CleaVR: Collaborative Layout Evaluation and Assessment in Virtual Reality

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Figure 1: CleaVR system showing a participant using gesture-based controls (a), first person viewing (b), and collaborative assessment with multiple users (c)

ABSTRACT

Layout planning is a process often used in architectural interior design, for factory production plans, and so on. We present CleaVR, a system that provides the user with an immersive virtual reality system that accurately visualizes the layout plan in three dimensions as shown in Figure 1(a). The user is able to freely orbit around the design to observe it in every angle for an accurate evaluation and assessment. The implemented gesture recognition system means that no physical buttons are required, allowing a complete immersion with intuitive controls. These controls allow the user to pan around the environment, pinch to pick and place objects, as well as swiping the view to switch into first person view, as shown in Figure 1(b). With our system, architects, engineers, designers, and even sports analysts may approach their targeted environment through a multi-user, multi-view tool with full control of the virtual environment purely by intuitive gesture controls.

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CCS CONCEPTS

• **Computing methodologies** → **Virtual reality**; • **Hardware** → *Sensor devices and platforms*;

KEYWORDS

collaborative virtual reality, layout planning, orbital navigation

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1 INTRODUCTION

Typically, layout planning requires the users to gather around to discuss about the design of the floor plan with documents showing the two dimensional or top down images of the design proposals. However, this lack of visualization causes inconsistencies among

Figure 2: CleaVR applied in sports formation planning

designers, engineers, or architects, further increasing the time and effort required to generate a feasible design. Furthermore, they do not get real-time updates on the design as well as a first person perspective, both which are extremely important yet severely lacking in conventional layout planning tools. There has been several work that addresses layout planning [Ibayashi et al. 2015; Stoakley et al. 1995], yet they require physical controllers or buttons, only caters to a fixed point of view with limited functionalities for the users, or can only facilitate a single participant. With our system, architects, engineers, designers, and even sports analysts may approach their targeted environment through a multi-user, multi-view tool with full control of the virtual environment purely by intuitive gesture controls.

2 IMPLEMENTATION

We developed the CleaVR system around the idea of a virtual reality (VR) environment with motion gestures. To achieve this, the Oculus Rift Development Kit 2 head mounted display (HMD) was used to display the virtual content. Hand motion was tracked by the Leap Motion sensor which was mounted on the Rift. This sensor provides an even wider 150°field of view which is suitable for gesture recognition. Powering these devices is a computer running an Intel Core i7-6700 clocked at 3.40Ghz and an Nvidia Geforce GTX 980 graphics card for VR rendering. The Unity engine was used for the development of the virtual environment. To facilitate multiple users, Photon's cloud-based networking was used to instantiate each user who joins the same environment. Remote Procedural Calls (RPCs) was used to sync the position and rotation of all the virtual objects across the network. All of the behaviors of the virtual content was coded with C# programming. This includes the networking aspect, positioning of the objects, manipulation of each object, toggling between the orbital and first person view, Leap's gesture recognitions, and VR output.

3 USER EXPERIENCE

Our system provides the user with an accurate visualization and representation of the environment and provides them with complete control over all of the virtual objects present. Compared to previous work, our system improves on three key aspects that are usually not the focus of other work, yet is extremely important; the absence of physical controllers or buttons that can disconnect the immersion in VR, multiple perspectives for a full environmental manipulation, including multistory buildings, and facilitates collaboration with other users as shown in Figure 1(c), while simultaneously providing the complete set of tools for each user in the shared environment. It is also worth mentioning that orbital viewing in different perspectives provides the user with a higher degree of control when determining features like lighting condition, open plan privacy, emergency escape routes, and so on.

Due to an intuitive use of gesture recognition, such as pinching of pick-and-place operations, right arm for panning the center point of the orbital view, and swiping across the screen to switch perspectives, arm fatigue can be minimized. This is a common issue when implementing gesture recognition, especially in VR that typically requires the user to constantly have both hands raised and visible. In our system, gesture is used sparingly since no form of navigation or locomotion is assigned to gestures, whereas both forms of viewing are assigned to head movement. The use of this system is diverse and can be extended not only for interior based layout design, but also for formation planning in sports. Past research in this field has mainly focused on first person view for sports simulation and rarely on formation planning [Miles et al. 2012]. Figure 2 shows that the user may pick and place players around the game field for strategizing formations, with a swipe gesture to pass the focus between each player to get every perspective of the game field. The new formation then can be viewed in action in an overview mode. This system is particularly useful for sports that require 3D formations, like synchronized swimming and aerobatics.

4 CONCLUSIONS

The proposed CleaVR system provides the user with an immersive an intuitive VR-based environment that facilitates the collaborative nature of layout planning. Since each user is provided with the freedom and tools to manipulate and view the environment in multiple perspectives, this naturally brings the interaction with virtual content to a new level that is rarely provided, such as the ability to view and interact in multistory environments with gestures. The potential application of the system has also been demonstrated in sports formation planning, proving that it is a useful tool in various fields. In the future, this system will be further improved so that each user can actually see other avatars' arm movements as well, instead of just the objects being picked and placed.

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