Syllabus - Special Topics: Mixed Reality

instructor

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texts

required text

Benford, S., Giannachi, G. *Performing Mixed Reality*. MIT Press. 2011.

online texts

You will be expected to read a number of texts provided directly online and/or via the ACM Digital Library (http://dl.acm.org). Note that to access the ACM DL, you must be on campus, proxied through the NMSU network (via http://lib.nmsu.edu), or have a paid subscription to the DL. **You are responsible for access.**

course description

Do you live in the real world? What about one or more digital ones? Ever dream of merging them? How might putting them together support yourself, or society? Together, this semester we will construct mixed realities that support living in two or more worlds simultaneously. Depending on your interest, we will aim to save lives by building disaster response systems, improve everyday efficiency and productivity, or relax and play. By building a mixed reality system, we will explore the frontiers of human-computer interaction, develop a deep understanding on how to use sensors in computer research, learn to undertake serious design challenges, and practice communicating our ideas.

We want to build new and exciting systems. As with any cutting-edge research, we don't want to re-make what someone else already has; we want to build *on* what is known. To develop your skills in HCI, mobile systems, sensor systems, tangibles, and/or wearable computers, you will need to read, design, build, and evaluate. In this class, we will:

- read a book and a number of research papers.
- perform contained design exercises where we imagine new mixed realities.
- prototype, throw out, and prototype again.
- build a functional mixed reality system.
- evaluate what we built.

objectives

Students completing this course will be able to:

- design a variety of mixed reality systems.
- build a mixed reality system, using sensors to track users and provide context-specific experiences.
- conduct human-computer interaction research by proposing, developing, and conducting experiments; analyzing data; and developing synthesized results from analyzed data.

- develop a project plan with literature review.
- communicate designs and evaluations through presentations, demonstrations, and reports.

Students completing this course will develop knowledge of:

- characteristics of sensors that enable mixed reality experiences.
- research and products in mobile interfaces, wearable computing, tangible computing, ubiquitous computing, etc.
- techniques to gather data and evaluate designs.

prerequisites

This course has no class pre-requisites.

team-based learning

This course is a **team-based learning course**, which means that much of the work will be carried out within a team. Following the team-based learning principles, this course might also be considered a "flipped" classroom. What this means is that there will be **minimal in-class lecturing**, there will be **a lot of in-class do-ing** that captures our objectives, and there will be **out-of-class reading** (and accountability for that in class). Some of this is likely new to you as a student (and it is a little new to me, as an instructor). So, in this class, you can expect:

- You will be responsible for readings outside of class.
- There will be a quiz on every reading at the start of class; you will take it individually, then take it with your team.
- There will be minimal lectures on the readings, mostly to answer your questions about them. Students will present some work.
- There will be a team project, with deliverables throughout the semester, that will take you from concept to completed and evaluated system.
- Most of class time will be spent working in groups on activities, typically two class periods at a time. Many of these are design activities, meant to engage you in creative thinking about how to build systems, and some will help you progress on your overarching team project.
- At the end of class, at least once a week, your team will report on and / or show off what you have accomplished.

policies

team formation

Teams will be formed after students have identified their areas of interest through the Micro Proposals assignment. **Teams must consist entirely of either graduate students or undergraduates**; this segregation is necessary because the graduate curriculum is slightly accelerated from the undergraduate one. Teams are limited to 3 students, although teams of 2 or 4 will be considered when necessary.

code

This course does not have a required programming language. **It is assumed most students are competent in at least one language; if not, you will need to identify an alternative strong role you can play within your group.** Because your instructor and/or TA may not be proficient in your chosen language, you must make your code as clear as possible! It must be styled appropriately (use liberal whitespace, use appropriate indentation, etc.) and should be extensively, but not excessively, documented. Failure to do so is grounds for losing points.

reading / quizzes

You are responsible for reading all materials prior to class. Graduate students are required to do additional reading from the Reading++ column. Undergraduates are encouraged, but not required to, read these papers as well. **For every day with a reading assignment, daily quizzes will be administered in class.** Missed quizzes cannot be made up.

grad / bonus paper presentations

Graduate students will present papers from the current literature throughout the semester, as found under the Reading++ column of the schedule. At the beginning of class we will set aside time for the presentations. By the second week of class, we will assign the readings to graduate students. **All graduate students are expected to make at least one presentation of a long paper**

(potentially two, depending on number of students in class). Short papers count as ½ a presentation.

Of the remaining unselected papers, **undergraduates may contact the professor at any time in advance of the class day to present an upcoming paper and potentially receive bonus points on his/her final average**. These presentations are graded in the same was as graduate paper presentations. If there is more interest than papers available, we will select additional readings to accommodate students, assuming there is time left in the semester to provide adequate time for the class to read the paper and for the student to present. (For example, if 5 undergraduates ask to present papers on the last day, most likely only the first two or three will get the opportunity; it is recommended you select in advance.)

presentation questions

Over the course of the semester, students are expected to ask questions of the presenters (in addition to generally engaging in class discussion). **All students must ask at least 2 questions of the presenters over the course of the semester to achieve full credit on the Presentation Questions / Class Participation component of her/his grade.** Students are encouraged to be strategic about this, as there will be time for no more than 2–3 questions per presentation. Students may find it best to read and/or skim interesting papers and prepare questions in advance.

Presentation questions should be thought of as preparation for an academic/industrial/professional conference. When asking a question of a speaker, the student should raise her/his hand. When called upon, the student should stand up, announce his/her name and institution, then ask the question.

attendance / class participation

Attendance is expected at every class, unless the class is released to work on class projects. Students should be present both physically and mentally, asking questions, discussing, and not otherwise engaged (in a device). A student with more than two unexcused absences will lose points from the Presentation Questions / Class Participation component of his/her grade.

assignments

Students are expected to turn in assignments before class on the day specified in the assignment, as specified in the assignment description (usually via Canvas). Frequently, this constraint is a logistics issue, as students will present work in class. **Late work will be accepted, but with a 10% penalty per day late.** Note that this means if you were to present in class and fail to do so, you will face a 20–50% penalty, depending on when class meets next. Some assignments may include a bonus component; this bonus applies only to the assignment and cannot push an assignment's grade beyond 100%.

Graduate student assignments may have modifications from the base undergraduate assignments (generally there is more to do).

You will be working with a team most of the semester, and team activities will make up most of your grade. **Students are only eligible for the team portion of the grade if they earn at least 70% of their individual grade.** This measure is intended to ensure that each student pulls his/her own weight within the team.

rubric

Your rubric depends on whether you are taking the graduate version of the course (C S 579) or the undergraduate one (C S 479). The graduate rubric includes an additional assignment of reading and presenting current HCI papers in class, in addition to having a different weighting scheme. Undergraduates have the opportunity to earn up to an additional 3% by opting in to reading and presenting a current paper.

Below the project sequence row, within your course, the left-hand column shows how the component's grade affects your overall score, while the right-hand column shows the percentage of the project sequence represented by that component.

Most activities are graded on a team basis; individually assessed items are starred.

course	479		579	
total	103		100	
daily reading quizzes*	5		2.5	
team daily reading quizzes	5		2.5	
grad paper presentations*	-		5	
presentation questions / class participation*	20		10	
design exercises	20		20	
bonus paper presentation*	3		-	
project sequence	50	← 100	60	← 100
micro proposal*	2	4	1.5	2.5
literature review presentation*	-	-	1.5	2.5
literature review*	1.5	3	3	5
concept sketch	1.5	3	3	5
alternative designs*	-	-	3	5
full proposal (or revision)	2.5	5	1.5	2.5
project plan (or revision)	2.5	5	1.5	2.5
functional prototype 1	2.5	5	3	5
user study 1	5	10	4.2	7
functional prototype 2	5	10	3	5
complete system	-	-	4.8	8
user study 2	-	-	3	5
final presentation	12.5	25	12	20
final report	12.5	25	12	20
peer review	2.5	5	3	5

TENTATIVE schedule

date		topic	reading		reading++		activity	due 479	due 579
1/16	R	Intro	-	-	-	-	-		
1/21	T	Mixed Reality Basis	Milgram & Kishino 1994	15	-	-			
1/23	R	Intro to Trajectories	B&G intro	26	-	-	build teams	micro proposals	
1/28	T	Hybrid Space	B&G ch1, pt1 [27-52]	25	Benford et al. 2006	33	design site-specific experience		
1/30	R		B&G ch1, pt2 [53-70]	17	Benford et al. 2005	9		full proposals	
2/4	T	Synchronizing Time	B&G ch2, pt1 [71-92]	21	Stenros et al. 2007	9	design a MR without location		
2/6	R		B&G ch2, pt2 [92-113]	21	Luesebrink 1998	6			
2/11	T	Tangible & Ubiquitous	Ishii & Ulmer 1997; Wieser & Brown 1996	11	[literature review]		design a tangible-based MR	proposal revision	
2/13	R	Vision-Based Tracking	Moeslund et al. 2006	36	[literature review]				
2/18	T	-	[literature review]		[literature review]		library session		
2/20	R	Sensing Technologies	Hightower & Borriello 2001; Zhou et al. 2008; Zogg 2007 ch1, ch4	?	[literature review]		present lit. review (579)		
2/25	T	Seamful Design	Chalmers & Galani 2004	10	Bell et al. 2006	10	develop concept sketch	literature review	
2/27	R	Assembling Interaction (1)	B&G ch3, pt1 [115-146]	31	Jiang et al. 2004	17			
3/4	T	-	-	-	-	-	present concept sketches	concept sketch	
3/6	R	Assembling Interaction (2)	B&G ch3, pt2 [147-164]	17	Birchfield et al. 2008	19			alternatives
3/11	T	The Experience of Mixed Reality	B&G ch4, pt1 [165-206]	41	Dünser et al. 2012a	12	develop project plan		
3/13	R		B&G ch4, pt2 [206-227]	21	Dünser et al. 2012b				
3/18	T	Mixed Reality Coding					in-class tutorial		
3/20	R							project plan	

date		topic	reading		reading++		activity	due 479	due 579
3/25	T	Spring Break							
3/27	R								
4/1	T	Trajectories through Mixed Reality Performance	B&G ch5, pt1 [230-253]	23	Cheok et al. 2002		design experiments		
4/3	R		B&G ch5, pt2 [253-268]	15	Tuan & Hoelscher 2001	11			
4/8	T	-	-	-	-	-	run studies in class students (579)		func. prototype 1
4/10	R	Mobile Interface Design	Tognazzini 2014	?	Ajanki et al. 2011	13			
4/15	T	Quantitative Evaluation [Prof. T. @ SPAWAR]	*Research Methods in HCI* ch4	28	-	-	run studies in class (479, 579)	func. prototype 1	user study 1
4/17	R	Qualitative Evaluation	Research Methods in HCI ch11	23	Bai & Blackwell 2012, Ashbrook et al. 2009	12, 21			
4/22	T	Wearable Computing	Starner et al. 1997		Feiner et al. 1997	10	run studies in class (479, 579)		func. prototype 2
4/24	R	[Prof. T. @ CHI]	-		-	-		user study	
4/29	T	[Prof. T. @ CHI]	-		-	-	run studies in class (579)		
5/1	R	Games	Hughes et al. 2005		Cheok et al. 2003	12		func. prototype 2	complete system
5/6	T	Final Exam **(6PM)**					present project	final project presentation	
5/10	S							final project report	user study 2, final project report

papers list

1/21

[Milgram & Kishino 1994] Milgram, P. and Kishino, F. (1994). A taxonomy of mixed reality visual displays. *IEICE Transactions on Information and Systems*, 77(12): 1321–1329.

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[Benford et al. 2006] Benford, S., Crabtree, A., Flintham, M., Drozd, A., Anastasi, R., Paxton, M., Tandavanitj, N., Adams, M., and Row-Farr, J. (2006). Can you see me now? *ACM Transactions on Computer- Human Interaction*, 13(1):100–133.

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[Benford et al. 2005] Benford, S., Rowland, D., Flintham, M., Drozd, A., Hull, R., Reid, J., Morrison, J., and Facer, K. (2005). Life on the edge: Supporting collaboration in location-based experiences. In *CHI '05: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 721–730. ACM Press.

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[Stenros et al. 2007] Stenros, J., Montola, M., Waern, A., and Jonsson, S. (2007). Play it for real: Sustained seamless life/game merger in momentum. In *Proceedings of DiGRA 2007 Situated Play Conference*, pages 121–129.

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[Luesebrink 1998] Luesebrink, M. C. (1998). The moment in hypertext: A brief lexicon of time. In *Proceedings of the Ninth ACM Conference on Hypertext and Hypermedia : Links, Objects, Time and Space*, HYPERTEXT '98, pages 106–112, New York, NY, USA. ACM.

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[Ishii & Ullmer 1997] Ishii, H. and Ullmer, B. (1997). Tangible bits: Towards seamless interfaces between people, bits and atoms. In *Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems*, CHI '97, pages 234–241, New York, NY, USA. ACM.

[Weiser & Brown 1996] Weiser, M. and Brown, J. S. (1996). The coming age of calm technology. http://ubiq.com/hypertext/weiser/acmfuture2endnote.htm.

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[Hightower & Borriello 2001] Hightower, J. and Borriello, G. (2001). Location systems for ubiquitous computing. *Computer*, 34(8):57–66.

[Zhou et al. 2008] Zhou, F., Duh, H. B.-L., and Billinghurst, M. Trends in augmented reality tracking, interaction and display: A review of ten years of ISMAR. In *Proceedings of the 7th IEEE/ACM International Symposium on Mixed and Augmented Reality* (2008), IEEE Computer Society, pp. 193–202.

[Zogg 2007] Zogg, J. M. Essentials of satellite navigation - compendium. Tech. Rep. GPS-X-02007-C, u-blox AG, 2007.

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[Bell et al. 2006] Bell, M., Chalmers, M., Barkhuus, L., Hall, M., Sherwood, S., Tennent, P., Brown, B., Rowland, D., and Benford, S. (2006). Interweaving mobile games with everyday life. In *CHI '06: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 417–426. ACM Press.

[Chalmers & Galani 2004] Chalmers, M. and Galani, A. (2004). Seamful interweaving: Heterogeneity in the theory and design of interactive systems. In *DIS '04: Proceedings of the 2004 Conference on Designing Interactive Systems*, pages 243–252. ACM Press.

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[Jiang et al. 2004] Jiang, X., Chen, N. Y., Hong, J. I., Wang, K., Takayama, L., and Landay, J. A. (2004). Siren: Context-aware computing for firefighting. *Pervasive Computing*, 3001:87–105.

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[Birchfield et al. 2008] Birchfield, D., Thornburg, H., Megowan-Romanowicz, M. C., Hatton, S., Mechtley, B., Dolgov, I., and Burleson, W. (2008). Embodiment, multimodality, and composition: Convergent themes across HCI and education for mixed-reality learning environments. *Advances in Human-Computer Interaction*, 2008:1–19.

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[Dünser et al. 2012a] Dünser, A., Billinghurst, M., Wen, J., Lehtinen, V., and Nurminen, A. (2012). Exploring the use of handheld AR for outdoor navigation. *Computers and Graphics*, 36(8):1084–1095.

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[Tuan & Hoelscher 2001] Tuan, Y.-F. and Hoelscher, S. (2001). Experiential perspective. In *Space and Place The Experience of Perspective*, pages 8–18. University of Minnesota Press.

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[Ajanki et al. 2011] Ajanki, A., Billinghurst, M., Gamper, H., Järvenpää, T., Kandemir, M., Kaski, S., Koskela, M., Kurimo, M., Laaksonen, J., and Puolamäki, K. (2011). An Augmented Reality Interface to Contextual Information. *Virtual Reality*, 15(2-3):161–173.

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[Starner et al. 1997] Starner, T., Mann, S., Rhodes, B., Levine, J., Healey, J., Kirsch, D., Picard, R., and Pentland, A. Augmented reality through wearable computing. *Presence 6*, 4 (Winter 1997), 386–398.

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[Hughes et al. 2005] Hughes, C. E., Stapleton, C. B., Hughes, D. E., and Smith, E. M. Mixed reality in education, entertainment, and training. *Computer Graphics and Applications, IEEE 25*, 6 (2005), 24–30.

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