Pond of Illusion: Interacting through Mixed Reality

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Figure 1: *(left) Setup using two screens each with a Microsoft Kinect camera. (middle)(right) Throwing breadcrumbs into a virtual pond.*

Pond of Illusion is a mixed reality installation where a virtual space (the pond) is injected between two real spaces. The users are in either of the real spaces, and they can see each other through windows in the virtual space as illustrated in Figure 1(left). The installation attracts people to a large display in either of the real spaces by allowing them to feed virtual fish swimming in the pond. Figure 1(middle) shows how a Microsoft Kinect mounted on top of the display is used for detecting throw motions, which triggers virtual breadcrumbs to be thrown into the pond for feeding the nearby fish. Of course, the fish may not be available because they are busy eating what people have thrown into the pond from the other side.

Beck et al. [2013] presented a telepresence system where depth cameras are used to extract 3D representations of people in a real space which are then embedded in the virtual environment. In the Pond of Illusion, the other group is seen through a window in the virtual environment. Thus, our installation is an example of a fairly unexplored part of mixed reality as described by Milgram and Kishino [1994] where you interact with both the virtual environment and with people in a real environment. Compared to the work of Beck et al. [2013], our approach is simpler. This simplicity restricts applications, but is otherwise a great advantage, making the system very easy to implement and artifacts very few.

The goal is to create an immersive and playful game-like experience designed to be easy to understand and use. The only usability hint given is a red sign ironically warning people not to feed the fish. The fish-feeding mechanic indirectly encourages people in both real spaces to compete on which side can attract the largest flock of fish.

1 Our approach

The installation uses two computer systems each with its own display and Kinect camera. A video stream is captured by the camera, sent in compressed form over a network cable and displayed as a textured quad on the opposite system at 30 frames per second.

Skeletons tracked by the Kinect are used for detecting throw gestures, simply by looking at the velocity and acceleration of the skeleton hands. A velocity above a certain threshold with an oppositely directed acceleration will trigger breadcrumbs to be thrown into the virtual room from the hand position.

When only a single person is detected in the camera field of view, the head is tracked and the view into the virtual room is adjusted to achieve head-coupled perspective [Francone and Nigay 2011]. This gives a more immersive experience allowing people to see more of the environment.

The water in the scene is simulated using the wave equation. A heightmap texture is updated using a semi-implicit Euler method running on the GPU. Waves are generated by both a small fountain and by breadcrumbs colliding with the water. Rendering of the water surface uses the gradient of the heightmap texture for both lighting and reflection. Caustics are rendered by tracing light particles through the surface to the first intersection with the basin.

The fish behavior is simulated on the GPU using flocking [Reynolds 1987]. The flocking algorithm models collision avoidance against walls and other fish, velocity matching with nearby fish, flock centering and attraction to breadcrumbs. Some random movement is added to make the fish act more naturally. Breadcrumbs attract the fish while the breadcrumbs flow on the surface, but the attraction goes away when the breadcrumbs dissolve as they sink toward the bottom. The fish are animated on the GPU procedurally.

The Pond of Illusion was created as a technical demo for the inauguration of our department. It is a fun installation, which we now also see as a proof of concept for a simple and effective way to implement mixed reality: the Kinect acquires both video and information about the body pose and movement of one or more users. This combination makes the Kinect (and similar devices) a powerful tool not only as an input device but also for communication.

References

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