ Leary is highly appreciated and there is still a lot of work to do in this field of research. It seems like a rapidly expanding field of research and a hot topic. But, I learned a lot but I have many suggestions for potential improvement, although the manuscript already looks very good. Some of my suggestions are major comments (MajC) and some are minor comments (MinC).

Major comments:

- MajC1: From experience with LA ICP MS I know that the laser ablation system only takes images using reflected light, unfortunately. To my opinion, many of the segmentation errors are actually caused by the reflected light images that are too sensitive to scratches or cracked grains. This paper finds a solution for this trouble that is more or less induced by using (low quality) reflected light images. However, it would be interesting to use images taken with a camera without reflected light, but with (option A) transmitted light from an optical light microscope, or option B: SEM images using a CL detector) would give you less segmentation problems and also textural (or even chemical zoning using CL) information.
- MajC2: Line 154: Figure 1a: in this figure it is quite obvious that different minerals (with each a different reflectivity) are shown. My best guess would be that there is

some apatite present and this "zircon generalization" troubles me a lot.

- MajC3: Line 154: Figure 1c: explain why the red sticks extend out of the mineral. The segmentation seems quite good, but the red sticks are longer. So, I cannot judge if there is a problem with the segmentation but maybe the problem lies in the calculation of the radius or perhaps in the entire image calibration (!). Also, for figure 1 it would have been appreciated that much more results were shown, for example of images that include air bubbles or cracked grains.
- MajC4: The resolution of the Youtube tutorial video is (for some reason) not sufficient and needs to be improved.
- MajC5: the paper would definitely benefit from an additional application (such as done by AnalyZr (Scharf et al., 2022)) that illustrates the strength and usefulness of the developed method. An additional data visualisation plot in the notebook where you can compare the zircon U-Pb age with the computed grain size metrics would be amazing (see figure 12 in Scharf et al. (2022)).

Minor comments:

- MinC1: Line 32: name the "published studies" that you mentioned.
- MinC2: Line 113: which GPU's could you use in Google Colab? K80? T4? P100? It is an interesting detail. And please mention the training time for a particular GPU and network as well.
- MinC3: Line 148: you jumped from Swin to Swin-T in some lines without explaining why. Some literature research learned me that this Swin-T variant of Swin is about 4 times smaller and that its complexity is about the same as the ResNet50 network architecture. These light versions are often called "tiny" variants and are a lot quicker than the original "full-option" network. This should be mentioned in order to let the reader realize that these network architectures are very large and that you're trying to solve that problem by using a tiny variant.
- MinC4: Line 188: why did you not try resizing for the largest images (1280p on 1024p)? It would save a lot of computing time.
- MinC5: Line 178: following the book of Russel and Norvig (2002) (4th edition, page 832, section 22.7.2) it seems not so smart to start to train models from scratch. You would need a lot more training time or a very small network in order to overcome this trouble. So I think this is not surprising and do not think the "start-from-scratch" models are of much added value.
- MinC6: Line 192-193: please use "heavy mineral" instead of "zircon" because this "zircon" class is incorporating apatites and monazites as well. Perhaps also change the name of the Colab notebook in that case.
- MinC7: Line 203: describe the learning rate more in detail in the text
- MinC8: Figure 3: why not use cropping and scaling as well for data augmentation?
- MinC9: Figure 4: what were your criteria to prevent over-fitting your model to the data? Did you just pick the most performant network?
- MinC10: Table 3: line 326: Otsu thresholding has a failure rate of 0.00%. This is contradictory to what you state in line 326 and, on top of that, failure rate is never explained in the text.
- MinC11: Table 3 below: please provide a metric to compare both GPU's against each other. A logical question that comes up into a reader's mind would be: "which one is the best?"
- MinC12: Figure 6: in this figures I need to see a 1:1 line which indicates the ideal ratio of an automated measurement and a manual measurement. In the horizontal axis, you need to add "manual" before "measurement (μm)" in each of the two figures.

- MinC13: Line 335: explain “negative skew” in plain language.
- MinC14: Figure 7: mention in the text that this “grain merging” problem can be perhaps solved with the NMS threshold that you mentioned earlier in line 133
- MinC15: caption Figure 8: the median value is displayed by the black horizontal lines inside the boxes (!).
- MinC16: please add the scale on the upper panel of the figure, instead of the lower panel.
- MinC17: Lines 77-94: it is indeed important to emphasize the history of this method development and to clearly give the (dis)advantages of both methods.

Once these comments are incorporated (where possible), I would certainly want to see this published in Geochronology.

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References:

Russel, S., Norvig, P., 2002. Artificial Intelligence: a modern approach.

Scharf, T., Kirkland, C.L., Daggitt, M.L., Barham, M., Puzyrev, V., 2022. AnalyZr: A Python application for zircon grain image segmentation and shape analysis. Comput. Geosci. 162, 105057. https://doi.org/10.1016/j.cageo.2022.105057