Subjective Evaluation of Diminshed Reality

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Abstract:	This report gives an overview of subjective evaluation experiments to assess the perception of DR, in particular in combination with AR.		

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Introduction

One issue neglected in current augmented reality (AR) indoor planning tools is the fact that most users do not start from scratch, but modify or redecorate and existing room. Visualising computer generated objects to be added in AR thus often overlaps with physical objects in the room, thus negatively impacting the AR experience. Diminished reality (DR) aims to solve this issue, by visually concealing objects to be removed, before adding new ones. DR typically relies on a type of methods call inpaiting, which tries to hypothesise the content behind the removed object. Due to lack of information what is behind an object, DR methods may produce artifacts. The aim of our experiments was to assess the differences in perceived quality between using AR without DR, DR only (i.e., emptying the room) and AR+DR.

Experiments

Before the first formal usability evaluation of the ATLANTIS tool and to complement user testing of prototypes, an online survey was conducted to gather subjective ratings of Diminished (DR) and Diminished and Augmented (DR-AR) scenes. There were 38 participants in the preliminary evaluation conducted in May 2021. In this study, three scenarios were evaluated: pure DR on selected objects, DR-enhanced AR, and pure AR. As in formal evaluations, the respondents provided ratings on a 5-point Likert scale. The objective of this preliminary evaluation is to showcase the importance of DR for supplementing the AR experience. More information on the results can be found in the published work "An AI-based system offering automatic DR-enhanced AR for indoor scenes. International Conference on Artificial Intelligence and Virtual Reality (AIVR) 2022". Specifically, on a 1-5 scale (1=Bad, 2=Poor, 3=Fair, 4=Good, 5=Excellent), participants rated pure AR (superimposing an object on top of the previous one) an average of 3.04. Interestingly, the rating increases to 3.38 when AR is enhanced with DR. This showcases the importance of the DR for providing visually pleasant experiences to the user. Particularly, the user needs to perceive the superimposed object without interfering with the one already present. Some samples of scene types of the survey are shown in Figure 1.

Figure 1: Example user study scene types. The first column depicts the original panorama, the second column the panorama with the object removed (i.e. pure DR), the third column, the one with the virtual furniture added in the diminished scene (i.e. DR-enhanced AR), and the final column, the one with the virtual object added without previously removing the existing object (i.e. pure AR).

Table 1: User evaluation of Augmented Reality application, with and without Diminished Reality provided by our Inpainting service.

Method	Score: **1=Bad, 2=Poor, 3=Fair, 4=Good, 5=Excellent**
pure AR	3.04
DR enhanced AR	**3.38**

The results of the user survey are shown in Figure 2. The left side shows the aggregated scores for all scenes, while the right side divides them into two groups, those unfamiliar with AI (Group A) and those who have experience with it (Group B). When using pure DR, the scores are lower than when using DR enhanced AR. This is expected since some defects are hidden when superimposing a new object on an inpainted region. Furthermore, DR-enhanced AR outperforms pure AR. However, where the objects (to be removed and superimposed) are of similar size and shape, the contribution of DR is not crucial. However, the presence of DR may outweigh the need for high-quality DR results in the rest of the cases. Regarding the two user groups, those familiar with AI presented with larger discrepancies between the different scene types, albeit the ranking across both groups remained the same.

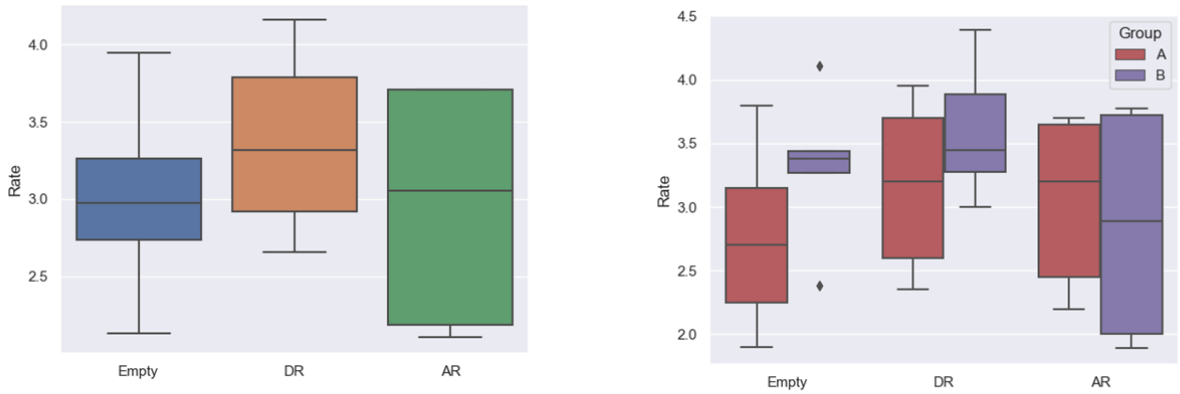

Figure 2: Results of the user tests. On the left, the graph presents the total average rating for all the scenes, which includes pure DR (Empty), DR-enhanced AR (DR) and pure AR (AR). The graph on the right depicts the average rating separated by sub-group (A&B, not familiar with A.I. versus those familiar with it).

More information

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