VirtualTable: a projection augmented reality game

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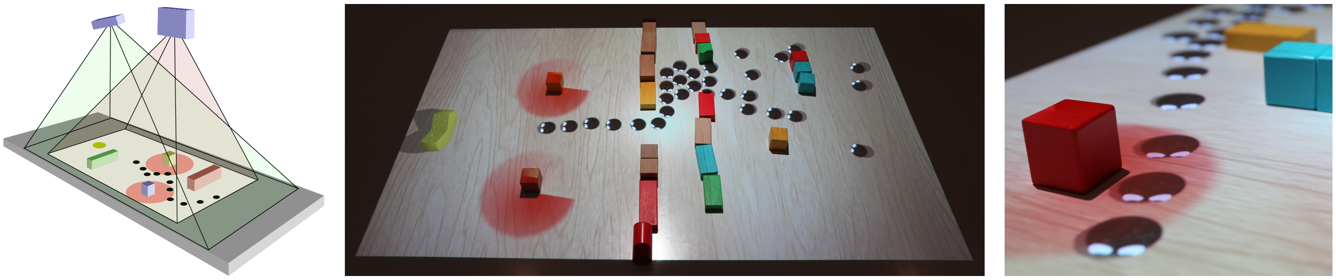

Figure 1: *(left) Our setup using projector (red frustum) and a Kinect camera (green frustum). (middle,right) Pictures of the gameplay.*

VirtualTable is a projection augmented reality installation where users are engaged in an interactive tower defense game.The installation runs continuously and is designed to attract people to a table, which the game is projected onto. Any number of players can join the game for an optional period of time. The goal is to prevent the virtual stylized soot balls, spawning on one side of the table, from reaching the cheese. To stop them, the players can place any kind of object on the table, that then will become part of the game. Depending on the object, it will become either a *wall*, an obstacle for the soot balls, or a *tower*, that eliminates them within a physical range. The number of enemies is dependent on the number of objects in the field, forcing the players to use strategy and collaboration and not the sheer number of objects to win the game.

Our installation is an example of a combination of tangible user interfaces [Shaer and Hornecker 2010] and projection augmented reality [Mine et al. 2012]. Leitner et al. [2008] presented IncreTable, a tabletop game that includes multiple inputs from different devices, including physical objects. Molla and Lepetit [2010] present a similar concept of augmented board game, but in their case the output is shown on a screen and not re-projected on the game. Compared to Leitner et al. [2008], our interaction design can be learned by exploration and thus requires no instructions. This is important in child-computer interaction and in combination with the use of tangibles it empowers the shift from “learning by being told” to “learning by doing” [Hourcade 2008]. We thus believe that our VirtualTable is an excellent concept for development of immersive and engaging learning games for children.

Our approach

VirtualTable uses a computer unit attached to both a Kinect camera and a projector. We first process the input from the Kinect depth camera, then we pass it to the actual game to display the output.

The objects are recognized using the depth camera of the Kinect. We automatically calibrate our software once before the game is actually started, to estimate both a ground depth and the Kinect-projector homography. After the calibration, objects of any significant depth (at least 0.5 cm) can be recognized. The output of the depth camera is used to create a bounding box around the objects. We exclude objects that are connected to the border, to avoid recognizing the players’ hands. In Figure 1 (left) we see that the Kinect camera covers an area bigger than the game area, to not accidentally exclude objects lying on the border.

We transmit the identified bounding boxes to the actual game using a custom made protocol. In the virtual game, wall objects are invisible and affect only the behavior of the soot balls. We project a red glow around the towers to distinguish them and give a visual feedback on their range (see Figure 1 (right)). When we update the set of recognized boxes, we compare it with the existing set. Matching boxes have their position updated, interpolating it with their old position to avoid flickering. The remaining boxes are either added or removed to the game accordingly. Objects are distinguished only by shape: elongated objects are walls, square-like objects towers.

The behavior of the soot balls is simulated using Unity Engine’s built-in navigation system on navigation meshes. A tower, with a given frequency, shoots bullets to the soot balls within its range, removing them from the game.

The game explores the concept of augmented reality games, combining the tangible sensation of the pieces from board games and the immediate visual feedback from modern computer games.

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