

GAMES: Virtual Worlds and Reality

Selected Papers of ISAGA 2008

Eugenijus Bagdonas & Irena Patasiene (eds.)

Editorial Board

Prof. Eugenijus Bagdonas, Kaunas University of Technology – Editor-in-Chief

Associated professor dr. Irena Patasiene, Kaunas University of Technology – Editor-in-Chief

39th ISAGA Conference Scientific committee

Prof. Dr. Arata Ichicava Ryutsu Keizai university, Japan

Dr. Elysebeth Leigh The University of Technology, Sydney, Australia

Prof. Dr. Jan H. G. Klabbers KMPC, The Netherlands

Dr. Jeremy J. S. B. Hall Churchill Fellow, Managing Partner, Hall Marketing, UK

Prof. Dr. Raimundas Jasinevicius Kaunas University of Technology, Lithuania

Assoc. Prof. Dr. YY Cai Nanyang Technological University, Singapore

Prof. Dr. Richard D. Teach Georgia Institute of Technology, US

Assoc. Prof. Dr. Maria Angeles Andreu Universidad Politecnica of Valencia, Spain

Prof. Dr. Beverly Rising Universidad Pontificia Comillas de Madrid, Spain

Assoc. Prof. Dr. Igor Mayer Delft University of Technology, The Netherlands.

Dr. Pieter. van der Hijden Sofos Consultancy, The Netherlands

Dr. Amparo Garcia-Carbonell Universidad Polit'ecnica de Valencia, Spain

Prof. Dr. Willy C. Kriz University of Applied Sciences, Austria

Prof. Dr. Dmitry Kavtaradze Moscow state University, Russian Federation

Prof. Dr. Shigehisa Tsuchiya Chiba Institute of Technology, Japan

Assoc. Prof. Dr. YEO Gee Kin National University of Singapore, Singapore

Anne Villems, Tartu University, Estonia

Prof. Dr. Viktorija Barsauskiene Kaunas University of Technology, Lithuania

Assoc. Prof. Dr. Raimonda Minkute Kaunas University of Technology, Lithuania

Assoc. Prof. Dr. Danguole Rutkauskiene Kaunas University of Technology, Lithuania

Prof. Dr. Eugenijus Bagdonas Kaunas University of Technology, Lithuania

Assoc. Prof. Dr. Irena Patasiene Kaunas University of Technology, Lithuania

Editorial Board address:

The Editorial Board of "ISAGA 2008 Selected Papers"

K. Donelaičio str. 20-101,

LT-44239 Kaunas, Lithuania

Telephone +370 37 300118; fax.: +370 37 300102

e-mail: rpk@ktu.lt, irena.patasiene@ktu.lt

Cover design: Laimute Varkalaite

© 2009 Eugenijus Bagdonas & Irena Patasiene (eds.) Kaunas University of Technology. All rights reserved. No part of this publication may be reproduced, stored in the retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior permission in writing from the proprietor.

ISBN 978-9955-25-682-3

CONTENTS

EUGENIJUS BAGDONAS, IRENA PATASIENE	
<i>Preface</i>	i
JAN H.G. KLABBERS	
<i>Virtual worlds and reality: knowing through imitation</i>	1
ELYSSEBETH LEIGH	
<i>Exploring questions for facilitators of learning in simulations</i>	11
ELIZABETH J TIPTON MURFF	
<i>Unexpected multicultural experiential learning</i>	19
MIKA IGARASHI	
<i>Developing a Research Methodology for the Quantitative Analysis of In-Game Social Behavior</i>	23
MIKA IGARASHI, YOSUKE NAGASHIMA, AKIRA BABA	
<i>Are Tendencies in Real-World Social Behavior Reproduced in the Virtual World? – Investigation and Implications</i>	27
GINTA RAILIENĖ, RIMANTĖ HOPENIENĖ	
<i>The Assessment of Key Pedagogical Objectives using ProfitPlanner Board Game in Diversified Environment</i>	31
GERT JAN HOFSTEDE, TIM VERWAART, CATHOLIJN M JONKER	
<i>Lemon car game</i>	39
KLAUS-PETER SCHULZ, RALPH RIEDEL, MICHAEL FOX	
<i>Playing and Reflecting the Firm</i>	47
JYLDYZ TABYLDY KYZY, BRIDE MALLON, DAVID NEWMAN, PHILIP DAWID	
<i>“World of Uncertainty”: A Computer Game for Decision Makers</i>	53
ELI LINDBLAD REM	
<i>How can the multi-focused methodology applied to role plays improve educational learning / professional knowledge in higher education?</i>	57
WILLY C. KRIZ, EBERHARD AUCHTER, HELMUT WITTENZELLNER	
<i>Evaluation of Simulation Games in the German entrepreneurship education program “exist-priME-cup”</i>	63
ELLEN HIJMANS, VINCENT PETERS, MARLEEN VAN DE WESTELAKEN, JEANNETTE HELDENS, ANGELINE VAN GILS	
<i>Encounters of a safe environment in simulation games</i>	71
RICHARD TEACH, ELIZABETH JT MURFF	
<i>Confounded learning in business simulations</i>	83
JUOZAS PATASIUS, IRENA PATASIENE, MARTYNAS PATASIUS	
<i>Simulation of economic factors in public sector</i>	89
GRAZVYDAS ZAUKAS	
<i>Simulation of bank operations using “Powersim Studio”</i>	95
HARALD WARMELINK, GEERTJE BEKEBREDE, CASPER HARTEVELD, IGOR MAYER	
<i>Understanding Virtual Worlds: An Infrastructural Perspective</i>	99
SHINNOSUKE KAWAKAMI	
<i>Science Rooms : Developing a New Digital Game to Learn Science</i>	105

EVA KEERIS	
<i>Combining concepts from Modeling and Simulation and Game research: Realistic Virtual Environments ...</i>	109
M ^a ÁNGELES ANDREU-ANDRÉS, MIGUEL GARCÍA-CASAS	
<i>A Problem-Based Task becoming a Simulation</i>	115
ELENA V. ZARUKINA	
<i>Simulation and gaming methods in educational process at a higher school: enhancing students' scientific research activity</i>	121
ARATA ICHIKAWA	
<i>A Game: real and virtual worlds</i>	125
ADRIAN MALLON	
<i>Pleasure, Responsibility and the Ideated Author in Virtual-World Gaming</i>	129
MASAMI IDO, SHINTARO HAYASHI, MASAKO SASAKI, YOSHIO HAYASHI	
<i>University Education Reform by Employing Gaming-Simulation: A Case Study at Akita University in Japan</i>	137
MAAIKE DE JONG	
<i>The World, Your Playground; students at play in reconstructing reality</i>	143
ELENA LIHACHEVA, DMITRY KAVTARADZE	
<i>What is Uncertainty in Games and Simulations</i>	153
MIKHAIL KRYUKOV, ELENA LIKACHEVA, ANDRII MIROSHNYCHENKO, DMITRY KAVTARADZE	
<i>Defining Strategy in Natural Resource Management on Simulation Game CoMPAS</i>	157
YEO GEE KIN, BIMLESH WADHWA, VU TRUONG VINH, NGUYEN PHUC KHANH LUAN, TRAN QUOC TUAN	
<i>In-process Assessments in Serious Games</i>	165
JUSSI HOLOPAINEN, STAFFAN BJÖRK	
<i>Gameplay Design Patterns for Motivation</i>	169
JEANNE TOLORDAVA	
<i>Business Games and Modern Training Technologies in University Education</i>	173
BEGOÑA MONTERO FLETA, BEVERLY RISING, CARMEN PÉREZ-SABATER	
<i>New Insights into Group Work Assessment</i>	179
EUGENIJUS BAGDONAS, IRENA PATASIENE, VALENTINA DAGIENE, VYTAUTAS SKVERNYS, MARTYNAS PATASIUS	
<i>Web-based Business Game for multidisciplinary teaching</i>	189
JOAN K. TEACH	
<i>TEACHING TEACHERS TO TEACH: A Game-Frame approach</i>	195
CASPER HARTEVELD, HARALD WARMELINK, MICHELE FUMAROLA, IGOR MAYER	
<i>Bringing Concepts Alive in Second Life: A Design Based Experiment</i>	199
LIN ZHIYUAN, CHOW NAM CHI, YEO GEE KIN	
<i>Towards An Ontologically-Supported Collaborative SGX</i>	205
GERT JAN HOFSTEDE, VINCENT PETERS, LÉON DE CALUWÉ, DENNIS MARTENS	
<i>WHY DO GAMES WORK? In search of the active substance</i>	211
ULRICH NORBISRATH, IVAR MÄNNAMAA, ANNE VILLEMS, KÜLLI KALAMEES-PANI	
<i>Mullivelled – Wrapping Computer Games into Educational Gaming Environments</i>	219

ELISABET M NILSSON	
<i>Simulated real worlds: science students creating sustainable cities in the urban simulation computer game SimCity 4</i>	227
CĂTĂLINA CIUCE, ELYSSEBETH LEIGH, HIDEHIKO KANEGAE	
<i>The development of a frame-game designed for organizational change management processes</i>	233
IRENA STANISLAVA BAJORUNIENE, VIKTORIJA BARSAUSKIENE, IRENA PATASIENE, AGNE KAZAKEVICIUTE	
<i>The Implementation of Business Game for Stimulating Socially Discriminated People Integration into Labour Market</i>	237
QINGQING DONG, ZHONGYI SUN, BRIAN MAC NAMEE	
<i>Physics-Based Table-Top Mixed Reality Games</i>	243
RAIMONDA MINKUTĖ, RIMA ŽITKIENĖ, DALIA KUNIGĖLIENĖ	
<i>The Analysis of the Importance of Students' Practice during Their Studies: Case of the Study Programme in Business Administration</i>	249
KLAUS-PETER SCHULZ, MICHAEL FOX	
<i>Creating Understanding and Meaning across Cultures: Playing a Business Game with Groups from the US, South Africa and Germany</i>	257
ARTHUR VAN BILSEN, GEERTJE BEKEBREDE, IGOR MAYER	
<i>Understanding complex infrastructure systems by playing games: Is it possible?</i>	265
SHINTARO HAYASHI, AKIRA TASUNE, AKIHIKO FUJINAWA , MASAMI IDO, YOSHIO HAYASHI	
<i>Libra 2: a Gaming Simulation for Learning Evacuation during Volcanic Eruption Crises</i>	271

Physics-Based Table-Top Mixed Reality Games

Qingqing Dong, Zhongyi Sun, Brian Mac Namee

Abstract

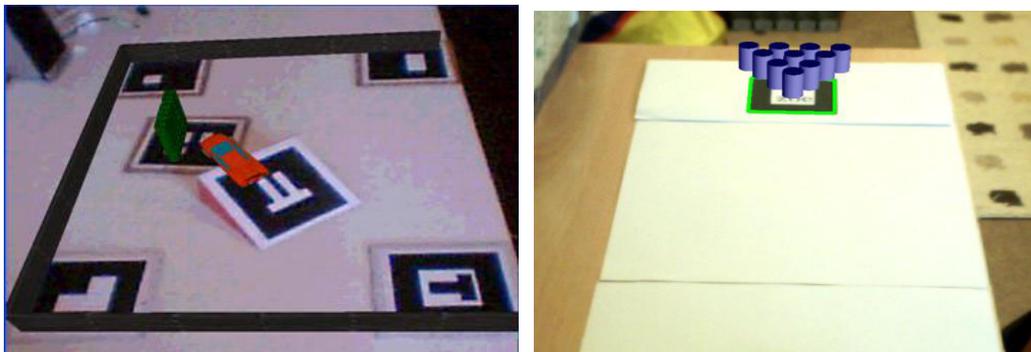
Mixed reality applications use techniques from computer vision, augmented reality and virtual reality to allow real and virtual objects interact physically together on a user's computer screen. This paper will describe two mixed reality applications which allow the user to play games that appear to take place on top of their physical desk. The games described are a desktop racing game and a desktop based game of ten pin bowling. In the desktop racing game virtual cars, controlled by the user, interact with both virtual objects (such as trees, walls and lampposts) and real ones (such as ramps and blocks). In the bowling game the player throws a real ball at a set of virtual bowling pins which react realistically as the ball appears to hit them. These initial games are being used as a springboard to investigate the core competencies required to make mixed reality games.

Keywords: Mixed reality, games, augmented reality, computer vision, physics.

Introduction

Drawing on techniques from the fields of computer vision, augmented reality and virtual reality, mixed reality applications (Milgram et al, 1994) bring together real and virtual objects in applications where they interact closely together. This offers potential unique interactions not possible in other applications. One area where these potentials sit ready to be exploited is that of computer games. Recent innovations in computer game control techniques such as the Sony EyeToy¹ and the Nintendo Wii Remote² show the potential for such novel interaction paradigms. Mixed reality techniques could free game players from the confines of traditional game controllers making possible some very interesting possibilities.

Figure 1: Screenshots of the two mixed reality physics-based table top games described in this paper



This paper will describe two mixed reality games in development at the DIT Experimental Games Group (EGG)³ that are played on the physical desktop of a user and mix together real and virtual objects to create interesting game-play possibilities. The first of these games is a driving game in which the player drives a car around on the top of their desk performing stunts using real and virtual obstacles. The second game is a mixed reality bowling game in which the player throws a real bowling ball at a virtual set of bowling pins. Screenshots from both of these games are shown in figure 1. The next section of this paper will give a background to mixed reality applications, including some existing games. The section after this will then describe our games, including a description of the technologies used and the lessons learned in developing them. Finally, some

¹ <http://www.eyetoy.com/>

² <http://www.nintendo.com/wii/>

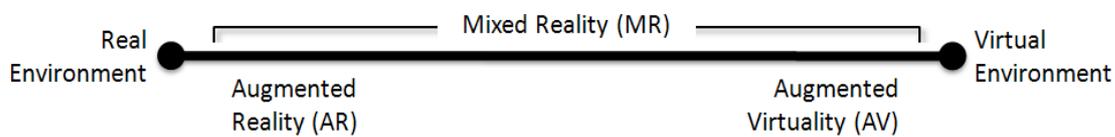
³ <http://www.seriousgames.ie/>

conclusions as to interesting avenues in which to take mixed reality applications will be drawn along with some suggestions as to what we intend to do next.

Mixed Reality Environments

In one of the earlier works on the subject, Milgrim et al (1994) define a mixed reality environment as “one in which real world and virtual world objects are presented together”. However, this leaves open a very large number of possibilities and so Milgrim et al propose a spectrum of mixed reality environments (reproduced in figure 2). This spectrum places real environments on one end, totally virtual environments on the other, and various blends of mixed reality environments across the remainder of the spectrum. Major classes of applications in this range include augmented reality (AR), in which a predominantly real environment is augmented with virtual objects (Bimber & Raskar, 2005, Green et al, 2008), and augmented virtuality (AV) in which a predominantly virtual environment is augmented with real objects (Regenbrecht et al, 2003, Wang, 2007).

Figure 2: Milgrim’s mixed reality spectrum



The applications described in this work fit squarely at the centre of this spectrum, rather than towards either end. This is due to the fact that they allow such close interaction between virtual and real objects. Virtual objects are physically modelled and are affected by real ones – for example a virtual car crashing into a real obstacle, or a real bowling ball knocking over a virtual bowling pin. In order to implement a mixed reality application there are a number of technical challenges that must be overcome. While this paper will not discuss any of these in detail it is worth mentioning the most important ones. Firstly, in order to allow real and virtual objects interact believably with one-another accurate tracking of real objects must be achieved. There is a large body of work from the field of computer vision on how to achieve this (Comaniciu, et al, 2003, Trucco & Plakas, 2006), but it is worth noting that often simple “cheats” are used such as only tracking black objects against white backgrounds or using special markers. Related to this first issue is the issue of registering real and virtual environments. This is one of the main concerns of augmented reality research. One of the most common solutions is the use of fiducial markers (such as the black and white square patterns shown in figure 1) which can be easily recognized from camera images and allow a transformation from the camera position to the marker position to be calculated. This is important so that virtual objects appear in the correct positions and appear correctly aligned to real objects. Modelling the physical interactions between virtual and physical objects is another key challenge. This is achieved by giving real objects a virtual alias within the physics simulation of a scene, which can then cause interactions with virtual objects. One of the key challenges here is making these interactions appear believable, and this generally involves a large amount of trial and error based tweaking of parameters such as mass and density. Finally, the virtual objects in a scene must be rendered in such a way as to make it appear that they exist seamlessly alongside the real objects in the scene. Shadowing, occlusion and rendering techniques can be used for this. Without achieving each of these it is not possible to create a successful game of the type that we are looking to make. There has, though, been some very interesting work in the area and some very interesting games have been created.

Mixed Reality Games

One of the most exciting mixed reality games developed in recent years has been ARQuake (Thomas, 2003), an AR game that extends the famous computer game Quake⁴. In the original Quake the player takes on the role of a soldier in a game played from a first person perspective and controlled using a combination of a keyboard and mouse. ARQuake used AR technology to bring Quake into the real world. Players can see virtual monsters in their real environment through a see-through head-mounted-display (HDM) (figure 3 (A)). Control is based on the player moving through their real environment and using a special gun shaped controller. An example of the ARQuake experience is shown in figure 3 (B). ARQuake is notable for its ambition to bring virtual objects into such a freeform and large environment.

Figure 3: (A) The ARQuake equipment, (B) a screenshot of ARQuake, (C) Phone Tennis being played, and (D) people playing Eye of Judgement



(A)



(B)



(C)



(D)

Phone Tennis (Henrysson et al, 2005) is another interesting mixed reality game, this time played on mobile phones. As shown in figure 3 (C), using their phones as racquets, players play tennis on a virtual tennis court which is located on a table top using fiducial markers. This game is particularly interesting as it blurs the lines between physical and virtual interactions and how virtual and physical objects can effect each other.

Finally, the Eye of Judgment⁵ is interesting as it is the first commercially available mixed reality game. Released in 2008 by Sony Computer Entertainment for their PlayStation 3 console, the Eye of Judgment is a card based fighting game in the vein of Pokemon⁶. However, in the game a camera is placed above the playing surface which detects when certain cards are played, and

⁴ <http://www.idsoftware.com/>

⁵ <http://www.eyeofjudgment.com/>

⁶ <http://www.pokemon.com/>

displays 3 dimensional monsters on top of these cards on a connected television. An example of this is shown in figure 3 (D). While the game does not make particularly novel use of mixed reality techniques, it is worth mentioning for being a commercial game resleased on a major console.

Our Games

This section will describe two table-top physics based mixed reality games in development by the DIT EGG. The first of these is a car game, Table-Top MR Racing, in which virtual cars appear to drive around the player's desk interacting with a range of virtual and physical objects. The second is an implementation of ten-pin bowling, Table-Top MR Bowling, in which the player uses a real ball rolled across their desk to knock over virtual pins. Both of these games use ARToolkit⁷ to locate fiducial markers for registration, the ODE physics engine⁸ for physics modelling, and OpenGL⁹ for rendering.

Figure 4: (A) The Table-Top MR Racing game set up and (B) a screenshot of the resulting game

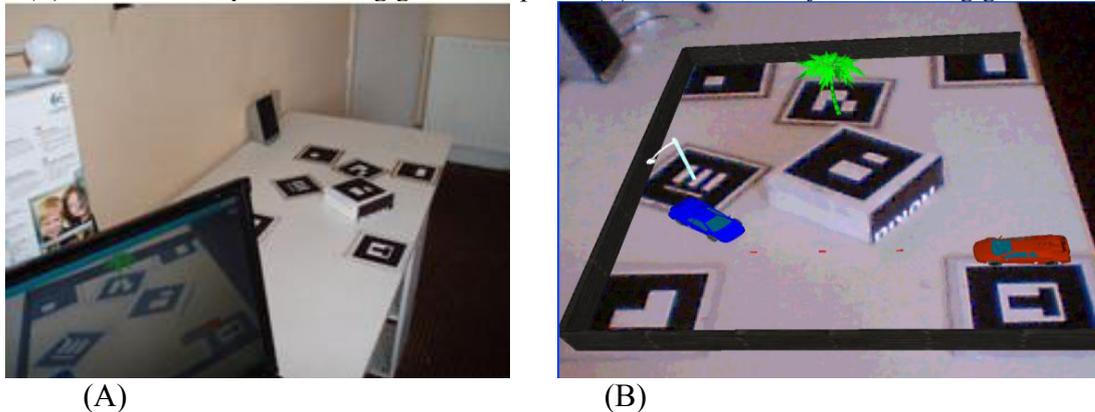
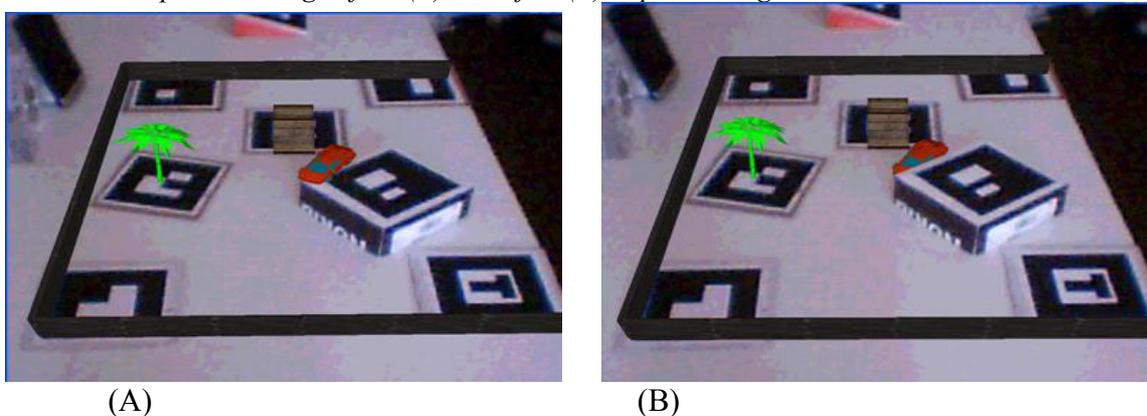


Figure 4 shows the setup (A) used for the racing game, and a screenshot (B) of what is displayed to the user. In this case the mixed reality version of the game is displayed via a monitor positioned at the edge of the game area (however, there is no reason why this could not be replaced with a HMD in the future). To play the game a selection of fiducial markers are laid out on a desk over which a camera is placed. The four outermost markers represent the boundaries of the playing area. Three sides of the playing area are walled in with virtual barriers, while the third side is assumed to be the edge of the playing surface. If a car is driven over the edge of the playing surface it is shown falling to the ground. The other fiducial markers represent objects that are used within the game. Supported objects include cars, ramps, tree, and piles of boxes.

Figure 5: Table-Top MR Racing before (A) and after (B) implementing occlusion



⁷ <http://www.hitl.washington.edu/artoolkit/>

⁸ <http://www.ode.org/> ⁹ <http://www.opengl.org/>

Probably the most important challenge in making the interactions between real and virtual objects appear believable is to achieve realistic occlusion – virtual objects must appear to be hidden when they pass behind real objects. An example of this is shown in figure 5, where in (A) no occlusion is implemented, while in (B) it is. When the game is running the difference between the level of believability achieved with and without occlusion is remarkable and this has been borne out in the user evaluations that have been undertaken so far. The technique used to implement occlusion is relatively simple and relies on manipulating the OpenGL depth buffer, however the details of this go beyond the scope of this paper.

Figure 6: (A) A screenshot of Table-Top MR Bowling and (B) a description of how interaction between the real ball and virtual pins is achieved

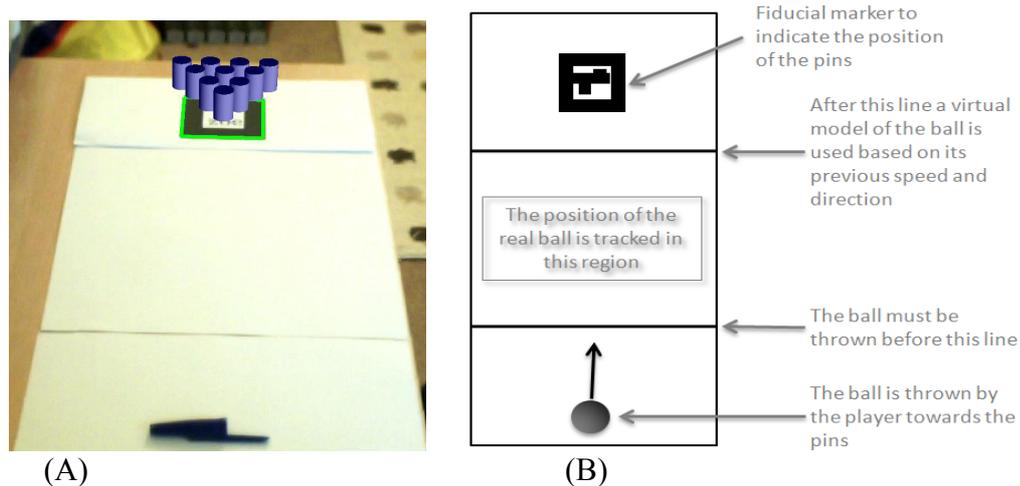


Table-Top MR Bowling uses many of the same techniques as the racing game. This time a camera is placed above the player's table which acts as a bowling alley. A single fiducial marker is placed on this table at the position where the pins are to appear. The player then throws a real ball towards the virtual pins which are realistically knocked over. This setup is shown in figure 6 (A).

Figure 6 (B) shows how the ball tracking and interaction with the pins is achieved. Within a small section of the alley the real ball is tracked and its trajectory and speed are measured. Once the ball exits this area it is no longer tracked and instead an invisible virtual ball (with the same physical characteristics as the real one) is simulated along the real ball's predicted trajectory. This virtual representation of the ball then interacts with the virtual pins causing the illusion that they are being knocked over by the real ball.

Conclusions & Future Work

This paper has discussed two mixed reality physics-based games that are played on a player's table-top. These games show that it is possible to create interesting play environments that mix real and virtual objects which interact physically together. While in themselves the games serve as entertaining diversions, they also serve as a first step in identifying the key competencies that are required to develop such games. These include object tracking, registration between virtual and real objects, physics modeling and rendering techniques. This is the direction in which we hope to take the research in the future, with the ultimate goal of developing a set of tools (making use of existing tools such as ARToolkit and ODE) to allow making such games straightforward.

Author information

Qingqing Dong, School of Computing, Dublin Institute of Technology, Ireland.
 Zhongyi Sun, School of Computing, Dublin Institute of Technology, Ireland.
 Brian Mac Namee School of Computing, Dublin Institute of Technology, Ireland.

References

- Bimber, O. & R. Raskar (2005). "Spatial Augmented Reality: Merging Real and Virtual Worlds". A K Peters LTD, 2005.
- Comaniciu, D., V. Ramesh & P. Meer, (2003) "Kernel-based object tracking", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 25, No. 5., pp. 564-577, 2003.
- Green, S.A., M. Billinghamurst, X.Q. Chen & J. G. Chase, (2008), "Human-Robot Collaboration: A Literature Review and Augmented Reality Approach in Design", Page 01-18 International Journal of Advanced Robotic Systems, Volume 5 Number 1, 2008.
- Henrysson, A., M. Billinghamurst & M. Ollila, (2005), "Face to Face Collaborative AR on Mobile Phones", In Proceedings of the Fourth IEEE and ACM International Symposium on Mixed and Augmented Reality (ISMAR'05), 2005.
- Milgram, Paul, Haruo Takemura, Akira Utsumi & Fumio Kishino, (1994) "Augmented Reality: A class of displays on the reality-virtuality continuum", SPIE Vol. 2351, Telemanipulator and Telepresence Technologies, 1994.
- Regenbrecht, H., C. Ott, M. Wagner, T. Lum, P. Kohler, W. Wilke & E. Mueller, (2003), "An Augmented Virtuality Approach to 3D Videoconferencing", In Proceedings of the 2nd IEEE/ACM International Symposium on Mixed and Augmented Reality, 2003.
- Thomas, B.H., (2003) "Challenges of Making Outdoor Augmented Reality Games Playable", In 2nd CREST Workshop on Advanced Computing and Communicating Techniques for Wearable Information Playing, 2003.
- Trucco, E., K. Plakas, (2006), "Video Tracking: A Concise Survey", IEEE Journal of Oceanic Engineering, Vol. 31, No. 2., pp. 520-529, 2006.
- Wang, X., (2007), "Specifying Augmented Virtuality Systems for Creative Architectural Design", In Proceedings of the 11th International Conference on Information Visualization (IV '07), 2007.