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# Diegetic vs. Non-Diegetic GUIs: What do Virtual Reality Players Prefer?

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**Abstract**

*Graphical user interfaces should not be a limiting factor when it comes to designing immersive virtual reality games. In this work we evaluate two different GUI designs for VR games: A non-diegetic HUD and a diegetic GUI, utilizing objects in the virtual environment to convey information. A pilot study was conducted to measure the players presence in VR and their GUI preference. Our results indicate that players prefer the diegetic GUI over the non-diegetic one. However the results lack statistical significance and thus further studies are necessary to identify the factors leading to the this preference.*

**CCS Concepts**

• ***Human-centered computing*** → ***Virtual reality; Graphical user interfaces;*** *User studies;*

## 1. Introduction

Graphical user interfaces (GUIs) are important components of interactive video games. They present information to the player about their avatar, environment and how to interact with it. A poorly designed GUI hinders the felt *presence* in a game, leading to a less enjoyable player experience. Presence is the feeling of being in one place while physically being in another [WS98]. A high degree of presence leads to virtual objects being experienced as real objects. In order to create an enjoyable experience for the player, a high feeling of presence is required [Lee06].

In video games, the two most popular design approaches for GUIs are diegetic and non-diegetic. *Diegesis* describes all objects existing within the VE (i.e. diegetic objects) [Gal06]. All other objects that are not part of the VE are considered non-diegetic [SBLJM13]. A GUI that displays information on a heads-up-display (HUD) is not part of the VE and therefore non-diegetic. In contrast, a GUI that utilizes objects within the VE to display information is considered diegetic.

Our research on diegetic GUI design is driven by the hypothesis that the presence is higher in the diegetic game version compared to the non-diegetic version. Therefore, we expect that players will prefer the diegetic GUI over the non-diegetic one.

## 2. Methodology

To evaluate the two GUI designs a VR one-on-one fighting game was developed using the Unity3D engine. Players deplete resources to attack their opponent or to defend themselves. Game immersion was achieved through the use of a VR headset and the Microsoft Kinect (depth camera) for full body tracking, allowing complete avatar control. To test whether a player prefers diegetic or non-diegetic GUIs in VR games, two game versions were created that differ by their respective GUI, as shown in Figure 1.

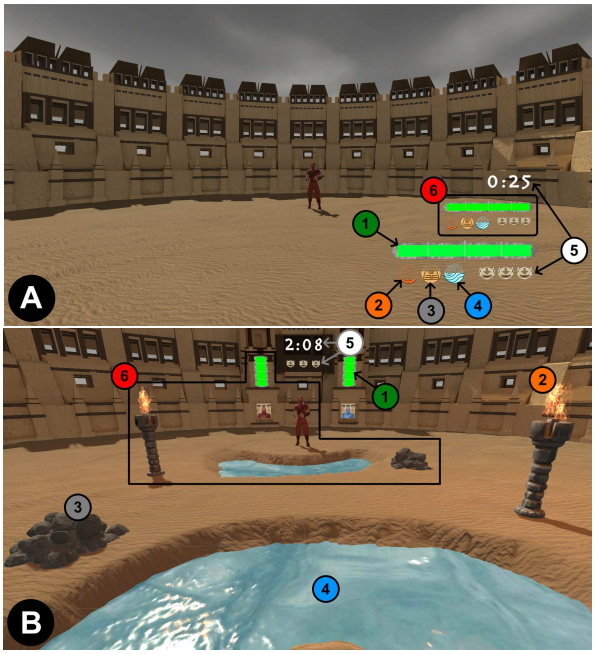


**Figure 1:** *Non-diegetic (A) and diegetic GUI (B). Both display the same information: Player health (1), element amount (2-4), remaining time and round indicators (5), enemy status (6).*



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All participants played two matches, switching GUI versions in between. After each match, participants removed the VR headset and answered a questionnaire, quantifying the players presence in the VE. To quantify the players presence, the presence questionnaire by Witmer and Singer [WS98] was used.

## 3. Results

Thirteen participants (11 male, 2 female) aged between 19 and 30 (Avg=25.79, SD=3.09) participated in the user study. The group's mean level of VR experience on a 5-point scale was 1.38 (SD=0.87).

### Presence Questionnaire

For scoring, the Witmer and Singer Presence Questionnaire was divided into four categories: Control factors, sensory factors, distraction factors and realism factors.

One-way ANOVAs with repeated measures were performed to compare the factor sub scores between the two played versions. The median, means and standard deviations are displayed in Table 1. There was no significant difference between version A and version B in 'control factors' ($F(1,24)=0.06$, $p=0.8$, $\eta^2=0.003$), 'sensory factors' ($F(1,24)=1.26$, $p=0.28$, $\eta^2=0.050$), 'distraction factors' ($F(1,24)=0.9$, $p=0.34$, $\eta^2=0.036$) and 'realism factors' ($F(1,24)=0.04$, $p=0.82$, $\eta^2=0.002$).

| | Version A | | | Version B | | |
|---|---|---|---|---|---|---|
| | M | Avg | SD | M | Avg | SD |
| Control Factors | 4.77 | 4.73 | 0.74 | 4.77 | 4.66 | 0.70 |
| Sensory Factors | 3.91 | 4.29 | 0.82 | 4.36 | 4.61 | 0.59 |
| Distraction Factors | 3.17 | 3.26 | 0.64 | 3.00 | 3.04 | 0.51 |
| Realism Factors | 4.71 | 4.86 | 0.63 | 5.00 | 4.91 | 0.65 |

**Table 1:** *Evaluation of the four factors from the Presence Questionnaire. (M = Median, Avg = Mean, SD = Standard Deviation)*

### Ranking

The participants were asked which GUI they subjectively preferred. Eleven out of 13 participants preferred the diegetic version. To determine the degree that these results show a diegetic GUI preference, a right sided hypothesis test was performed. Given a rejection interval of [11:13] from our experiment, the certainties in Table 2 were calculated.

$H_0$: P(X = preference diegetic GUI) = $p_0$

| $p_0$ | 0.5 | 0.6 | 0.7 | 0.8 |
|---|---|---|---|---|
| $H_1$: P(X) > $p_0$ | 98.80% | 94.30% | 79.70% | 49.80% |

**Table 2:** *Certainties with which the data supports a diegetic GUI preference greater than $p_0$.*

## 4. Discussion

It was attempted to answer the question if players would prefer a diegetic over a non-diegetic GUI in VR games. Even though the results of the Presence Questionnaire are not statistically significant, trends can be observed.

The sensory- and distraction factor scores from the presence questionnaire are particularly interesting and show the most promising trends for future investigations. Future studies should keep in mind, that the non-diegetic version had considerably fewer objects in the VE, compared to the diegetic version. This might have impacted the presence scores. It could therefore be interesting to design a non-diegetic version with the same object count and visual fidelity inside the VE, as the diegetic version.

The HUD elements in the non-diegetic version needed to be kept small and placed in the corner of the screen to not obscure the players view. As a result, participants needed to move their eyes to the corners of their screen, eventually distracting them from their opponent. In contrast, the diegetic version utilised objects directly in front of the participants. In future studies, eye tracking could provide further insight into how much time participants spend looking at each GUI elements.

An overwhelming amount of 11 out of 13 participants preferred the diegetic GUI. However, the participant count is too low to make a definitive statement about an exact percentage of players preferring the diegetic GUI. But as shown in Table 2, with a certainty of nearly 99%, more than 50% of players prefer the diegetic GUI, leaving two explanations for the statistical insignificance of the presence scores: Either more participants are needed to detect significant differences, or the real reason resides in a factor not captured by our data.

## 5. Conclusion

This contribution extends the research on diegetic GUI design in VR games to evaluate its effect on presence and to determine a players preference. Two hypotheses were tested: (1) That the presence is higher in the diegetic game version than in the non-diegetic one and (2) that players prefer the diegetic to the non-diegetic GUI.

Our user study shows a clear preference for the diegetic over the non-diegetic GUI. Thus we can validate the second hypotheses. However, this study was unable to demonstrate any benefits in terms of the players sense of presence in the diegetic version compared to the non-diegetic version. This is likely due to the low amount of participants resulting in statistically insignificant scores for the presence questionnaire. Thus, we cannot verify nor reject the first hypothesis. Further studies are required to identify the factors leading to this preference.

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