Natural Hazards
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Interactive comment on "Mobile Augmented Reality in support of building damage and safety assessment" *by* W. Kim et al.

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Received and published: 20 December 2015

Dear anonymous referee, thank you very much for your interesting comments and feedback. Below we answer your questions one by one.

#General Comments: The paper at hand describes the design and development of an app for visualizing additional information on a mobile device by augmented reality. It is undoubtful that additional (location-based) (geo)information in the field is helpful and might increase performance (in whatever definition) of damage and safety assessment. Thus, from a practical point of view the developed prototypic app could be a good start for a more sophisticated tool that could be used by practitioners in the future. From a scientfic point of view no generic scientific question could be identified: not from a

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computer science / geoinformatics perspective, nor from a NHESS perspective. The paper presents an app implementation and includes a small user survey, which was performed under no realistic conditions (online and not in the field) and lacks a control group. Thus, the paper is an interesting case study and presentation of a prototypic app but does not reveal scientific findings that would justify publication in NHESS.

Answer: Rather than presenting an app as scientific contribution and final output, this study proposes a conceptual framework for efficient ground-level damage and safety assessment supported by augmented VR. The framework focuses on the specific methodology to address some of the persistent limitations of field-based building damage assessment. In addition, this study's aim is not just to implement a prototype but to show that the framework alone is already enough to improve current limitations from a NHESS perspective. Again, this study's main part is the conceptual framework not a prototype. We agree that user survey has limitations. However, in general research in the NHESS domain is not easy to conduct experimentally under realistic conditions. Therefore, we aimed at demonstrating to potential users what information may be available, how and where it could be obtained in a disaster scenario, and we presented images and videos to illustrate what the information would look like that a first responder would see in the field. Although the number of experts consulted was limited, most had extensive professional experience in field-based damage and safety assessment, and commented very positively about the added value of AVR-based information. We can now take this information (focusing on what was identified as very useful, and discarding what turned out to be practically less relevant for the experts), and rework the implementation, which can then be more thoroughly field tested.

-What is the advantage of AR compared to have the same information on an interactive map (LBS) in the field? AR is your unique selling point but it does not get clear what is the real feature of your AR LOCs compared to not having AR but the info of the LOCs. Furthermore, of course the app could be used in the context of natural hazards. However, NH is one of many application domains and it could simply be repaced in the

text by another application case. This can be a pro (i.e. it is generic) and also a con (i.e. no focus on NH) of the study.

Answer: Please refer to c602, line 4 to 20. Main difference between AR and LBS (or GIS) are that AR seamlessly and interactively combines the real and the virtual world in real-time. While a conventional data overlay in a GIS (LBS) replaces reality with virtual data, AR supplements reality. This allows a lever of immersion in the field that is currently entirely absent for first responders, the ability to place a tablet in a given direction and see, for example, was the buildings in the scene looked like before the disaster, what the interior setup (staircases, etc.) of a building is, etc. This perception of the scene can only be provided by a VR-type system. We agree that the presented concept is also applicable for other scenarios, for instance in city planning. However, our group has an extensive research record in disaster response research, including image-based damage mapping. Hence to us it was clear that the advances to be gained over the current situation are the greatest in this domain.

-The aim is to evaluate the increase of efficiency and improvement for damage and safety assessment. I could not find the methodology and experiments for that. You just asked the users whether it would make sense to have the app - but you did not make an experiment having a control group (without app).

Answer: Again, the point of the research was not to create an app, nor did we do that. We create a range of Levels of Complexity (LOC) of information relevant in a disaster area, and that can be provided to a user through AVR. We then carried out a questionnaire, asking a total of 34 experts about the perceived value of each LOC, and by what margin (in terms of percentage performance improvement or time saved) the specific information would make a difference in their work in the disaster field. Working with a control group does not make sense here in our view (ask them how long it takes them to orient themselves in the field without AVA?). Instead we got a broad range of responses from many individual with different expertise and preferences, allowing us to assess the level of agreement on a given question among users (though median and

SD, see Table 2/3)

-It is not clear form the paper why an indoor version has been developed? Most of the arguments in the paper do not support the indoor version. First time it is mentioned on page 2610 that also an indoor variant is developed. But why?

Answer: AR can be implemented using its relative location between virtual and real object (outdoor AR, sensor-based), but also using image recognition technology (indoor AR, marker-based). In disaster response there is well a need for both outdoor and indoor solutions. True, marker-based solutions without the aid of some of the many sensors now built into smart devices is a challenge, and not all LOC can be equally well supported. However, we found it important to consider also what value such indoor solutions for first response forces. We do mention already in the abstract that an indoor solution was also considered, but would be happy to expand this in the introduction in the revision.

-You write on page 2612 that "The result of the survey showed that mAR can improve the assessment accuracy (objectiveness) and time". You asked the people what they think if accuracy could be improved. This is a difference to really assess an improvement in accuracy! You need to be careful and check you manuscript for also other such conclusions which are not supported by your data/survey (e.g. evaluate efficiency, etc.)

Answer: We gave user specific questions and scale for answer that can quantify improvement of current issues (accuracy, efficiency, etc.). For instance, one of our question is like "How much do you think mobile AR can improve assessment accuracy (objectiveness) compared to traditional methods of building damage assessment?" We trusted the professional experience and expertise of the survey participantsâĂŤmost of them had more than 5 years experience in building damage assessment. Furthermore, in this context, terms like "accuracy", "efficiency" etc. could be subjective even in a real field assessment, since the assessment is conducted according to their experience and knowledge. We will carefully revise the terminology and claims during the revision.

#Specific Comments: - Avoid citing too many of your own papers if not really necessary.

Answers: We will carefully review all citations during the revision and reduce where appropriate.

- Why not designing a system that works using a service-oriented architecture and OGC formats/services? -

Answer: This is a good point. However, this study focuses on what data can be delivered through mobile devices, not on how data should be delivered. Furthermore, SOA and OGC services mostly rely on internet connections which tend to be limited in terms of availability, stability and bandwidth in disaster situations. However, we agree that they are interesting technologies to combine with AR especially from GIS perspectives, and will comment on this in the revision.

-The user study needs to be described in much more detail and already in the Methods section. Who are the people/institutions? What did they test exactly? For example, how was "situational awareness" tested in the experiment?

Answer: We agree. We will add more detail about the tests and experiments in the revision.

-The experiment needs to be reproducible, which is not given at all in the current version!.

Answer: We used online survey forms containing pictures and videos clips which is reproducible. If we are referring to the fact that with different experts we might get slightly varying answers, then yes, that is true. It is also true for any other questionnaire, census, PPGIS method, crowdsourcing etc., which are accepted scientific methods if done and described properly.

-Also LOC 5/6 need to be presented already in the Methods

Answer: We wrote "Since LOC5 and LOC6 only emerged as possibilities from the user

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evaluation of our prototypes, in this paper they were only conceptualized but not yet implemented and tested". In other words, those LOC were not part of the initial setup and experiments, but rather are results in that they were devised in response to the feedback from the experts.

-You need to define structural integrity for non-expert readers.

Answer: We agree, and will put it on introduction section.

-You state that ground surveys are inefficient (page 2601) but AR is also a ground survey?

Answer: True, and most of our work focuses on image-based damage mapping. However, first response and urban search and rescue remain field-based, and thus countless people will continue to struggle with issues such as orientation, state of the pre-event situation, location of hazardous substances and many more such location – specific questions. The aim of our research is to work towards improving the way such forces operate on the ground.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 2599, 2015.