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Literature Review-2(COMP-5460 Spring 2018)

The paper chosen for the review is '*Effects of Different Types of Virtual Reality Display on Presence and Learning in a Safety Training Scenario*' [Fabio Buttussi and Luca Chittaro] published in IEEE Transactions on Visualization and Computer Graphics (Volume: 24, Issue: 2, Feb. 2018) on 16 January 2017. The primary reference of this paper is *'From visual simulation to virtual reality to games*' [M. Zyda]. The reference is most important and the highest contributor to the paper. Since the publication is extensively makes use of games to gather data from the users and use the results to study the scenario, the reference paper proves to be the most important tool in their arsenal.

In addition, the effects of different types of display have been scarcely explored in the domain of procedural training, i.e., training that deals with the execution of procedures. For these reasons, the study Author describe in this paper compares a new HMD for home VR with other types of displays, using them for training in cabin safety procedures with a serious game that simulates a runway overrun accident in VR. First, to the best of our knowledge, our study is the first to explore the possible effects of different types of display on safety knowledge acquisition. Third, unlike previous studies of the effects of different types of display, our study tests knowledge gain and self-efficacy not only immediately after using the serious game, but also two weeks later. Since different studies show connections between type of display and presence, between presence and emotions, and between emotions and retention, Author hypothesize that the different types of display might play a role in the retention of procedural knowledge over time, and Author assess this aspect in the study.

Effects of different displays were studied especially with visual search tasks, i.e., tasks that require users to search for one or more targets in a virtual environment. Studied how the combination of display size, stereoscopy, and head tracking in a CAVE affected user performance in understanding mathematical graphs. The study found better overall task performance with the higher fidelity condition. The effects of different components of fidelity, namely head tracking, stereoscopy, and field of regard on different tasks concerning volume data visualization were instead studied in and . In summary, the different studies on visual search tasks, data visualization tasks, and small-

scale spatial judgement tasks indicate a positive overall effect of higher fidelity displays on performance, with an influence of the different components that varies based on the task. Display and interaction fidelity in a FPS game were studied independently in : users tried a CAVE with a 6-DOF wand , a single screen with mouse and keyboard , a low display and high input condition, a low input and high display condition. Results showed that performance in the game was better in low display with low input and high display with high input conditions rather than in the two mixed conditions. In summary, the studies concerning games do not show performance gains due to higher fidelity displays, but indicate that users tend to prefer higher fidelity displays to play games. They found that users who tried the highest fidelity display performed the complex procedure faster and with less mistakes, while no difference was found for the simple procedure. The few studies concerning procedural knowledge indicated that using higher fidelity displays improves learning of spatial procedures, but, to the best of our knowledge, no study tested the effects of different displays on procedural training scenarios different from the movement of objects among different spatial locations.

The game plot begins on-board the aircraft approaching the destination airport, twenty seconds before the captain announces very bad weather conditions and ends when the player succeeds in reaching a safe place, after the aircraft overruns the runway and crashes in a nearby field. On the contrary, if the error is reversible in the real world, then the game does not stop, and nearby characters give verbally the recommendation to the player. However, if the player ignores the verbal recommendation, and persists in the error, then the game treats the error in the same way as irreversible ones. If the player takes the luggage, avatar movement becomes slow, and other passengers complain about the slowdown of the evacuation, telling the player to drop luggage. The flight attendant who assists passengers at that exit orders everyone to go towards the front of the aircraft because fire is coming. The player has to reach an exit on the wings, while smoke continues to propagate towards the front. Then, the game restarts from the instant before coughing. If the player moves too slowly, fire reaches his/her avatar, and the game restarts from 7 seconds before fire reached the player. When the player reaches a wing exit, the flight attendant near the exit tells him/her to exit on the wing, reach the slide, and jump down. If the player does not comply within a few seconds, the avatar is reached by fire and the player must repeat. To move in the direction they are currently facing, players push the left joystick forward. Each time the player has to take an action, between one and three

icons appear. Players select icons using left and right arrows on the D-pad control.

In the following, Author will refer to the group of participants who played the game on the desktop monitor as Low Fidelity group, those who used the HMD with narrow FOV and 3-DOF tracker as Medium Fidelity group, and those who used the HMD with wide FOV and 6-DOF tracker as High Fidelity group. It is important to remark that, in the group names, fidelity refers to display fidelity, but also to interaction fidelity, since the MF and HF conditions used head tracking and LF used the joystick for head rotation. The other aspects of interaction fidelity as well as scenario fidelity were the same for all groups. The Sony HMD used by the MF group had two OLED displays with 1,280 720 resolution each and 45 FOV, and the 3-DOF sensor was an Inter Sense Inertia Cube3.
Author asked participants to rate their frequency of use of video games on a 7-point scale. Author also assessed individual differences in frequency of air travel by asking participants to count their number of flights in the last two years, as in. Finally, Author used the 32-items Flight Anxiety Situations questionnaire developed by to assess participants anxiety in flight-related situations, and control for it in the analysis of engagement and presence, in case individual sensitivity to the considered situations could affect emotional response.

Participants were assigned to the three groups in such a way that: (i) each group had 32 participants (18M, 14F in the LF and HF groups; 19M, 13F in the MF group); (ii) the three groups were similar in terms of age (LF: M = 24.53, SD = 3.82; MF: M = 23.84, SD = 4.07; HF: M = 23.06, SD = 2.65), frequency of video game use (LF, HF: median = 4; MF: median = 3.5), number of flights (LF: M = 2.84, SD = 3.10; MF: M = 3.19, SD = 2.81; HF: M = 3.06, SD = 2.96), and FAS score (LF: M = 59.75, SD = 20.99; MF: M = 55.91, SD = 21.02; HF: M = 57.31, SD = 18.66). Lack of significant differences among the three groups was confirmed by one-way ANOVA for age, frequency of air travel, and flight-related anxiety, and by Kruskal-Wallis test (used because the variable was ordinal) for frequency of video game use.

To measure participants knowledge about cabin safety, we used a test with nine questions: what to do in case of turbulence; what to do in preparation for impact; which exit should be the first choice for evacuation; when it is not possible to use an exit; what to do if the chosen exit cannot be used; what to do if there is smoke in the cabin during evacuation; what to do after using a

wing exit; what to do after leaving the aircraft; what to do with luggage. Answers were audio recorded and later rated by the experimenter as correct or wrong, following a codebook that listed the possible answers and their rating. To measure self-efficacy, we used a questionnaire with six items: I feel able to deal with an emergency evacuation of an aircraft; I would be able to deal with an emergency evacuation even if the aircraft is on fire; I would be able to deal with an emergency evacuation even if one or more exits are blocked; I would be able to deal with an emergency evacuation even if most of the passengers scream or cry; I feel confident of my ability to exit from the aircraft in time; 6) I would be able to help passengers in need. Each item was rated by participants on a 7-point scale. To measure the level of engagement experienced by participants, we administered a questionnaire that asked them to rate their level of agreement about six statements on a 7-point scale.

However, our study considered three displays with different fidelity, and showed that the serious game significantly increased participants safety knowledge regardless of the display used to play it. These results advance knowledge about the effects of display type on games: while previous studies compared only two displays, and showed that players preference went to the higher fidelity display , , , our study compared three types of display, and indicated that only the highest fidelity HMD led to a significant increase in self-reported engagement with respect to the monitor. Overall, our results confirm previous studies about the positive effects of higher fidelity displays on presence , , , , , and extend the findings to the domain of procedural training. Moreover, while those studies compared six-screen CAVE versus single screen , desktop versus HMD versus CAVE , desktop versus single stereo projected screen , or desktop versus HMD , , we compared desktop versus two different types of HMDs and found that the two types of HMDs led to different presence scores. In particular, the outcomes of studies that compared presence with such HMDs and other displays might change using new, wider FOV HMDs with a 6-DOF tracker. The hypothesis about the effect of display type on knowledge retention was not met. The knowledge gained using the serious game was retained two weeks later regardless of display type.

Analysis of the different aspects of presence found that overall presence, spatial presence, and the sense of being there were highest using the highest fidelity display, while no significant differences were found on the involvement and realism aspects of presence. While this study investigated the overall effects of three typical VR display setups, we plan to carry out a study that will focus on the highest fidelity display and assesses its effects with 3-DOF versus

6-DOF head tracking enabled. In particular, using the same high-fidelity display, we plan to compare the use of a joystick versus hand tracking for activating actions, assessing if higher interaction fidelity will result in higher presence and engagement.