Singularity: Designing a Cooperative Mixed Reality Game for a Co-located Setting

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INTRODUCTION
Fostering cooperation within a mixed reality game requires careful planning of interaction, movement and communication. The factors that need to be taken into consideration include the limited interaction space, latency and occlusion of the tracking system, and the physical proximity of players (Kortbek, 2008; Mueller et al, 2014), in addition to issues such as the mapping of co-located to virtual space, motion sickness and guiding the attention of the VR player.

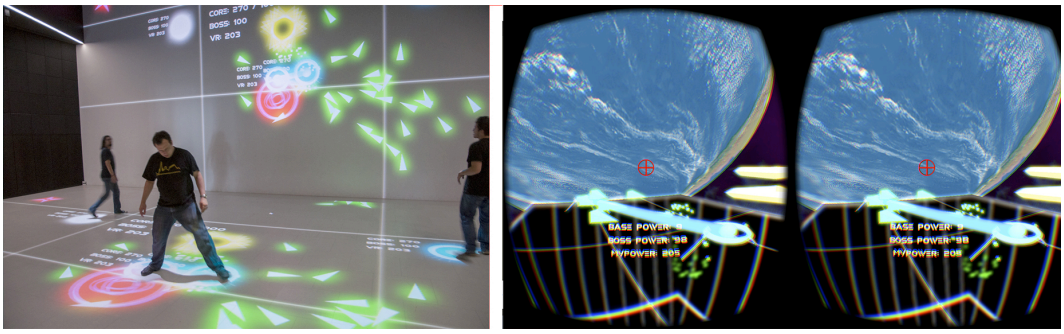

Figure 1: Co-located gameplay (left). Virtual reality perspective (right).

Singularity consists of two networked applications: a 2D co-located game, tracking player movement and augmenting physical space with virtual avatars based on their position; and a VR game, providing a 3D representation of the 2D game for one player, who communicates and interacts with the virtual avatars of the co-located players (see Figure 1). Cooperation between these environments is essential for defeating a common computer-controlled enemy and defending the home base. The games are isomorphically mapped (Lindley, 2005) to each other in order to avoid confusion and provide players with a smooth transition between game environments. To stimulate collaboration, each of the player types is given a specific set of abilities. Co-located players can connect in pairs and generate a laser between each other. The VR player has an extended view of the world and is able to see where enemies are coming from and alert co-located players. In addition, the VR player can summon co-located players and, with their help, trigger an

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area attack which is used to destroy a particularly resilient enemy. A capture mechanic which required co-located players to stand close to the VR player in order to expand a net and capture enemies, was also tested, but proved to be too complex for players.

EVALUATION

An expert evaluation was conducted with two specialists from the field of VR focusing on three main areas: the experience of the VR player; communication and collaboration between the two environments; and usability and audiovisual presentation. The results of the evaluation suggested specific areas of improvement, but also provided support for the proof-of-concept and aspirations for future exploration of the subject matter. The following design elements were discussed:

- **Co-located players' abilities**: Allowing players to connect by standing close to each other fosters collaboration, but makes single player mechanics obsolete due to the fact that people prefer working together if that benefits them more. More complex mechanics such as the aforementioned capture mechanic are often not understood.

- **Virtual reality environment:** The speed and scale of the VR avatar need to be fine-tuned, and more intuitive input methods should be considered (i.e. the game controller used for VR avatar movement was not an optimal choice). Providing co-located players with more accurate positional information could be achieved by drawing paths in space.

- **Audiovisual presentation:** Color codes and contrast need to be adjusted. Animations present users with important visual feedback to their actions. Audio feedback is essential for notifying players about game events, the positions of enemies and the state of the VR player. Dedicated sound for the VR player (separate from the co-located players) would be required for better orientation.

CONCLUSION AND FUTURE WORK

The design and implementation of collaborative mechanics and audiovisual communication methods have led to a number of informative discoveries regarding this hybrid setting. Fostering player collaboration and sociability in a VR game by connecting it to a co-located setting presents players with a new form of interaction and opens the door for further experiments in this area. Future work will explore the use of mobile VR HMDs to allow players to physically move in a 'holodeck' type experience, located in the same space as other players, but each presented with their own 3D view of the game world.

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