Development of an Augmented Reality Game by Extending a 3D Authoring System

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ABSTRACT

In this paper, we describe the development of augmented reality games using the virtools dev 3D authoring system and custom extensions that allows to integrate augmented reality features and advanced interaction techniques. We used this system to create an AR game by extending an existing board game with virtual objects. The concept of predefined high-level building blocks and the visual programming environment supports the iterative design approach and allows to quickly develop and test new game ideas.

Categories and Subject Descriptors

D.2.6 [**Programming Environments**]: Graphical environments – *authoring system, iterative prototype approach.*

General Terms

Design, Human Factors

Keywords

Augmented Reality, Iterative Prototyping, Virtools

1. INTRODUCTION

With the advent of advanced 3D interaction techniques, a new class of games is now ready to fulfill the gamers' requests for new and intuitive ways of interaction. With intuitive interactions concepts like Nintendo's Wii or Sony's Eyetoy a new game experience is available. Game interaction techniques are based on real movements and are important parts of the game concept. To achieve those natural and intuitive types of controlling a game new interaction techniques and graphical representations are required, for example tangible computing or augmented reality. While tangible user interfaces are excellent in simplifying the interaction between user and computer, augmented reality techniques are very suitable to integrate computer-generated content seamlessly in the real world. For game designers and programmers of new game ideas it is necessary to quickly generate prototypes and to test different interaction techniques and graphical representations, especially if major parts of the final game are not yet available. This requires a visual authoring environment that allows to switch between design elements, provides a repository of advanced interaction techniques, and easily allows to generate new elements.

2. AUGMENTED REALITY GAME

A number of AR games have been proposed in recent years and one of the first projects was a mobile AR version of Quake [1] that could be used outdoor. Billinghurst and Kato did another pioneer work with the work on the magic book [7]. They described an intuitive way of using AR to visualize stories in a more advanced way than with simple pictures. An interesting game in the field of AR and tangible user interfaces is MonkeyBridge [1], a collaborative augmented reality game, in which the player have to position virtual bridge elements on a virtual ocean to enable the player's avatar to reach a given destination. Neon Racer [3] is a project that used physical obstacles as game element to block the path of a virtual spaceship. Figure 1 shows our current game prototype. A wooden plate is positioned on a cork ball placed on top of a conical stand. The two players move (real) wooden objects that tilt the plate. Through the plate's orientation, with gestures, and speech commands the players direct a sorcerer to cast an evil spell (virtual fireball) towards the opponent's castle. The real objects can be used as bouncing elements. After five hits, a player's castle is destroyed and she lost the game. If the wooden plate falls off the conical stand due to lost balance the game is also lost.

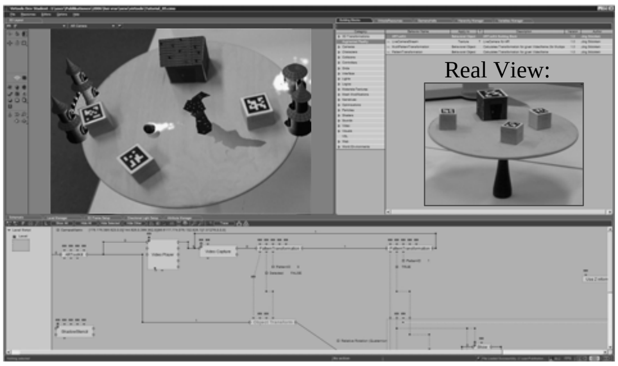

Figure 1. Visual authoring of an augmented reality game (image composition due to space limitations)

3. AUGMENTED REALITY AUTHORING

Technical base for this project is the Virtools system from Dassault Systèmes (www.virtools.com) - a 3D authoring system for rapidly developing interactive and real-time 3D content and applications. In Virtools the content is visually created by linking logical components (building blocks) to a workflow. Input and output ports of these building blocks (BBs) are connected by links and implement a data and control flow within a visual scripting environment. The authoring system provides a large set of predefined elements stored in a repository for creating high-level 3D graphics. Virtools supports advanced computer graphics technologies (physical animation, point based rendering, visual effects, HLSL shader programming). A scripting language and a SDK allow to develop complex applications and custom extensions. We employ an iterative prototyping approach and use a number of externals applications that provide a quick and prototypical development of interaction techniques. For example, GlovePie [4] provides a mapping of a number of devices to system events, e. g. mouse, joystick, keyboard, MIDI-input devices, Wiimote, and different trackers. We use GlovePie [4] as a proxy component and provide a simple wrapper for virtools that allows starting, stopping, and configuring the external software.

4. AUTHORING EXTENSIONS

We developed a number of extensions for Virtools that allows creating augmented reality scenarios and 3D interaction techniques. The ARToolKitPlus [6] is a software library for building augmented reality applications. It is based on optical tracking and uses fiducial markers (square black and white patterns). ARToolKitPlus is based on the well-known ARToolKit [5]. Advantages of ARToolKitPlus are the integrated marker library, more accurate pose estimation, and the automatic threshold adjustment for changing light conditions. The use of the Virtools video capturing and display engine made it easy to integrate ARToolKitPlus in Virtools. A webcam captures images and the ARToolKit BBs calculate the transformation matrix between camera and markers based on the recognition of the fiducial markers. 3D objects can be registered in a video image and attached in 3D. Multimarker tracking is also provided. OptiTrack (www.naturalpoint.com) is a low-cost infrared tracking system that uses USB cameras surrounded by eight IR-LEDs and passive reflective markers. These markers are recognized by the camera and a 2D position of each marker in the current camera frame can be queried. In addition, the 3D position of three markers can be computed, if these are arranged in a predefined triangle. A set virtools BBs was developed that wrapped the Optitrack API. To enable haptic feedback in Augmented Reality games the OpenHaptics API (www.sensable.com), was used. In our building block wrapper of OpenHaptics we used the low level-level access HDAPI for getting and setting device data. This enables the user to get the current state of the device (6 DOF position and orientation of the phantom’s stylus, button states, velocity, and other parameters) and to set the current force feedback.

5. RESULTS

Figure 2 shows a typical game scenario. Each player’s turn is divided in two parts: First, the sorcerer has to be moved to a new position. This is done by moving the square obstacles on the game plate. During the movement, the destination point of the sorcerer is calculated and visualized to the player. Once satisfied with the destination, the player commands the sorcerer to start his walk by shouting “GO”. The second part of the user’s turn is to cast the evil spell. The sorcerer can be rotated to manipulate the direction of the spell, which is visualized by a small arrow. The player moves her finger to the left or right and the sorcerer rotates. To cast the spell the player shouts “FIRE” and a fire ball is sent out. The game is won if the player hits the enemy castle five times or the opponent overthrows the instable game plate.

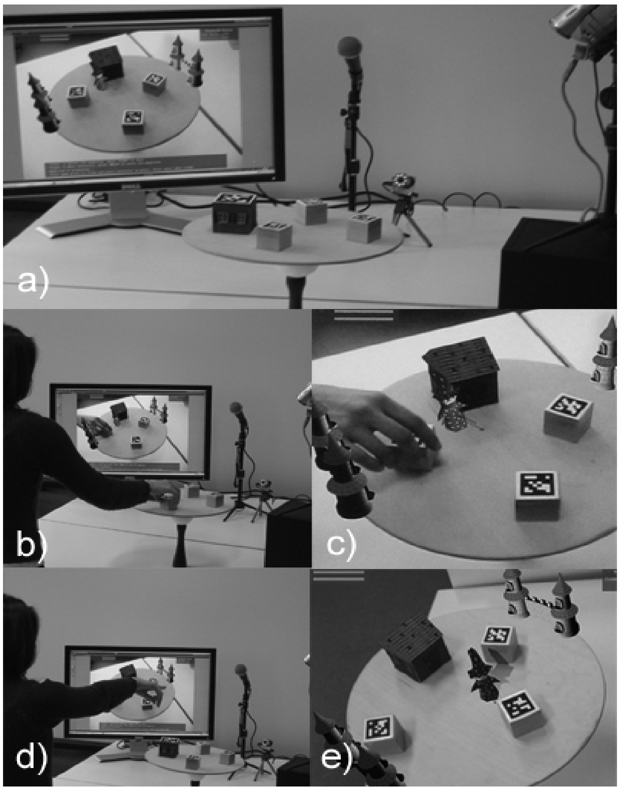

Figure 2. Typical game scenario

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