Characterising the Benefits of Multi-Modal Play in Virtual Reality

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ABSTRACT

With the rising popularity of VR technologies, more people are experiencing what this medium has to offer. Right now, the most popular games are either single-player or online-multiplayer, leaving the people in the same room without a way of interacting with the HMD (Head Mounted Display) player. For VR to become mainstream, this problem has to be solved. A preliminary experiment was conducted in which two different ways of including a second person in the VR experience (through a PC or a Phone) were compared in terms of co-presence and immersion. Results showed that both ways are valid and can be used to add a second player — the quantitative data gathered from two surveys (Networked Minds Measure of Social Presence for co-presence and iGroup Presence Questionnaire for Immersion) showed that there was no significant difference, and the qualitative data, which revealed 13 distinct themes divided into five categories, helped with understanding the survey results. The next steps are to concentrate on one of the categories (embodiment) and conducting a systematic review into ways of increasing it, followed by expert interviews to confirm the findings and create a definitive list of factors that affect embodiment. Finally, a second experiment will be conducted in order to confirm the validity of the factors.

CCS CONCEPTS

• **Applied computing** → Computer games; • **Human-centered computing** → **User studies**; **Virtual reality**; *Collaborative interaction.*

KEYWORDS

co-presence; immersion; virtual reality; mixed reality; multi-modal; co-located; StuckInSpace; asymmetrical play

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1 INTRODUCTION

As Virtual Reality technology grows more accessible and widespread, we need to start exploring how it can be used in the social setting, more precisely, in the living room. Currently, the technology is predominantly concentrating on serving a single user, to make the experience more immersive. When discussing social VR, there are also a few notable examples like *VRChat* where people can gather around in online rooms and socialize. What this leaves is "the social living room environment" [7] — while a person may have a VR headset at their home, it is difficult for others to participate.

Of course, there are some examples of games where multiple players participate alongside the HMD player, such as *Keep Talking and No One Explodes* [5], where the non-HMD players are reading a manual to help the HMD player defuse a bomb, or *The Playroom VR* [12], in which non-HMD players use a controller and a TV screen to interact with the game and the HMD player. They show us two different ways of achieving a local co-op VR game, both having advantages and disadvantages. But there are many more ways of introducing multiple players to the game.

2 RESEARCH GOALS

My research focuses on multi-modal play in virtual reality, and thus the research questions are about that: Is having a second player participate in the VR game beneficial in terms of immersion and co-presence for both users? What are the best ways to include such player so that the experience is as good as possible? What types of interaction are possible between HMD and non-HMD players?

3 BACKGROUND RESEARCH

Prior work into VR often centres around co-presence [6, 11], immersion [10], and co-located experiences [2, 3, 7].

Co-presence, as defined by [6] and [11], is the way that the other person perceives you and the reciprocal feeling of them doing the same. This is important for the research as seeing if one method brings about a more pronounced feeling of co-presence would help when creating an experience where one would want people to feel each others' presence more.

The term immersion has a few interpretations in the literature: [10] talks about it being more a measurable property of a system, while [13] think it is closer to how a person responds to the system. [13] also define presence, which is the *"subjective experience of being in one environment, even when physically in another"* [13]. I use the term immersion to mean [13]'s definition of presence.

Previous work in this sphere includes ShareVR [7], where the authors created a multi-modal setup using projectors and screens, to explore ways of making the second player interact more easily

with the HMD user. [2] on the other hand go though a different approach where the second player is there to aide the experience of the HMD player, and show that even though the non-HMD users are not playing the game, they still found enjoyment in helping the other person experience a more immersive game.

4 METHOD

I have experimentally compared the effects of co-presence and immersion on the players in a multiplayer virtual reality game. Immersion was chosen as it is a main motivation behind the idea of VR, and thus knowing whether the second player heightens or lowers the immersion of the HMD player is needed, and if either of the two versions is better in that regard — this can also be applied to the second player. Co-presence, on the other hand, was chosen because I wanted to see if having a second player next to the HMD player (in the case of the phone) would increase their sense of co-presence, possibly leading to an increased sense of enjoyment as [4] suggest in their study. A game was created for the purposes of the study (*Stuck In Space*), in which a HMD player is an astronaut in their spaceship that breaks down, and the second player is a drone that has to help them fix it using either a PC or a tracked Phone. This creates a game where both players have to cooperate to finish. Using this game, I explored the difference in co-presence and immersion using two questionnaires — the Networked Minds Measure of Social Presence [1, 8] for co-presence and the iGroup Presence Questionnaire [9] for immersion. The study consisted of the two players going through the game once, filling in the questionnaires and then swapping and repeating. After that, a short semi-structured interview was conducted with questions inspired by the aforementioned questionnaires.

5 RESULTS TO DATE

24 people participated in the study, and analysis of the quantitative results showed that there was no significant difference in immersion and co-presence between the versions, except for the immersion between the VR headset and the phone and PC respectively. The results were surprising to an extent, as the expectation was that the phone version would see an increase in co-presence as both players are closer to each other, and an increase in immersion for the phone player compared to the PC player based on the fact that they have to physically move in the space and thus should feel more immersed into this space. After analysing the qualitative data, a total of 13 themes emerged, across 5 major categories: Cognitive engagement, Embodiment, Sensory Perception, Knowledge, and Agency in the Virtual World. These themes could help explain the surprising results of the quantitative data, suggesting that there were multiple competing factors affecting each version.

6 CURRENT AND EXPECTED CONTRIBUTIONS

Currently, my research has contributed in several ways:

- *Stuck In Space*, a multi-modal co-op VR game that is used to explore the difference between two modes of play;
- results from a user study, comparing how the introduction of a second player affected the participants' co-presence and immersion;
- a list of design considerations for when creating such multi-modal co-op VR games.

By the end of this PhD I would have also contributed with a list of ways of achieving *embodiment* in multi-modal games, together with results from a study testing them.

7 CONCLUSIONS AND FUTURE WORK

From the current results a few different points of interests came up. For example, how *maintaining a mental model of the real world* or how different kinds of *embodiment* (physical and narrative) affect the immersion of the players. Considering that, future work will concentrate on exploring *embodiment*: a systematic review will be conducted, in which the different ways of achieving it will be investigated. After which, a number of expert interviews will be conducted, to verify the methods suggested by the systematic review, and to discover what experts in the field do to increase *embodiment*. The next step would be taking the results from the systematic review and expert interviews and putting them into a multi-modal VR game to test whether there is a difference in the methods that were found.

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