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Solid Earth Discussions

SED
7, C1999–C2002, 2016

Interactive Comment

Interactive comment on "Beam-hardening correction by a surface fitting and phase classification by a least square support vector machine approach for tomography images of geological samples" *by* F. Khan et al.

F. Khan et al.

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In general, we do not agree with the statement of referee #2 that a lack in novelty of the results provided does not qualify publication in your journal. This may hold true for our BH correction approach, but definitely not for our main LS-SVM approach. The reviewer did not provide any other citation of a reliable implementation of the proposed LS-SVM methodology for classifying XCT images of multi-phasic geological materials, and we respectfully rebut this argument in the same lump.

In more detail:

Reviewer #2: "Two topics (BH and "least square support vector machine") are glued together, which are simply two consecutive processing steps of many and sold as a new procedure (Abstract line 4). BH approaches exist many in the literature and the vector machine (VM) approach itself is not new (page 3385, line 24). I would not call this combination (BH+VM) a new approach."

Author's answer: In our manuscript, we addressed as main scope of our study the capability of LS-SVM for a machine learning algorithm for the purpose of "classification task" as applied on complex geomaterial XCT images in presence of beam-hardening (BH) artefact and without BH artefact. In the latter case, the artifact was removed by a 2D quadric polynomial fitting approach to the range of grey values. The output classification of LS-SVM on both cases were tested, and the performance of the classifier was validated both by presenting the classified images (Fig. 6) and ROC curves (Fig. 7)

Our main message is that pixel-based phase classification of tomography images of geological samples by least square support vector machine approach works well, but only after BH correction as an important prerequisite for accurate LS-SVM analysis. We propose by this chance an explicit implementation (Matlab Code) of our surface fitting Approach as a 2D quadratic polynomial on the post-reconstructed images to get rid of the BH artefact.

It is true that BH-correction methods have been studied and their limitations were highlighted in many studies yet published. Reviewers' argument that "LS-SVM approach is not new. . . " is in principle also right, since for a decade this method is used for many pattern recognition and classification problems. However, to the best of our knowledge, so far none has explicitly been implemented on XCT images of geomaterials for pixel-based multi-classification. The reviewer might wish to provide at least one citation in case she/he knows better.

Reviewer #2: "The whole procedure is described for 2D datasets. The complexities of geomaterials require the handling of 3D datasets."

Author's anwer: All procedures are demonstrated in 2D slides to ease publication. Of course, all datasets are in 3D and accessible in 3D with the described procedures.

Reviewer #2: "In the Abstract it was stated: "A minor drawback is that the proposed segmentation algorithm may become computationally demanding in the case of a high dimensional training dataset". This was not discussed further. I ask myself: Is the approach really useful for anything? Not discussed in this manuscript."

Author's answer: p12, L9-10, and page 12, L13-17, Figure 6a,d: The total number of data selection and the choice of regions selection for training data set are explained here. LS-SVM deals with the dot product of the combination of all data points at higher-dimensional feature space, and this enhances computational cost when a large number of data set for training is to be accounted for. Therefore, it is a trade-off between a good number of data selection and the choice of regions selection for optimal classifier performance. We have shown that with a limited training data set (<1%) of the total data set, the multi-classification is successfully possible on the complex structures. However, we agree that this sentence might irritate readers if to be mentioned without explanation, and have removed it from abstract.

Page 2, L3-8: In digital rock physics, the dependency of physical parameters on image analysis segmentation (classification) techniques is highlighted. Our methodology shows an alternative way to detect phases in CT images.

Reviewer #2: "On page 3395 (line 2) you state that there are three phases: "halite, anhydride, and clay minerals". How you know? Where is the geological description of your sample? How arbitrary you have selected the phases with your chosen resolution with respect to the real rock sample? Unclear.

Author's answer: A detailed mineralogical description of the sample was published

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previously as now cited in manuscript (unfortunately, however, a publication in German language): Enzmann F., Meier T., Janz M., Jovanovic Z., Rheingans K., Schwarz J., Göbbels J., Kersten M. (2009): Bestimmung der durchflusswirksamen Porosität an Bohrkernproben mittels Computer-Tomographie. Deutsche Gesellschaft für Geowissenschaften, Heft 242, 90-96.

Reviewer #2: "In the last sentence of your Conclusions you state that there is a companion paper, which present a comparison of your methods. This is maybe useful to judge your classification algorithm. The present manuscript is not able to justify your approach."

Author's answer: The comparison between machine learning methods in the area of CT image processing (i.e., classification), can be done qualitatively (as in many related literature) by the individual classifier outcome image results by direct eye inspection of image classification and by classifier performance in terms of accuracy, and more quantitatively (but seldom done in literature), by the Receiver Operating Characteristic (ROC) method. All these criteria are discussed at length in our manuscript.

Interactive comment on Solid Earth Discuss., 7, 3383, 2015.