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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Use of a remotely piloted aircraft system for hazard assessment in a rocky mining area (Lucca, Italy)" *by* Riccardo Salvini et al.

Anonymous Referee #1

Received and published: 5 July 2017

GENERAL COMMENTS:

This paper presents an interesting case study of the application of RPAS for rock slope characterization in a mine/quarry for hazard assessment. It highlights the advantages of using recently developed technologies (RPAS and SfM) in a mine/quarry.

In my opinion, the main contribution is related to the persistence of critical joints and the role of intact rock bridges in rock slope stability. This is a difficult topic, and lots of literature exists already. New characterization techniques, such as photogrammetry, bring new perspective and may allow better understanding of the role of rock bridges. Therefore, I think that this manuscript is a topical case study, and the discussion (Sec-

tion 5) is interesting.

However, before being published, I think the manuscript needs to be further completed. I would suggest including a more comprehensive literature review on the topic of discontinuity persistence and rock bridges in the introduction (including the current paragraph Line 14-19 on Page 8). I would suggest reviewing recent case studies on rock bridges such as the one by Frayssines and Hantz (2006), Sturzenegger and Stead (2012), Tuckey and Stead (2016), and Matasci et al (2014). In particular, the results presented in Line 15-18 on Page 9 could be compared to rock bridge percentage estimate by the above authors. Finally, the specific comments listed below should be addressed.

SPECIFIC COMMENTS:

Page 1, Title: Is there a specific reason why the authors use "remotely piloted aircraft system" instead of UAV, which is more commonly used in the literature?

The abstract is well written. I would suggest adding a sentence on the rock bridge analysis, which is an important aspect of this manuscript.

From Page 1, Line 33 to Page 2 Line 5: these sentences seem a bit vague. In what ways does alteration of geological structures by exploitation, or morphological features influence slope stability? In my opinion, the main parameter controlling slope stability is the relationship between the slope morphology and geological structures, as rightly explained in the third sentence.

Page 3, Lines 10-13: is it really necessary to add these sentences and to mention this accident? Safety is definitely very important for mining operation, but is this really relevant for the scientific contribution of this paper?

Section 3.1: Could "zenithal", "parallel" and "frontal" be defined?

Section 3.1: What is the exact meaning of Ground Sample Distance: is it the ground pixel size? Or the distance between points in the generated point clouds?

Section 3.2: I don't think it is necessary to explain in detail every steps of the processing work using Agisoft. It may be better to explain the key steps and refer to Agisoft manual for more information. Details about the parameters and options selected in Agisoft could be listed in a table if necessary. In addition, I would consider including Section 4.1 here instead of in the Result section of the manuscript.

Section 3.3, Lines 16-17 and Lines 25-26 do not seem necessary.

Page 7, Line 10: a table showing the parameters used to obtain the RMRb and GSI would be useful here. I assume the geometric parameters come from the RPAS, but what is the source of the non-geometric parameters?

Page 6, Line 30: is the reproduction error resulting only from manual placement of GCPs or also to other parameters of the alignment process?

Section 4.2: would it be possible to add a paragraph to discuss the results of the kinematic analysis? How do they compare with field-/SfM-based observations? What are the main failure mechanisms?

Page 7, Line 25: do the orientation of the faults and discontinuity basal plane correspond to specific discontinuity sets defined previously? I think the sentences Line 14-19 on Page 10 should appear here.

Section 4.3: it is not clear how Block A parameters shown in Table 5 were input in Swedge. What is the slope orientation? How were the geometric parameters of Table 5 used to generate the wedge shown in Figure 10? Can the "length" and "height" of the block in Table 5 be defined, or illustrated on Figure 9? How was Total Cohesion in Table 6 calculated?

TECHNICAL CORRECTIONS:

For clarity, I suggest subdividing the introduction into more paragraphs. I would start a new paragraph from (1) "Generally, ..." (Page 2, Line 5); (2) "However, ..." (Page 2, Line 13); (3) "Digital images..." (Page 2, Line 22); (4) "However, ..." (Page 2, Line 30),

and I suggest deleting the word "however" here.

I suggest starting a new paragraph on Page 10, Line 10 at "In this work"

All references to figures in the text should be in brackets (Fig. X)

Sections 3 and 4 need to be reviewed for clarity and the English checked.

Page 2, Line 3: I suggest using either "geological discontinuities" (Page 2, Line 3) or "geological structures" (Page 1, Line 4), but being consistent

Page 2, Line 6: I suggest adding a period and start a new sentence from "Measurement"

Page 2, Line 10: "DP" should be "TDP" for Terrestrial Digital Photogrammetry

Page 2, Line 12: "rocky outcrops" should be "rock outcrops". Similarly, on Page 7 "rocky slope" and "rocky blocks" should be "rock slope" and "rock block".

Page 2, Line 13: I suggest rephrasing this sentence, something like "A limitation of ground-based remote sensing is related to the survey of complex topography from suboptimal camera or scanner positions, resulting in occlusion zones..."

Page 2, line 16: I suggest deleting this sentence. It seems a bit redundant, and not really true, since the next sentences list several examples of the application of RPAS in open-pit mining.

Page 2, Line 20: delete "an"

Page 2, Line 26: a word is missing "...multicopters results ARE particularly suitable..."

Page 2, Line 28: delete "both"

Page 2, Line 34: should read " allow only a rough estimation of airborne camera external orientation"

Page 3, Line 1: I think the word "accurate" is not appropriate here, because SfM pro-

vide accurate models whether they are geo-referenced or not. I suggest rephrasing, something like “in order to geo-reference (or register) 3D models, ...”

Page 3, Line 3: should be “dependent not only ON” (not “from”); same comment at the end of the line

Page 3, Line 3: I suggest rephrasing and use “a preliminary rock fall hazard assessment, requested...”

Page 3, Line 24: I suggest rephrasing “The bottom of the pit is located at 1,180 meters above sea level (masl) and the top of the excavated rock face is at 1,300 masl.

Page 3, Line 29: “compressive tectonic phase WHICH originated...”

Page 3, Line 32: “fragile” should read “brittle”?

Page 4, Line 1: “motion” should read “displacement” or “offset”?

Page 4, Line 3-5: please rephrase with something like “AS involves the oldest LITHOLOGIES of the ..., INCLUDING pre-Alpine...”

Page 5, Line 5: would “baseline” be a better terminology for the “two points necessary for the roto-translation of the measured GCPs”?

Page 7, Line 20: where are the results of block shape and size? Do you mean to say that the results of the kinematic analysis highlight potential for discontinuity-controlled failure mechanism and “therefore the high resolution images and the dense point cloud were analyzed in order to locate possible block source areas”?

Page 7, Line 23: do you mean to say :”In particular, the adopted approach identified two large blocks...”?

Page 7, Line 29-30: I suggest moving this sentence to Line 25, after “high persistence”.

Page 8, Line 14: I suggest wording “impossible to measure deterministically”

Page 8, Line 15: I suggest saying that for this reason, persistence is commonly mea-

sured as trace length on rock outcrop, and use a more appropriate reference than Einstein et al (1983)

Page 10, Line 10: “slope stability analysis” instead of “slope instability analysis”

Page 10, Line 25: the reference should be “(Kemeny and Donovan, 2005)”

Figures 3 and 5 captions: “top view” should read “plan view”

Figure 5 needs to be referenced in the text; the caption should explain that the blue rectangles correspond to the photographs locations; there is not scale nor indication of the north on the figure.

Figure 7: could you please clarify: the caption mention equal area, while the figure shows equal angle. In addition, Figure 7 uses Schmidt method while Figure 8 uses Wulff method.

Figure 9: “insect photo” should read “inset photo”

Figure 13 captions should read “Details of a series of tight discontinuities...”

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