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## ***Interactive comment on “UAV-based urban structural damage assessment using object-based image analysis and semantic reasoning” by J. Fernandez Galarreta et al.***

**J. Fernandez Galarreta et al.**

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Dear anonymous referee, thank you very much for your interesting and positive feedback. Below you can find each of your comments addressed independently. We hope our responses answer the concerns and suggestions you had.

General comments

- How do authors pre-process oblique, multi-perspective and highly overlapping imagery, in order to achieve a unique and consistent image for the later image-based analysis?

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Author response: The pre-processing of the multi-perspective and highly overlapping imagery for the image-based analysis was mainly done manually due to the complexity of the scenes. From the suitable images used for the 3-D point cloud generation we selected the ones that best captured the front of the façades and roofs. In the future we would expect that 3-D point cloud analysis could automatically detect the most suitable image for the analysis using the relative position of the camera, though this was not the focus of our work.

Besides the image selection we also manually cropped those selected images in order to obtain scenes where only façades and roofs were visible. At the beginning of the research OBIA was tested in order to classify and, hence, limit the analysis to the actual façades and roofs, however to accomplish the rest of the objectives proposed on this research paper we had to limit those pre-processing selection algorithms. Potentially, parameters such as the z-component could also be used to differentiate between ground, sky, actual façades and roofs in the images. This would allow the damage features algorithms to be directly focused on the objects of interest, avoiding the manual cropping.

### Specific comments

- In figure 7, the legend could be misunderstood, as the color of intact roof in figure 7(a) is different from the one in figure 7(b).

Author response: The color in the legend for intact roof has been slightly changed. However, notice that the color will never be the same since the transparency of the classification layer on top of the real image changes with the background's main color. Figure 1 (note that the numeration here does not coincide with the original document)

- In figure 8, please also explain some phenomena on connecting crack, crossing crack and inclined column in the right hand of figure 8(D).

Author response: The phenomena of connecting and crossing cracks is explained in

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3.3 section II. Additionally, the caption of figure 8 has been extended to include a better explanation of such phenomena: “Fig. 8. Results of applying the concrete ruleset on 6 concrete façade images B’ & C’ were edited in order to remove the damage feature. Images A & B illustrate cases of cracks connecting with windows, shown as yellow objects on the corners of the windows (highlighted by circles). Façade image D illustrates a crack crossing a column (in green). Scale approx.” Figure 8 now also includes two circles to highlight mentioned phenomena Figure 2 (note that the numeration here does not coincide with the original document)

- Discussions are needed on the difference of damage detection results on brick and concrete facades.

Author response: In section 5.2.2 (Page 5619, line 9-10) we pointed out the nature of those differences: “They included both false negatives (Fig. 12a) and false positives (Fig. 12b and c). In particular brick façades, due to the noisy nature that hindered accurate segmentation, were affected”. Now we have re-organized that explanation and added some extra information: “They included both false negatives (Fig. 12a) and false positives (Fig. 12b and c). This particular concentration of errors in the brick façades has to do with the actual pattern that the façade presents. The complex pattern presented in the brick façades challenges the segmentation algorithm that creates small non-damage related objects that during the classification process and mistakenly classified as cracks. Concrete façades having a smother texture pattern facilitate the segmentation algorithm task of creating large objects for the intact part of the façades and small object for the damage-related ones.”

- Page 16, Lines 5-6, correct this sentence: "Nevertheless, our work focused on the 3-D point cloud processing, with the actual damage detection still requiring manual assessment."

Author response: The sentence has been re-written into: “Nevertheless, our work focused on the 3-D point cloud processing, and not on automatic damage feature detec-

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tion in the point cloud information.”

- As shown in Fig. 8(D), authors showed OBIA-based results, but in fig.12(B), and Page 18, Lines 6-10, authors said " yet to an expert analyzing damage based on the OBIA damage features this type of misclassification posed no problem, according to the feedback obtained after the expert-based per-façade/roof classification" . Please give some explanations on this semantic error, which still exists in the OBIA-based results.

Author response: In section 5.2.3. we have extended that explanation. “Further, traditional accuracy assessment approaches do not address the semantic dimension of the extracted features. According to the feedback obtained after the expert-based per-façade/roof classification (Sect. 4.3.5 in Fernandez Galarreta, 2014) errors such as the one in Fig. 12b are flagged as FP, yet to an expert analyzing damage based on the OBIA damage features this type of misclassification posed no problem. For the specific case of Fig. 12b the expert knowledge allows an easy recognition of such an object as an artefact of the façade, a letter. It is directly understood as a non-damage related object despite its erroneous classification.”

- Spelling error in reference of "Dell'Acqua, F. and Gamba, P.: Remote sensing and earthquake damage assessment: experiences, limits, and perspectives, Proceedings of the IEEE, 100, 2876–2890,doi:10.1109/jproc.2012.2196404, 2012."

Author response: Corrected:

Again, we appreciate the constructive comments and suggestions made in this review by the anonymous referee #1, and trust that we have addressed all questions and comments satisfactorily.

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 2, 5603, 2014.

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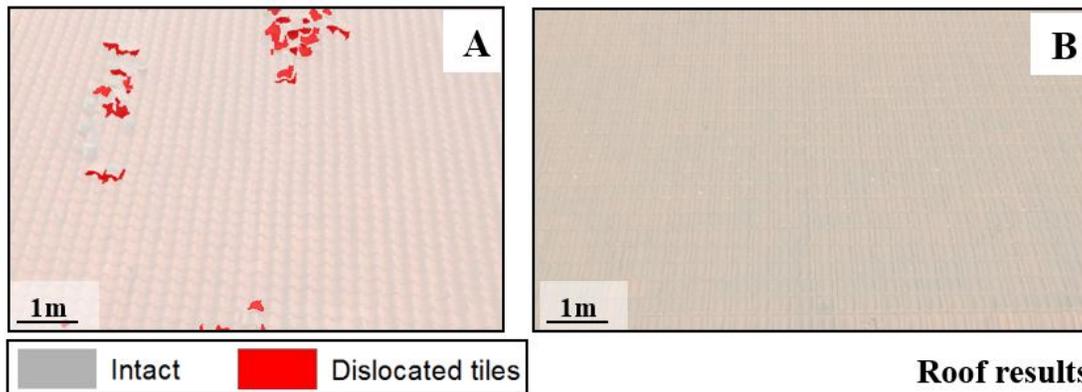
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**Fig. 1.** Corresponds to Fig. 7 in the original document.

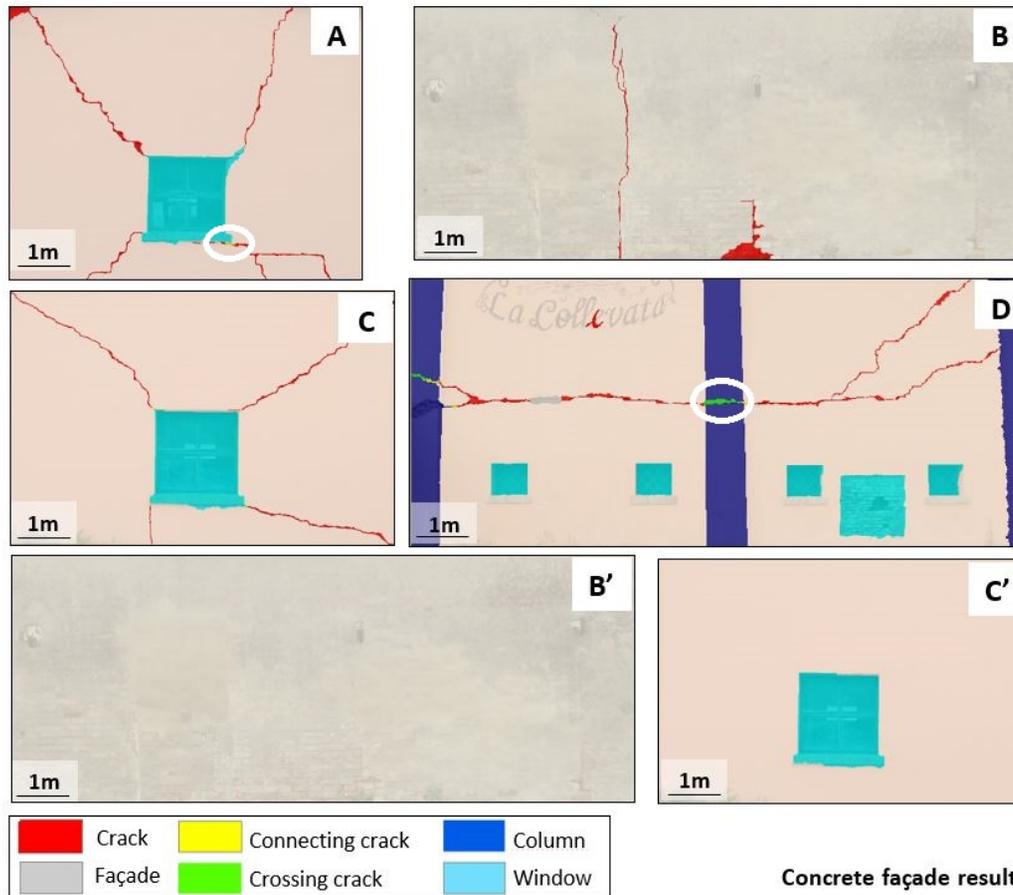
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**Fig. 2.** Corresponds to Fig. 8 in the original document.