CMPSCI 691w
Seminar - Introduction to Wearable Computing
Spring 2002

Andrew H. Fagg

April 3, 2002

With computing devices becoming smaller and smaller, it is now (almost) possible for an individual to don such a device as easily as one does a hat or a jacket. It is clear that these technologies will enable us to ultimately extend the desktop resources (including memory, computation, and communication) to almost anywhere we travel. More importantly, this constant access, augmented by a battery of body-mounted sensors, will enable our computers to be sensitive to the activities in which we are engaged, and thus allow the computer to participate in a collaborative and active manner as we perform our tasks. Realizing this dream requires the synthesis of many areas of computer science, computer engineering, and psychology. These areas include: operating systems, human-computer interaction, embedded systems, computer vision, robotics, computer networks, software architectures, computer security, artificial intelligence, machine learning, information retrieval and computer architecture.

This course will combine seminar-style reading/discussion of the relevant literature with hands-on work with wearable computers. Grades will be based upon presentation of papers, participation in the lecture, several programming-oriented homework assignments, degree of assimilation, and a semester-long project.

Class Details

Meeting Times: M/W 2:05-3:20
Meeting Location: CS 142
Class Web Page: http://www-anw.cs.umass.edu/~fagg/classes/cs691w/
Office/Lab Hours:

- Andrew Fagg: TBD, and by appointment

Grading

Grades will be based on class participation (35%), performance on the homework assignments (15%) and on the class project (50%).

Class Participation includes presentation of papers, written analyses of papers, and contributions to class discussion. The number of papers an individual will present depends on the enrollment (probably 3 or 4 papers). The presentation should be professional (organized and with slides), but should be seen as a way to lead the discussion about the paper (i.e., the presenter should not do all of the talking).

A one paragraph analysis of 16 of the 32 papers must be ready to hand in on the day the paper is first presented. The choice of papers is left to the students - but you must turn in at least one paragraph each week (this will take care of 13/16). Focus on what is important about the paper and how you see the work as pushing forward.

Homework assignments A total of two homework assignments will be given. These assignments are intended to bring students up to speed on using the UMass Wearables.

The class project: will be on a topic of the student's choosing (with approval) and will be due by May 23rd. Although the project is worth 50% of your grade, points will be accumulated throughout the semester. So - it is important to meet all of your deadlines (see **the project web page**).

Wearable Computer Access

A set of wearable computers will be available for use; there will be at least one machine for every three students. These will be stored in CS 144, and may be checked out for use in the CS building (to begin with). In general, these machines will be on the Computer Science network, so remote access will be possible from home laboratories or from the EdLab. See me for special arrangements.

Class Schedule

As this is an experimental class, the actual schedule will be adjusted as the semester progresses. Schedule changes will be announced in class, and the web page will be updated accordingly.

Class #	**Date**	**Topic**	**Reading**	**HW Assign**	**HW Due**
1	1/30 (W)	Intro & getting started			
2	2/4 (M)	WearTools Apps	-Twiddler -WT Startup -WT User	HW 1	
3	2/6 (W)	Compelling Examples	-Navigation -Remembrance Agent		
4	2/11 (M)	Augmented Reality I	-Stochasticks -Amstutz	HW 2	HW 1
5	2/13 (W)	Augmented Reality II Class projects	-Tinmith-Metro -Possible Projects List		
holiday	2/18 (M)				
6	2/19 (Tuesday)	Augmented Reality III Weartools Programming	-AR Evaluation -WearTools Programmer's Guide		
7	2/20 (W)	Context I	- Wearable Sensors		
8	2/25 (M)	Context II HW2 Discuss	-Pants		HW 2
9	2/27 (W)	Projects			Project Proposals
10	3/4 (M)	Proactive Behavior I	-Fagg/Davis -Elves		
11	3/6 (W)	Proactive Behavior II	-Adjustable Autonomy		
12	3/11 (M)	Project Design Review			Design Doc
13	3/13 (W)	Proactive Behavior III Navigation I	-Talking Wearables -Touring Machine		
holiday	3/18 (M)				
holiday	3/20 (W)				
14	3/25 (M)	Navigation II Software I	-Context Compass -Generic		
15	3/27 (W)	Projects			Proto I

Class #	**Date**	**Topic**	**Reading**	**HW Assign**	**HW Due**
16	4/1 (M)	Software II Networking I	-“Right” Framework -PEDnet		
17	4/3 (W)	Networking II	-WPKI -Body Busses		
18	4/8 (M)	Applications I	-Panoramic Vid -Mission planning		
19	4/10 (W)	Projects			Proto II
holiday	4/15 (M)				
20	4/17 (*W)	Applications II	-ECG -Orientation		
21	4/22 (M)	Communication	-Canard -Nomadic Radio		
22	4/24 (W)	System Design I	-Netman -AR in Manufacturing		
23	4/29 (M)	Projects			User Eval
24	5/1 (W)	System Design II	-Video Conf -Mobile services		
25	5/6 (M)	Affective Wearables Clothing	-Affective -Clothing		
26	5/8 (W)	Future of Wearables	-Artificial Retina -Brain-based control		
27	5/13 (M)	Final Project Reports I			Writeup Draft Presentation
28	5/15 (W)	Final Project Reports II			
–	5/23 (Th)				Final Project Writeup Due

Class Topics

Introduction to Wearable Computing Definitions, goals, dreams, constraints, managing cognitive bandwidth, class goals, homework assignments, extended class project, and getting started on the UMass Wearables (care & feeding, logging in, and the twiddler keyboard).

Presenter: Andy

WearTools Applications Audio messaging system, speech synthesis, speech recognition, positional context & infrared beacons, calendar reminder system, and stock market monitor. More on care & feeding.

Reading: **Twiddler2 User Manual** (Available in lab), the **WearTools Startup Guide**, and the **WearTools User Guide**.

Presenter: Andy

Compelling Wearable Examples

A. Helal, S. Moore, and B. Ramachandran (2001), **Drishti: An Integrated Navigation System for Visually Impaired and Disabled**, Proceedings of the Fifth International Symposium on Wearable Computers (ISWC'01)

Presenter: STUDENT (1): Michael

B. J. Rhodes and P. Maes (2000), **Just-in-time information retrieval agents**, IBM Systems Journal, Vol. 39, Nos. 3 & 4.

Presenter: STUDENT (2): Fernando

Augmented Reality The real-time overlay of images on top of the real world.

T. Jebara, C. Eyster, J. Weaver, T. Starner and A. Pentland (1997), **Stochasticks: Augmenting the Billiards Experience with Probabilistic Vision and Wearable Computers**, Proceedings of the First International Symposium on Wearable Computers (ISWC'97)

Presenter: STUDENT (3): Josh

Amstutz, P. and Fagg, A. H. (2002), **Real Time Visualization of Robot State with Mobile Virtual Reality** to appear in Proceedings of the International Conference on Robotics and Automation (ICRA'02)

Presenter: Peter Amstutz

W. Piekarski and B. Thomas (2001), **Tinmith-Metro: New Outdoor Techniques for Creating City Models with an Augmented Reality Wearable Computer**, Proceedings of the Fifth International Symposium on Wearable Computers (ISWC'01)

Presenter: STUDENT (4): Chao

R. Suomela, J. Lehikoinen, and I. Salminen (2001), **A System for Evaluating Augmented Reality User Interfaces in Wearable Computers**, Proceedings of the Fifth International Symposium on Wearable Computers (ISWC'01)

Presenter: STUDENT (5): Jeremy

WearTools Programming Using and programming with the UMass WearTools suite. Speech synthesis for messaging, and message prioritization; PostgreSQL for object-based communication; Insertion of messages; Coordinates: GPS, beacons; event generation and reception. Dissection of the stock monitor application.

Reading : **WearTools Programmer's Guide**.

Presenter: Andy

Context Using sensors to infer what the user is doing.

B. Clarkson, K. Mase and A. Pentland (2000), **Recognizing User Context via Wearable Sensors**, Proceedings of the Fourth International Symposium on Wearable Computers (ISWC'00)

Presenter: STUDENT (6): Fernando

K. Van Laerhoven and O. Cakmakci (2000), **What Shall We Teach Our Pants?**, Proceedings of the Fourth International Symposium on Wearable Computers (ISWC'00)

Presenter: STUDENT (7): Jeremy

Proactive information presentation Dynamic mapping of context onto the presentation of relevant information.

A. H. Fagg (in preparation), **An Adaptive, Context-Sensitive Document Retrieval System for Wearable Computers** (no paper to read)

Presenter: Andy

Pynadath, D., Tambe, M., Arens, Y., Chalupsky, H., et al (2000). **Electric Elves: Immersing an agent organization in a human organization**. Proceedings of the AAAI Fall Symposium on Socially Intelligent Agents – the human in the loop

Presenter: STUDENT (8): Josh

Scerri, P., Pynadath, D., and Tambe, M. (2001). **Adjustable autonomy in real-world multi-agent environments**. International Conference on Autonomous Agents (Agents'01)

Presenter: STUDENT (9): Peter

S. Geldof and J. M.B. Terken (2000), **Talking wearables exploit context** Proceedings of CHI'2000

Presenter: STUDENT (10): Fernando

Positional Context and Navigation Wearable use of position information: tour guides, information towers, and direction-finding systems.

S. Feiner, B. MacIntyre, T. Hllerer, and A. Webster (1997), **A Touring Machine: Prototyping 3D Mobile Augmented Reality Systems for Exploring the Urban Environment**, Proceedings of the First International Symposium on Wearable Computers (ISWC'97)

Presenter: STUDENT (11): Chao

R. Suomela and J. Lehikoinen (2000), **Context Compass**, Proceedings of the Fourth International Symposium on Wearable Computers (ISWC'00)

Presenter: STUDENT (12): Michael

Software organization How to flexibly organize the resources and services on the local machine.

J. Pascoe, **Adding Generic Contextual Capabilities to Wearable Computers** Proceedings of the Second International Symposium on Wearable Computers (ISWC'98)

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Presenter: STUDENT (13): Peter

R. W. DeVaul and A. Pentland (2000), **The Ektara Architecture: The Right Framework for Context-Aware Wearable and Ubiquitous Computing Applications**, unpublished

Presenter: STUDENT (14): Fernando

Networking and Security Personal area networks (PANs); Body-based networks; Ad hoc networks; networks for small and inexpensive devices (PEDnet).

J. Davis, A. Fagg, and B. Levine (2001), **Wearable Computers as Packet Transport Mechanisms in Highly-Partitioned Ad-Hoc Networks**, Proceedings of the Fifth International Symposium on Wearable Computers (ISWC'01)

Presenter: James Davis

N.P. Smart and H.L. Muller (2000), **A Wearable Public Key Infrastructure (WPKI)**, Proceedings of the Fourth International Symposium on Wearable Computers (ISWC'00)

Presenter: STUDENT (15): Michael

E. R. Post, M. Reynolds, M. Gray, J. Paradiso, and N. Gershenfeld (1997), **Intrabody Buses for Data and Power**, Proceedings of the First International Symposium on Wearable Computers (ISWC'97)

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Presenter: STUDENT (16): Jeremy

Applications

T. Pintaric, U. Neumann, A. Rizzo (2000). **Immersive Panoramic Video**, Proceedings of the 8th ACM International Conference on Multimedia, pp. 493-494, October.

Presenter: STUDENT (17): Chao

A. Medl, I. Marsic, M. Andre, C.A. Kulikowski, and J. L. Flanagan (1998). **Multimodal Man-Machine Interface for Mission Planning**. In the Proceedings of the AAAI Spring Symposium on Intelligent Environments, pages 41-47.

Presenter: STUDENT (18): Michael

T. Martin, E. Jovanov and D. Raskovic (2000), **Issues in Wearable Computing for Medical Monitoring Applications: A Case Study of a Wearable ECG Monitoring Device**, Proceedings of the Fourth International Symposium on Wearable Computers (ISWC'00)

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Presenter: STUDENT (19): Josh

D. A. Ross and B. B. Blasch (2000), **Evaluation of Orientation Interfaces for Wearable Computers**, Proceedings of the Fourth International Symposium on Wearable Computers (ISWC'00)

Presenter: STUDENT (20): Peter

Wearable Communication Enabling of person-to-person communication.

P.R. Chesnais (1997), **Canard: A Framework for Community Messaging**, Proceedings of the First International Symposium on Wearable Computers (ISWC'97)

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Presenter: STUDENT (21): Fernando

N. Sawhney and C. Schmandt (1999), **Nomadic Radio: Scaleable and Contextual Notification for Wearable Audio Messaging**, Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems

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Presenter: STUDENT (22): Michael

System Design

G. Kortuem, M. Bauer, T. Heiber, and Z. Segall (1999) **Netman: The Design of a Collaborative Wearable Computer System** ACM/Baltzer Journal on Mobile Networks and Applications (MONET), Volume 4, Number 1, 1999

Presenter: STUDENT (23): Jeremy

U. Neumann and A. Majoros (1998). **Cognitive, Performance, and Systems Issues for Augmented Reality Applications in Manufacturing and Maintenance**. Proceedings of IEEE VRAIS'98, pp. 4-11, 1998.

Presenter: STUDENT (24): Chao

B. Hestnes, S. Heiestad, P. Brooks, and L. Drageset (2001), **Real Situations of Wearable Computers Used for Video Conferencing – and Implications for Terminal and Network Design**, Proceedings of the Fifth International Symposium on Wearable Computers (ISWC'01)

Presenter: STUDENT (25): Peter

M. Biemans, H. van Kranenburg, and M. Lankhorst (2001), **User Evaluations to Guide the Design of an Extended Personal Service Environment for Mobile Services**, Proceedings of the Fifth International Symposium on Wearable Computers (ISWC'01)

Presenter: STUDENT (26): Josh

Affective Wearables Making use of the user's current emotional state.

R. Picard and J. Healey (1997), **Affective Wearables** Personal Technologies, Vol 1, No. 4, pp. 231-240

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Presenter: STUDENT (27): Josh

Computational Clothing Hiding the device in your clothes.

E. R. Post, M. Orth, P. R. Russo, and N. Gershenfeld (2000), **E-broidery: Design and fabrication of textile-based computing**, IBM Systems Journal, Vol. 39, Nos. 3 & 4

Presenter: STUDENT (28): Jeremy

Future of Wearables & Other forms of Computational Augmentation Direct biological interfaces and modern prosthetics.

J. F. Rizzo III and J. L. Wyatt, Jr. (1998), **Retinal Prosthesis**, in *Age-Related Macular Degeneration* (J.W. Berger, S.L. Fine and M.G. Maguire, eds.), Mosby, St. Louis, pp. 413 - 432

Presenter: STUDENT (29): Michael

J. K. Chapin, K. A. Moxon, R. S. Markowitz, and M. A. L. Nicolelis (1999). **Real-Time Control of a Robot Arm Using Simultaneously Recorded Neurons in the Motor Cortex**, Nature Neuroscience, 2(7):664–670

(paper copy to be handed out in class)

Presenter: STUDENT (30): Josh