

Human–Computer Interaction Series

Editors-in-chief

Desney Tan
Microsoft Research, Redmond, WA, USA

Jean Vanderdonckt
Louvain School of Management, Université catholique de Louvain,
Louvain-la-Neuve, Belgium

More information about this series at <http://www.springer.com/series/6033>

Arun K. Kulshreshth · Joseph J. LaViola Jr.

Designing Immersive Video Games Using 3DUI Technologies

Improving the Gamer's User Experience

Arun K. Kulshreshth
School of Computing and Informatics
University of Louisiana at Lafayette
Lafayette, LA
USA

Joseph J. LaViola Jr.
Department of Computer Science
University of Central Florida
Orlando, FL
USA

ISSN 1571-5035 ISSN 2524-4477 (electronic)
Human-Computer Interaction Series
ISBN 978-3-319-77952-2 ISBN 978-3-319-77953-9 (eBook)
<https://doi.org/10.1007/978-3-319-77953-9>

Library of Congress Control Number: 2018941215

© Springer International Publishing AG, part of Springer Nature 2018

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG part of Springer Nature
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

To my parents, wife, family and friends.

Preface

A 3D user interface (3DUI) is an interface that involves human–computer interaction in which the user performs tasks in three dimensions, for example, interaction using hand/body gestures, interaction using a motion controller (e.g. Nintendo Wii, Sony PlayStation Move), interaction on a virtual reality device using tracked motion controllers. All these technologies which allow a user to interact in three dimensions are called 3D user interface technologies. These 3D user interface technologies have the potential to make games more immersive and engaging and thus potentially provide a better user experience to gamers. Although 3D user interface technologies are already available for games, it is still unclear how their usage affects gameplay and if there are any user performance benefits. A systematic study of these technologies in game environments is required to understand how gameplay is affected and how we can optimize the usage in order to achieve a better gameplay experience. This book presents the current state of research in usage of 3D user interface technologies for improving the gamer’s user experience. As part of this book, we have focussed on a few technologies: stereoscopic 3D, head tracking, and hand gesture-based menu systems.

Chapter 1 introduces several 3D user interface technologies which could be potentially used for games. Chapter 2 discusses stereoscopic 3D technology and its usage in games. Chapter 3 talks about usage of head tracking in games and how one could use it to design better games. Chapter 4 presents several hand gesture-based menu selection techniques. Chapter 5 discusses an experiment which explores if dynamic stereoscopic 3D parameters (convergence and separation) could enhance the depth discrimination in the scene and thus improve the overall gaming experience of the user. Chapter 6 discusses an experiment which analyses the effect of simultaneous usage of several 3DUI technologies. In Chap. 7, we discuss the implications of our experiments and propose some directions for future research. Chapter 8 summarizes the findings of our experiments and concludes this book.

Lafayette, LA, USA
Orlando, FL, USA
February 2018

Arun K. Kulshreshtha
Joseph J. LaViola, Jr.

Contents

1	3D User Interface Technologies and Games	1
1.1	Introduction	1
1.2	3D User Interface (3DUI) Technologies	2
1.2.1	Stereoscopic 3D	2
1.2.2	Head Tracking	2
1.2.3	Gesture Based Menus	3
1.3	Utilizing 3DUI Technologies for Games	4
1.4	Outline of the Book	5
	References	6
2	Stereoscopic 3D for Video Games	9
2.1	Introduction	9
2.2	Related Work	10
2.2.1	Benefits of Stereoscopic 3D	10
2.2.2	Performance with Display Type	11
2.2.3	Interplay with Interaction Technique and Motion Cues	11
2.2.4	Stereoscopic 3D Game Design	12
2.2.5	Negative Aspects of Stereoscopic 3D	12
2.3	Our Hypotheses	12
2.4	User Evaluation Experiment	13
2.4.1	Selecting the Games for Our Experiment	13
2.4.2	Participants and Equipment	15
2.4.3	Experimental Task	16
2.4.4	Design and Procedure	17
2.5	Results and Analysis	20
2.5.1	Hustle Kings	20
2.5.2	Pain	21
2.5.3	The Fight: Lights Out	22
2.5.4	Tumble	23

2.5.5	Virtua Tennis 4	25
2.5.6	Stereoscopic 3D Questions	25
2.6	Discussion	26
2.7	Conclusion	29
	References	29
3	Head Tracking for Video Games	33
3.1	Introduction	33
3.2	Related Work	34
3.3	Our Hypotheses	35
3.4	User Evaluations	36
3.4.1	Selecting the Games	36
3.4.2	Participants and Equipment	37
3.4.3	Experimental Task	38
3.4.4	Design and Procedure	39
3.5	Results and Analysis	41
3.5.1	Arma II	42
3.5.2	Dirt 2	42
3.5.3	Microsoft Flight	44
3.5.4	Wings of Prey	45
3.5.5	Head Tracking Questions	46
3.6	Discussion	47
3.7	Conclusion	49
	References	50
4	Gestural Menus for Games	53
4.1	Introduction	53
4.2	Related Work	54
4.3	Menu Selection Techniques	56
4.3.1	Hand-n-Hold Menu	57
4.3.2	Thumbs-Up Menu	57
4.3.3	Finger-Count Menu	58
4.3.4	3D Marking Menu	59
4.4	User Evaluations	59
4.4.1	Subjects and Apparatus	60
4.4.2	Procedure	61
4.4.3	Experiment 1: Hand-n-Hold, Thumbs-Up, and Finger-Count Menu Comparison	61
4.4.4	Experiment 2: Compare Finger-Count Menu with 3D Marking Menu	65
4.5	Discussion	68
4.6	Conclusion	71
	References	71

5	Dynamic Stereoscopic 3D Parameters	73
5.1	Introduction	73
5.2	Related Work	74
5.3	Dynamic Stereoscopic 3D	74
5.3.1	Type 1: Large Depth Range Variation	74
5.3.2	Type 2: Large Object in Front of Camera	75
5.3.3	Implementation Details	76
5.4	User Evaluations	78
5.5	Results	80
5.6	Discussion	80
5.7	Conclusion	81
	References	81
6	Simultaneous Usage of Several 3DUI Technologies	83
6.1	Introduction	83
6.2	Related Work	84
6.3	Design of the Game	85
6.3.1	Game Mechanics and Controls	86
6.3.2	Stereoscopic 3D Features	87
6.3.3	Dynamic Stereoscopic 3D	88
6.3.4	Head Tracking Features	89
6.3.5	Why Five Enemies and Five Weapons?	90
6.4	User Evaluations	90
6.4.1	Subjects and Apparatus	91
6.4.2	Experiment Design and Procedure	92
6.5	Results	93
6.5.1	Quantitative Results	93
6.5.2	Qualitative Results	99
6.6	Discussion	100
6.7	Conclusion	102
	References	102
7	Discussion and Future Work	105
7.1	Discussion	105
7.2	Future Work	107
7.2.1	More Game Genres	107
7.2.2	Multi-session Experiments	107
7.2.3	Better Demographics	107
7.2.4	Dynamic Stereo Algorithm Improvements	108
7.2.5	Educating Stereoscopic 3D Gaming	108
7.2.6	Display Technology	109
7.2.7	Virtual Reality Games	109
	References	110

8 Summary and Conclusion 111

8.1 Summary of Our Experiments 111

8.2 Conclusion 113

References 113

Acronyms

3D	Three dimensional
3DUI	Three-dimensional user interface
ANOVA	Analysis of variance
API	Application programming interface
CAVE	Cave automatic virtual environment
CPU	Central processing unit
CT	Computed tomography
DLP	Digital light projection
DOF	Degree of freedom
FPC	First-person controller
FPS	First-person shooter
GB	Gigabytes
GPU	Graphics processing unit
GUI	Graphical user interface
HCI	Human-computer interaction
HDMI	High-definition multimedia interface
HDTV	High-definition television
HMD	Head-mounted display
PC	Personal computer
RAM	Random access memory
S3D	Stereoscopic 3D
SDK	Software development kit
VE	Virtual environment
VR	Virtual reality