CoGlobe — a Co-located Multi-Person FTVR Experience

Extended Abstract

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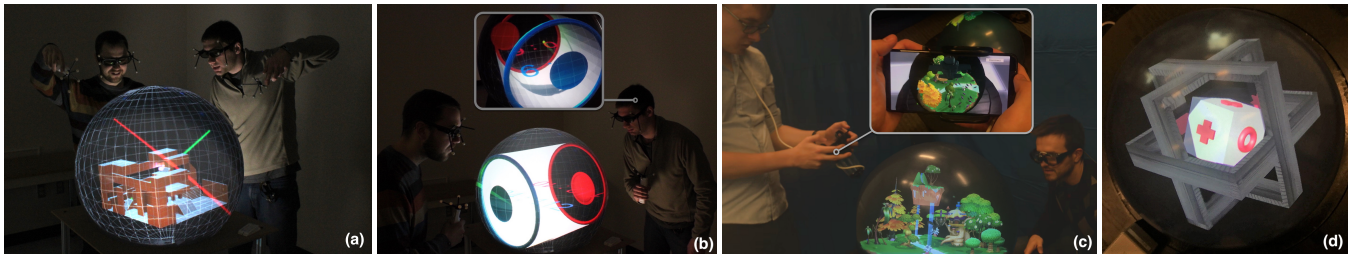

Figure 1: With CoGlobe, two users (a) collaborate on a pathtracing task, (b) play 3D Pong, (c) play a 3D drone game together with left user using his phone as display and input device, and (d) solve a mental rotation puzzle.

ABSTRACT

Fish Tank Virtual Reality (FTVR) creates a compelling 3D illusion for a single person by rendering to their perspective with head-tracking. However, typically, other participants cannot share in the experience since they see a weirdly distorted image when they look at the FTVR display making it difficult to work and play together. To overcome this problem, we have created CoGlobe: a large spherical FTVR display for multiple users. Using CoGlobe, Siggraph attendees will experience the latest advance of FTVR that supports multiple people co-located in a shared space working and playing together through two different multiplayer games and tasks. We have created a competitive two-person 3D Pong game (Figure 1b) for attendees to experience a highly interactive two-person game looking at the CoGlobe. Onlookers can also watch using a variation of mixed reality with a tracked mobile smartphone. Using a smartphone as a second screen registered to the same virtual world enables multiple people to interact together as well. We have also created a cooperative multi-person 3D drone game (Figure 1c) to illustrate cooperation in FTVR. Attendees will also see how effective co-located 3D FTVR is when cooperating on a complex 3D mental rotation (Figure 1d) and a path-tracing task (Figure 1a). CoGlobe overcomes the limited situation awareness of headset VR, while retaining the benefits of cooperative 3D interaction and thus is an exciting direction for the next wave of 3D displays for work and fun for Siggraph attendees to experience.

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CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Collaborative and social computing**; **Collaborative and social computing devices**; • **Hardware** → *Emerging interfaces*;

KEYWORDS

Fish Tank Virtual Reality, Mixed Reality, 3D Displays, Collaboration

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1 INTRODUCTION

Spherical Fish-Tank Virtual Reality (FTVR) displays have advanced in recent years with new form factors [1] and improved calibration techniques for both viewpoint-tracking [2] and multi-projector blending [3]. These advances have increased the fidelity of the 3D FTVR experience, but it remains almost exclusively a single person experience. The challenge for co-locating multiple people around a FTVR display is that different images need to be rendered to the display simultaneously based on each user's viewpoint. If users are exposed to images not correctly aimed at their viewpoint, the image will look distorted and break the 3D illusion. To overcome this limitation, we have created two different approaches to enable multiple people to see the 3D content from their own perspective registered to the same location in the real world, thus, enabling 3D co-located work and play.

Working and playing in virtual reality is much more exciting if it allows people to share their experience. Efforts have been made by Belloc et al. [1] to introduce two-person viewing using shutter glasses, but their focus was on a handheld form factor with

low fidelity projection. We have created a more compelling display called *CoGlobe*. It provides a view for both users by using 120Hz projectors with a larger spherical display to provide a frame rate of 60Hz to each user and a large display area. For the version we propose to bring to Siggraph E-tech, we use a 24" diameter spherical display, with four 120Hz stereo mini-projectors calibrated with an advanced automated camera-based, multi-projector calibration technique [3] to enable the edges to be rendered correctly to maximize the view area. We use a multi-camera OptiTrack system for tracking users' heads and multiplex viewpoints using modified active shutter glasses. We also introduce multi-person interaction with CoGlobe using tracked mobile smartphone screens.

2 CONCEPT

Our concept targets multiple co-located users around CoGlobe. In the current version of CoGlobe, two people are able to interact directly with the FTVR content simultaneously by using active shutter glasses to multiplex the participants' views. Projectors operating at 120Hz generate images for both users on the spherical surface of our FTVR. By multiplexing views using shutter glasses, each user only sees the monocular images from their own tracked head position while the other person's views are filtered out.

As they can move completely around the sphere, they can choose to either stand side-by-side to gain a similar perspective or further apart to look at the scene from different angles simultaneously. By co-locating users around the same screen we adhere to the main idea of putting FTVR and its content as an entity into the real world.

Additionally, we provide mobile screens to allow more co-located people to also look at the same content in CoGlobe. By using a separate, tracked mobile screen for each additional user to look at CoGlobe, we overcome the problems that would occur if we further multiplexed the views using active shutter glasses. Specifically, further multiplexing views would lower the frame rate as well as make the images look dimmer for each user. Thus, we currently limit the number of users looking directly at CoGlobe to two and others join using the tracked mobile display. Essentially, each user's phone becomes a virtual camera into the virtual world so that they can participate in the experience too. By moving it around, they also experience a motion parallax 3D effect. Users can also interact with the scene with the touch screen on their smartphone or can directly touch the touch-sensitive surface of the CoGlobe.

Through co-location, users can explore a virtual environment together while at the same time interacting with each other in the real world. At *Siggraph 2018*, participants will experience this new spherical FTVR interaction through a number of cooperative and competitive games and tasks discussed next.

2.1 Experience

In our first scenario, a two-player competitive Pong game, two players can simultaneously interact with the same FTVR and play against each other. In a similar fashion to desktop split-screen multiplayer games, people will engage in playing while being able to see the other player, talk to them and have fun together. However each person only sees their own view on the screen. Using our approach, each player uses the full screen during gameplay and can see what the other person is looking at for strategic fun which improves the overall experience of the game significantly. We use a Wii remote controller to make the game highly responsive, fun and engaging.

Our second scenario, a multi-person drone game, offers a 1 + many-player experience where one person is primarily using CoGlobe directly, a second person interacts using the tracked smartphone. The direct player moves a drone with a claw around in 3D to pick up apples to drop in a basket controlled by the smartphone player. The smartphone player moves their phone and uses the touch screen to move a helicopter around in 3D and put a basket in the correct place to catch apples dropped by the direct player. The smartphone player is also able to shoot candies at butterflies who are trying to get the apples that the direct player is trying to pick up. So, together, they can collect as many apples as possible while saving the apples from hungry butterflies. This game is highly engaging and illustrates how co-located 3D interaction gets people talking and helping each other.

In our third scenario, we also present more work-oriented tasks we are studying in our human computer interaction research to showcase two-person collaboration on difficult problems related to real-world tasks using CoGlobe. In one task, users cooperate through discussion and pointing into the scene to solve a difficult mental rotation task, shown in Figure 1d, by looking from different perspectives and thus being able to provide information which is hidden from their counterpart. The same principle is also explored in a path tracing task that is shown in Figure 1a. Here players try to follow a path around a 3D building by pointing along the path. Since the environment features substantial occlusion, different viewpoints are critical for following the path. These tasks have been carefully chosen to represent some of the challenging 3D interaction tasks found in real-world situations, thus, Siggraph participants can feel the difference working together in 3D FTVR can make.

2.2 Novelty

We have now created new ways to support multiple users while at the same time keeping the core concept of FTVR which is a perspective-corrected three-dimensional display. Thereby, we have overcome the problems with users losing awareness of their surroundings that are present in other VR concepts. Instead, users orient themselves closer to traditional displays which place the virtual world as an entity inside the real world. With CoGlobe, We now are providing a full FTVR experience for two people at the same time and allowing additional people to participate through tracked mobile smartphone displays. Thus, we allow users to experience VR together while keeping the ability to interact with each other in the real world. Furthermore, we have substantially improved upon the handheld spherical FTVR presented at [1] by introducing augmented smartphone screens as well as using improved automatic multi-projector calibration to provide a high-quality, multi-person, co-located, large spherical FTVR experience.

REFERENCES

OR Belloc, MR Nagamura, D Fonseca, A Rodrigues, DAR Souza, CS Kurashima, MM Almeida, EZ Borba, RD Lopes, and MK Zuffo. 2017. OrbeVR: a handheld concave spherical VR display. In *ACM SIGGRAPH 2017 Emerging Technologies*. 19.

A Wagemakers, D Fafard, and I Stavness. 2017. Interactive visual calibration of volumetric head-tracked 3D displays. In *ACM CHI 2017*. 3943–3953.

Q Zhou, K Wu, G Miller, I Stavness, and S Fels. 2017. 3DPS: An auto-calibrated 3D perspective-corrected spherical display. In *IEEE Virtual Reality 2017*. 455–456.