CS7497: Virtual Environments

Dedication

Acknowledgements

Course Information

Syllabus

By Blair MacIntyre

Anthologized by: Blair MacIntyre

Attributed to: Blair MacIntyre

Instructors

- Blair MacIntyre, blair@cc.gatech.edu
  Office hours: Â 9:30-10:30 M, 4-5 Tuesday (TSRB 231)
- No TA

General Infromation

- Meet Mon/Wed 3:00-4:30 ES&T L1105
- Textbook: 3D User Interfaces: Theory and Practice, by Bowman, Kruijff, LaViola and Poupyrev.
- Other books of interest are listed on the references page
- You are required to read and discuss papers in this class, and implement and discuss technical prototypes. Â This class is a graduate class in Computer Science, and assumes the students have technical sophistication. Â We will not be teaching and programming environments or SDKâ€™s, but will assume students can learn the necessary tools on their own.

Announcements

See the announcements area in T-Square!

Course Information

Description

This course is an introduction to virtual environments, including virtual reality, augmented reality and multi-user online virtual worlds. Issues covered will include VR/AR technology, software design, 3D human-

computer interaction, and application issues. The course is intended for graduate students in the CS program at Georgia Tech, especially PhD students. The goals of this class are:

- To examine the computer hardware and software technology that is used to build virtual environments.
- To learn about 3D human interaction techniques and issues in the context of virtual environments

The exact topics covered each week are listed on the schedule, but may change as we go along, depending on the interests of the class and the direction of discussions. Â The general structure of the class (project deadlines, etc.) will follow the schedule, but the topics may evolve.

Prerequisites

There are no specific listed prerequisites for this class. As a senior level graduate CS class in the Graphics area, and also the HCI area, you are expected to:

- Have a solid understanding of 3D graphics. This class focuses on 3D interactive virtual environments. Your projects will use 3D graphics, and many of the papers and concepts relate to 3D systems.
- Have a basic understanding of HCI and UI design. You will be implementing projects aimed at people, and reading papers containing user studies.
- Have strong programming skills. The projects may involve significant programming. If you are not comfortable programming or picking up new languages and tools, you may have difficulty.
- Read and discuss research papers. We will read multiple research papers each week, and discuss them in class. Each student will lead the discussion at least once during the semester.

Textbooks/Readings

We will read selections from Bowman et alâ€™s 3D UI book. Â We will also read research papers each week. Â I will generally post the papers for each week at least one week in advance, and you should read them before the class they are due in. Â The class will generally follow the structure of lecture/discussions of major topics on Mondays, and class-led discussions of specific research papers on Wednesdays.

The list of papers/books is long, and is a collection of many of the papers discussed or mentioned the last time the class was taught (in 2008). Â You will not read all of these. Â Rather, they are there for reference. Â If you discover a book or paper you think is interesting, please add a reference to the comments section (along with a sentence or two as to why itâ€™s interesting)!

Grading

The grade for the class will be computed as follows:

- Class participation: 10%
- Paper discussion: 10%
- Projects and assignments: 60%
- Exams: 20%

Late Policy

Late submission will have 25% taken off the grade immediately, and an additional 25% taken off for each additional day. Â A day is 24 hours from the specific time the assignment is due (e.g., if something is due at 6am Monday, and it turned in at 6:01am Monday, it is 25% off; Â if itâ€™s turned in at 5:59am Tuesday, itâ€™s 25% off but will be 50% off at 6:00am Tuesday).

AssignmentsÂ

The major activity of the class is centered around the group project (below), but there will be one or more individual assignments as well worth part of the 60% project grade.

Reports, Assignments and Paper Discussions

We will using a mixture of the blog and t-square for submitting deliverables. Â For some deliverables, such as the discussions of papers, we will publish them publicly on the blog. For others, we will use the assignment mechanism of t-square.

Project

The main assessment component of this class will be the semester-long project and the assignments. The project topic will have some flexibility, but will be centered around a multi-user, multi-display experience that includes both a mobile AR and desktop VR component. Â You are expected to work in groups of two for the project. Â The assignments will be individual. We will post more information on choosing and managing the projects, and how projects will be graded,Â on a dedicated project page on the blog.

Schedule of In-Class Activities

This course meets on Mondays and Wednesdays. Typically, the instructor will lecture on Mondays, and Wednesdays will be focused on discussing that weekâ€™s readings. However, be alert for changes to the schedule.

Attendance

Attendance at all classes will be necessary for students to succeed in this course. Please show respect for the instructor and the other students by arriving on time and prepared.

Honor Code

All work in this course is to be your own, and the university honor code is in effect. Groups will collaborate on projects, but the other graded aspects of the course are based on individual work.

Collaboration

By Blair MacIntyre

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You are expected to collaborate in this class, EXCEPT for those parts of the class that are specifically designated as individual work. Â Individual work includes any tests and individual assignments, and the core part of each project. Â By â€œcore partâ€, I mean that the project should represent the work of the students who turn it in, but it is fine to collaborate on the â€œincidental workâ€ required by your project. Â If you are to develop a demonstration of an interaction technique, for example, the core development of the

interaction should be yours, but you are free to collaborate on the extra code required to create extras (nice menus, sounds, etc). Â In all cases, if you get help with something you consider â€œextraâ€, please document that when you turn it in.

In general, asking for help with technical issues, suggestions for how to accomplish certain things, and so on is fine on these individual assignments; Â as long as the project and prototype you create are yours. Â For example, you can get a pointer on how to implement something, but you should then do the implementation in your project.

If you get code from somewhere, either a tutorial, web page or forum, you are allowed to include it as long as you document what you got where. Â Again, the prototype should have a significant element of your work; Â it is not acceptable to get a working prototype from somewhere and modify it slightly and turn it in. Â The goal of the class is for YOU to demonstrate that you have learned how to create what you turn in.

If in doubt, ask.

Participation

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A perfect grade for participation simply means that the student attended class and demonstrated his/her pre-class preparation by preparing summaries of the readings, making relevant comments, and asking relevant questions during class time, especially the time allocated for discussion.

A major part of the participation grade will be based on students **submitting summaries** of the articles for the week. Â Each week, several scholarly articles will be assigned relevant to the topic for that week. Students are responsible for reading each chapter or article before the discussion period for that topic (which will usually be during the Wednesday class period). Â Summaries should be submitted for all articles listed as **Background** or **DiscussionÂ** on the schedule.

The participation grade (10 percent total) will be calculated as follows:

- A base 10 percent will be based onÂ **written responses**Â to the assigned readings. Each student should prepare a written response for each article, as follows:
    - Each summary should be approximately 200-300 words, should be in the studentâ€™s own words, and should contain important information about the article, including information not found in the abstract. The summary should also contain at least one question that the student would like to ask the author(s) of the article.
    - Summaries should beÂ posted **to the blog AND emailed to the instructorÂ by class time** on the day of the discussion. (Note: students do not need to prepare a summary of the article for which they will serve as discussant.)Â (The purpose of emailing is to simplify time-stamping of the submissions as well as avoid copying issues;Â the purpose of posting to the blog is so that people can read each otherâ€™s posts and questions, especially come exam time).
- This 10 percent will be adjusted based on in-class discussion of readings during the class meetings.Â If you participate regularly (perhaps not every class, but in many classes), you will receive the full

grade earned above.Â If you do not participate at all, the above grade will be reduced by up to 50 percent.Â Participation includes asking thoughtful and relevant questions, answering questions posed by the discussant or instructor, or making a thoughtful comment or criticism about the readings.

Discussions

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Each student in the class will be responsible for leading the discussion of one or two of the papers assigned to the class. The student leading the discussion is called theÂ discussantÂ for that reading.

Pick one of the assigned readings (papers,Â notÂ book chapters) from the list of readings for a specified day; Â if you would like to sign up for a topic before the specific readings are listed, you may sign up for a day. (You might want to choose a second paper as well in case your first choice is already taken.) Then sign up for your selection on the discussant sign-up page on the T-Square Wiki on the appropriate day, and email the instructor with your choice.Â If there is a different paper you would like to suggest as the main paper for your discussion (which everyone needs to read), please email the instructor as soon as possible for permission (it will need to be added to the reading list, etc.)

You can see the current discussant schedule on the schedule page.

How To Prepare For The Discussion

1. **ReadÂ and understandÂ your chosen paper**!Â This might require you to do additional background reading to fully understand the content of the paper and itâ€™s relationship to previous work.
2. **Look up and read at least two (2) papers** that are strongly related to your chosen paper. These need to be published/archived papers from a journal, conference proceedings, book, or technical report series **that is web-accessible!** These papers may come from the list of references in your paper (in which case they are background material for your paper), or they may be later papers about the same topic by the same author(s) or others.Â Email the citations (and URLs) for these papers to the classÂ beforeÂ the class in which you present.Â (use the T-Square mail function to mail the papers, and make sure the email is added to the email archive)
3. **Prepare an oral summary of your paper and the 2 related papers**. No PowerPoint slides, transparencies, or handouts should be used. The oral summary should beÂ no longer than eight (8) minutes. Do not write out your summary and then read it as a speech, but you may make notes to help you as you speak. Your talk should brieflyÂ summarize each paper, spendingÂ more time on the 2 related papers, since your classmates will have already read the paper from the reading list. For each related paper, include information about the motivation and background for the research, what work the authors actually did, what the results were, and what the conclusions were. Make sure you also state how the three papers are related. For example, if you chose one background paper and one later paper, you might first describe the background paper, then the reading list paper, then the later paper, with a transition in between the first and second papers explaining how they are related and a similar transition between the second and third papers.
4. **Prepare a list of at least five (5) questions about the reading list paper**. These questions should not

simply be factual in nature, but should be designed to stimulate discussion in the class. Examples of good questions include: â€œHow is this software different from traditional 3D modeling software?â€, â€œWhy is calibration so important for this particular tracking system?â€, â€œAfter reading this paper, what is your assessment of the current state of the art in VE display devices?â€, or â€œBesides the ones mentioned in the paper, can you think of any alternate interaction techniques that could be implemented for this device?â€.Â **Email these questionsÂ to the class before the class in which you present** (again, using the T-Square mail function).

5. **Create a blog entry on the class blog before class**, that includes the references to the 3 papers, and the 5 questions.Â This is done in place of the paper summaries you normally do each week.Â You do not need to prepare a written summary of the main paper you will be discussing, but you should include a brief few sentences saying why the other two papers were chosen.
6. You will first give your oral summary, then you will lead a discussion of the reading list paper, based on your list of questions. Be prepared, however, to take the discussion in different directions based on the responses you get. Also be prepared to answer questions about the paper or related work from the class or instructor. Your entire discussion period (summary + questions/answers) will last approximately 20 minutes (at a minimum), but may go longer depending on how the discussion is going.

Suggested Places to Look for Papers and Background Material

Georgia Tech has a subscription to theÂ ACM Digital Library, which will allow you to search titles, abstracts, and full text of articles and download articles from selected proceedings or journals. ACM publications in the list below are followed by a link to the digital library. There are also links to the IEEExplore library, which is a similar electronic library for IEEE publications.Â The library also has a subscription toÂ Presence: Teleoperators and Virtual EnvironmentsÂ from MIT Press.Â All are available through the GT library web site.

Another great resource is Google Scholar (http://scholar.google.com).

Discussant Grading Criteria

The presentation is worth 10 points.Â You will be graded on the choice of the two papers, your poise and confidence in your oral summary, the clarity of your summary of the content areas, the list of discussion questions, your background knowledge and ability to answer questions and how well you spark further discussion.

Schedule

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Below is a schedule for the class. Â We will update this page if the schedule changes, and post to blog about the changes.

Date	Travel	Topic	Assignment

Jan 7		Overview, Intro (1-overview, 2-intro)	
Jan 9		What are VEs, AR, ARG, History of AR, Applications (Bowman: 1 & 2 & 12.1, Sutherland: Ultimate Display) (3-bowman-5754-2006-intro)	
Jan 14		What are VEs, AR, ARG, History of AR, Applications (contâ€™d) *Background Paper*:Â Brooks: Whatâ€™s real about VR (4-introAR-sm)	
Jan 16		*Discussant papers*:Â Bajura: Ultrasound,Â Hodges et al: Fear of Heights,Â Schell et al: Theme-park VR	
Jan 21		MLK Holiday â€" NO CLASS	
Jan 23		Argon, VEâ€™s and the Web *Background Paper:* MacIntyre: Â Argon	
Jan 28		Argon hands on, tech demos	
Jan 30		3D Tracking: Devices *Discussant paper:* Foxlin, shoe-mounted	
Feb 4		3D Tracking: Vision	a1 out
Feb 6		*Discussant papers:Â* Izadi, KinectFusion; Reitmayr and Drummond, Going Out	
Feb 11		project pitches and discussion	
Feb 13		VE Displays and Perception *Discussant paper:Â* Arsenault and Ware	a1 in
Feb 18		*MIDTERM*	
Feb 20		VE Displays *Discussant papers:Â* Ye/State/Fuchs, tabletop autostereo; Â Hua, Scape	Project Proposal due
Feb 25		VE Design Principles	a2 out
Feb 27	**Drop Deadline**	*Discussant papers:*	
Mar 4		Real-time 3D graphics, VE software	
Mar 6		*Discussant papers:Â MacIntyre: DART (UIST), Conway: Alice, Fritsch: Everquest*	a2 in
Mar 11	SXSW	Presence and Evaluation (Guest)	Project Progress Reports
Mar 13	(SXSW)	*Discussant papers:*	
Mar 18		GT SPRING BREAK	
Mar 20		GT SPRING BREAK	
Mar 25	GDC	3D Input DevicesÂ (Guest) *Discussant paper*:	
Mar 27	GDC	*group work time*	
Apr 1		3D Interaction Techniques *Background: 3DUI (Ch 7, 8, 9)*	Project Progress Reports
Apr 3		*Discussant papers:*	

Apr 8	3D UIs	
Apr 10	*Discussant papers:*	
Apr 15	EXAM	
Apr 17	*(project work time)*	
Apr 22	*In class project presentations*	Final project materials due
Apr 24	*In class project presentationsÂ*	
Exam Week	*Â*	

Readings

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This is a list of all the readings, required and optional, for the class.Â If a paper is on here and not specifically listed on the syllabus, itâ€™s simply provided as a reference.

Books

1. Barfield and Furness.Â Virtual Environments and Advanced Interface Design. Oxford Press, 1995.
2. Bowman, Kruijff, LaViola, and Poupyrev,Â 3D User Interfaces: Theory and Practice.Â Addison-Wesley, 2005. ISBN 0-201-75867-9.
3. Craig and Sherman,Â Understanding Virtual Reality: Interface, Application and Design.Â The Morgan Kaufmann Series in Computer Graphics, 2003. ISBN 1-558-60353-0.
4. Crawford, C. (2004).Â Chris Crawford on Interactive Storytelling.Â New Riders Games.Â link
5. Gibson, William.Â Virtual Light. 1994. link
6. Stephenson, Neal.Â Snow Crash.Â 1994.Â Â link
7. Vinge, Vernor.Â Rainbows End.Â 2007. Â link
8. John Hench and Peggy Van Pelt. Designing Disney.Â 2003. Â link

Papers

1. Roland Arsenault and Colin Ware, â€œThe Importance of Stereo and Eye-Coupled Perspective for Eye-Hand Coordination in Fish Tank VRâ€œ,Â Presence: Teleoperators and Virtual EnvironmentsÂ 2004Â 13:5,Â 549-559
1. Azuma, R., â€œA survey of augmented realityâ€, Presense, 6:4, pp 355-386, 1997
2. Bajura, M., Henry Fuchs, Ryutarou Ohbuchi (1992).Â Merging virtual objects with the real world: seeing ultrasound imagery within the patient. ACM SIGGRAPH Computer Graphics.
2. Barba, Evan,Â Blair MacIntyre, and Elizabeth Mynatt.Â 2012.Â â€Here We Are! Where Are We? Locating Mixed Reality in The Age of the Smartphone.â€œÂ Proceedings of the IEEE,Â 100Â (4):Â 929-936.Â IEEE.Â JPROC.2011.2182070
2. Barba, EvanÂ andÂ Blair MacIntyre.Â 2011.Â â€A Scale Model of Mixed Reality.â€œÂ Paper

presented at C&C â€™ 11.Â ACM,Â 117-126.Â 2069618.2069640
3. Barrus, J. W., Waters, R. C., and Anderson, D. B. 1996. Locales: Supporting Large Multiuser Virtual Environments.Â IEEE Comput. Graph. Appl.Â 16, 6 (Nov. 1996), 50-57.Â Â http://dx.doi.org/10.1109/38.544072
4. Balakrishnan, R., Fitzmaurice, G. W., and Kurtenbach, G. 2001. User Interfaces for Volumetric Displays. Computer 34, 3 (Mar. 2001), 37-45.Â http://dx.doi.org/10.1109/2.910892
5. Benford, S., Greenhalgh, C., Rodden, T., and Pycock, J. 2001. Collaborative virtual environments. Commun. ACM 44, 7 (Jul. 2001), 79-85.Â http://doi.acm.org/10.1145/379300.379322
6. Billinghurst, M. and Kato, H. 2002. Collaborative augmented reality. Commun. ACM 45, 7 (Jul. 2002), 64-70.http://doi.acm.org/10.1145/514236.514265
7. Bishop, G., Henry Fuchs, Leonard McMillan, and Ellen J. ScherZagier â€œFrameless rendering: double buffering considered harmfulâ€ Proceedings of SIGGRAPH 94, pp 175-176, 1994
8. Bowman, D.A., Chen, J., Wingrave, C., Lucas, J., Ray, A., Polys, N., Li, Q., Haciahmetoglu, Y., Kim, J-S., Kim, S., Boehringer, R., & Ni,T. New Directions in 3D User Interfaces. International Journal of Virtual Reality, 5(2), 2006.http://www.ijvr.org/sub/issues/issue2/02!ijvr_bowman_formatted.pdf
9. Bowman, D.A and Dheva Raja. A method for quantifying the benefits of immersion using the cave. Presence-Connect, 2, 2004.Â http://courses.cs.vt.edu/~cs5754/presence_connect.pdf
10. Frederick Brooks. Whats Real About Virtual Reality? IEEE Computer Graphics & Applications, November/December 1999, pp. 16-27.Â http://ieeexplore.ieee.org/iel5/38/17375/00799723.pdf
11. Cakmakci, O.; Rolland, J.; , â€œHead-worn displays: a review,â€Â *Display Technology, Journal of*Â , vol.2, no.3, pp.199-216, Sept. 2006Â doi: 10.1109/JDT.2006.879846 link
11. Matthew Conway, Steve Audia, Tommy Burnette, Dennis Cosgrove, Kevin Christiansen, Rob Deline, Jim Durbin, Rich Gossweiler, Shuichi Koga, Chris Long, Beth Mallory, Steve Miale, Kristen Monkaitis, James Patten, Jeff Pierce, Joe Shochet, David Staack, Brian Stearns, Richard Stoakley, Chris Sturgill, John Viega, Jeff White, George Williams, & Randy Pausch. Alice: Lessons Learned from Building a 3D System for Novices. Proceedings of CHI, 2000, pp. 486-493.Â link
12. Dietrich, A., Ingo Wald, Markus Wagner, and Philipp Slusallek. VRML scene graphs on an interactive ray tracing engine. In VR, pages 109-116. IEEE Computer Society, 2004.http://ieeexplore.ieee.org/iel5/9163/29078/01310063.pdf
13. Steven Feiner and Blair MacIntyre and Doree Seligmann, â€œKnowledge-Based Augmented Realityâ€, Communications of the ACM, 36:7, July 1993.
14. Foskey, M., MiguelÂ A. Otaduy, and MingÂ C. Lin. Artnova: Touch-enabled 3D model design. In VR, pages 119-126, 2002. ieeexplore link
15. Foxlin, E.; , â€œPedestrian tracking with shoe-mounted inertial sensors,â€Â *Computer Graphics and Applications, IEEE*Â , vol.25, no.6, pp.38-46, Nov.-Dec. 2005 doi: 10.1109/MCG.2005.140 link
15. Fritsch, T., Ritter, H., and Schiller, J. 2005. The effect of latency and network limitations on MMORPGs: a field study of everquest2. In Proceedings of 4th ACM SIGCOMM Workshop on Network and System Support For Games (Hawthorne, NY, October 10 â€“ 11, 2005). NetGames â€™05. ACM, New York, NY, 1-9. DOI=http://doi.acm.org/10.1145/1103599.1103623
16. B. FrÃ¶hlich and J. Plate, â€œThe Cubic Mouse: A New Device for 3D Input,â€ Proc. ACM CHI 2000, ACM Press, New York, Apr. 2000, pp. 526-531.Â Â link
17. Frohlich, B.; Plate, J.; Wind, J.; Wesche, G.; Gobel, M.;Â Cubic-Mouse-based interaction in virtual environments.Computer Graphics and Applications, IEEE.Â Volume 20,Â Â Issue 4,Â July-Aug. 2000 Page(s):12 â€“ 15.Â Â link
18. Gandy, Maribeth, Richard Catrambone,Â Blair MacIntyre, Cristobal Alvarez, Elsa Eiriksdottir, Matthew Hilimire,Â Brian Davidson, and Anne McLaughlin.Â 2010.Â â€Experiences with an AR Evaluation Test Bed: Presence, Performance, and Physiological Measurement.â€œÂ Paper presented at ISMAR â€™10.Â 13-16 October 2010.Â Seoul, Korea.Â IEEE,Â 127-136.Â ISMAR.2010.5643560

18. John C. Goble, Ken Hinckley, Randy Pausch, John W. Snell, and Neal F. Kassell. Two-handed spatial interface tools for neurosurgical planning. IEEE Computer, 28(7):20-26, July 1995.
19. Govindaraju, N., Lin, M., & Manocha, D. 2005. Quick-CULLIDE: Fast Inter- and Intra-Object Collision Culling Using Graphics Hardware. In Proceedings of the 2005 IEEE Conference 2005 on Virtual Reality (March 12 â€“ 16, 2005). VR. IEEE Computer Society, Washington, DC, 59-66, 319.http://ieeexplore.ieee.org/iel5/9989/32098/01492754.pdf
19. Hill, Alex, Matthew Bonner, andÂ Blair MacIntyre.Â 2011.Â â€ClearSpace: Mixed Reality Virtual Teamrooms.â€œÂ Paper presented at HCI â€™ 11.Â 9-14 July 2011.Â Orlando, Florida.Â Springer,Â 333-342.Â 978-3-642-22024-1_37
19. Hill, Alex,Â Evan Barba,Â Blair MacIntyre,Â Maribeth Gandy, andÂ Brian Davidson.Â 2011.Â â€Mirror Worlds: Experimenting with Heterogeneous AR.â€Â Paper presented at ISUVR â€™ 11.Â 22-25 August 2011.Â Daejoen, South Korea.Â 9-12.Â ISUVR.2011.28
20. Hinckley, K., Randy Pausch, John C. Goble, & Neal F. Kassell. A Survey of Design Issues for Spatial Input. Proceedings of the ACM Symposium on User Interface Software & Technology, 1994, pp. 213-222.link
21. Hodges, L., Barbara Rothbaum, Rob Kooper, Dan Opdyke, Tom Meyer, Max North, Johannes de Graaff, & James Williford. Virtual environments for treating the fear of heights. IEEE Computer, vol. 28, no. 7, 1995, pp. 27-34.Â http://ieeexplore.ieee.org/iel1/2/8856/00391038.pdf
22. Hoellerer, T., Steven Feiner, Tachio Terauchi, Gus Rashid, and Drexel Hallaway. Exploring MARS: developing indoor and outdoor user interfaces to a mobile augmented reality system. Computers & Graphics, 23(6):779-785, 1999.Â http://www1.cs.columbia.edu/graphics/publications/hollerer-1999-candg.pdf
23. Hua, H., LeonardÂ D. Brown, and Chunyu Gao. Scape: Supporting stereoscopic collaboration in augmented and projective environments. IEEE Computer Graphics and Applications, 24(1):66-75, 2004.link
24. Shahram Izadi, David Kim, Otmar Hilliges, David Molyneaux, Richard Newcombe, Pushmeet Kohli, Jamie Shotton, Steve Hodges, Dustin Freeman, Andrew Davison, and Andrew Fitzgibbon. 2011. KinectFusion: real-time 3D reconstruction and interaction using a moving depth camera. InÂ *Proceedings of the 24th annual ACM symposium on User interface software and technology*(UIST â€™ 11). ACM, New York, NY, USA, 559-568. DOI=10.1145/2047196.2047270 Â link
24. Johnson, A.E., ThomasÂ G. Moher, Stellan Ohlsson, and Jason Leigh. Exploring multiple representations in elementary school science education. In VR, pages 201-208, 2001.link
25. Kennedy, R., Kay Stanney, and William Dunlap. Duration and Exposure to Virtual Environments: Sickness Curves During and Across Sessions. Presence: Teleoperators and Virtual Environments, vol. 9, no. 5, 2000, pp. 463-472.Â link
26. Kushner, David.Â Engineering Everquest.Â Â IEEE Spectrum, July 2005.link
27. Lu, F., Parkin, S., and Morgan, G. 2006. Load balancing for massively multiplayer online games. In Proceedings of 5th ACM SIGCOMM Workshop on Network and System Support For Games (Singapore, October 30 â€“ 31, 2006). NetGames â€™ 06. ACM, New York, NY, 1.Â http://doi.acm.org/10.1145/1230040.1230064
28. Blair MacIntyre, Jay David Bolter, and Maribeth Gandy (2004) â€œPresence and the Aura of Meaningful Placesâ€ 7th Annual International Workshop on Presence (PRESENCE 2004), Polytechnic University of Valencia, Valencia, Spain, 13-15 October 2004.Â http://www.cc.gatech.edu/ael/papers/presence2004.html
29. Blair MacIntyre, Maribeth Gandy, Steven Dow, and Jay David Bolter. â€œDART: A Toolkit for Rapid Design Exploration of Augmented Reality Experiences.â€ To appear at conference on User Interface Software and Technology (UISTâ€™ 04), October 24-27, 2004, Sante Fe, New Mexico.Â http://www.cc.gatech.edu/ael/papers/dart-uist04.html
29. MacIntyre, Blair,Â Alex Hill,Â Hafez Rouzati,Â Maribeth Gandy, andÂ Brian Davidson.Â 2011.Â â€The Argon AR Web Browser and Standards-Based AR Application Environment.â€Â Paper

presented at ISMAR â€™ 11.Â November 2011.IEEE.
30. Mapes, D. P., and J. Michael Moshell. A two-handed interface for object manipulation in virtual environments. PRESENCE: Teleoperators and Virtual Environments, 4(4):403-416, 1995.
31. Mateas, M. and Stern, M. (2005).Â Â Procedural Authorship: A Case-Study of the Interactive Drama Facade.Â Digital Arts and Culture, Copenhagen.Â Â http://www.interactivestory.net/papers/MateasSternDAC05.pdf
32. Mateas, M. and Stern, M.Â (2005).Â Structuring Content in the Facade Interactive Drama Architecture.Â AIIDE, Los Angeles.Â http://interactivestory.net/papers/MateasSternAIIDE05.pdf
33. Michael Mateas, An Ozâ^'Centric Review of Interactive Drama and Believable Agents.Â June 1997.Â CMU Technical report CMUâ^'CSâ^'97â^'156, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA 15213.Â Â http://www.lcc.gatech.edu/~mateas/publications/CMU-CS-97-156.pdf
34. Michael Meehan , Brent Insko , Mary Whitton , Frederick P. Brooks, â€œPhysiological measures of presence in stressful virtual environments,â€ ACM Transactions on Graphics (TOG) , Proceedings of the 29th annual conference on Computer graphics and interactive techniques July 2002, Volume 21 Issue 3.http://portal.acm.org/citation.cfm?id=566570.566630
35. Meyer, K., Hugh L. Applewhite, and Frank A. Biocca. A survey of position trackers. PRESENCE: Teleoperators and Virtual Environments, 1(2):173-200, 1992.
36. Mine, Mark R., Frederick P. Brooks, & Carlo H. Sequin. Moving Objects in Space: Exploiting Proprioception in Virtual Environment Interaction. Proceedings of SIGGRAPH, 1997, pp. 19-26.link
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1. http://www.miccai.org/Â International Society and Conference Series on Medical Image Computing and Computer-Assisted Intervention

Interesting Other Reading

1. http://www.valve-erc.com/srcsdk/general/multiplayer_networking.html
   Multiplayer Networking in the Source Game Engine.Â Nice overview of a common approach.

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