

Ubiquitous/Pervasive Computing

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Agenda

- Area overview
- Four themes
- Challenges/issues



Pervasive/Ubiquitous Computing

- Move beyond desktop machine
- Computing is embedded everywhere in the environment



http://www.dreamlg.com/en/ref/internet/introduction_tv.shtml



Marc Weiser: The Father of Ubicomp

- Chief Technologist
Xerox PARC
- Began Ubiquitous
Computing Project in
1988
- Died April 27, 1999



Weiser on Ubicomp

- Read his Scientific American article from 1991
- “The most profound technologies are those that disappear.”



Ubicomp Notions

- Computing capabilities, any time, any place
 - Handheld, wearable, architecturally implanted
- “Invisible” or taken-for-granted resources
- Machines sense users’ presence and act accordingly
 - We don’t “use” such resources; we make use of them

Automatic hand soap dispenser



Critical Technical Issues

- Location
 - Knowledge of “where” substitutes for intelligence
- Scale
 - One size does not fit all needs
- Networking
 - Constant connectivity, wired and wireless



Location services

- Outdoor
 - Global Positioning Satellites (GPS)
- Indoor
 - Active badges, electronic tags
 - Vision
 - Motion detectors, keyboard activity
- Indoor/Outdoor
 - Beacon-based techniques (WiFi, GSM)



Device scales

- Inch
 - PDAs
 - PARCTAB
 - Voice Recorders
 - Smart phones



Device scales

- Foot
 - notebooks
 - tablets
 - digital paper



Device scales

- Yard
 - Electronic whiteboards
 - Plasma displays
 - Smart bulletin boards



Video Examples

- Ambient Room - H. Ishii, CHI '98
- Beyond the Desktop - J. Rekimoto, CHI '00



Four Themes

1. Natural/Implicit interfaces
2. Automated capture of experiences with easy access
3. Context-aware/sensitive interactions and applications
4. Ubiquitous services independent of devices/platforms



1. Natural/Implicit Interfaces

- How do input and output change?
- Input
 - Towards implicit information
 - Feeds context-aware computing (later)
- Output
 - Towards distributed, peripheral and ambient displays



Ideas

- Computer interfaces and devices are more natural interaction tools
 - Pen input
 - Speech
 - Gesture
 - Tangible interfaces



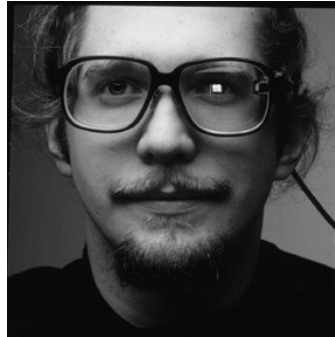
Examples

- Pen applications
 - T9 predictive text entry demo (R. Groeneweg)
<http://hcc.cc.gatech.edu/hccvideos/commvids.html>
- Speech applications
- H. Ishii's tangible UI work



Wearable Computing

- Computation devices accompany you, rather than you seeking them out
- T. Starner



Implicit input at GT



The Gesture Pendant



Input Challenges

- Errors are more likely (handwriting recognition, speech, ...)
 - How can the system discover that an error has occurred?
 - Implies the need for independent confirmation (e.g. repeating back), which is an obstacle to interaction
 - How can errors be corrected?
 - A room doesn't have a help menu
- Is there truly a comparative advantage over more traditional input mechanisms?



What about output

- Multiple displays
 - Managing multiple monitors
 - Distributed in environment
- Ambient displays
 - Controlling environment for output
- Peripheral displays
 - Non attention-grabbing information displays



Multiple monitors

Pros:

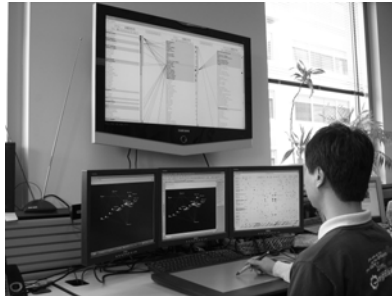
Real estate!



Cons:

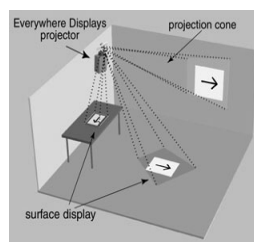
Input slowed

Applications not multi-mon aware



Distributed in Environment

- The Everywhere Display Project at IBM



Ambient and Peripheral Displays

- Ambient – A property of the display's relationship to the environment
- Peripheral – A property of the display's relationship to the user's attention, e.g., background and foreground



Ambient Displays 1

- The Dangling String
 - <http://www.ubiq.com/hypertext/weiser/calmtech/calmtech.htm>

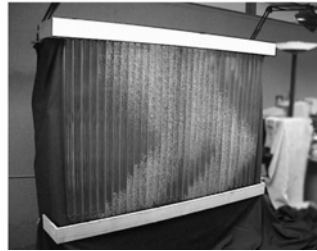


- AmbientOrb
 - <http://www.ambientdevices.com/>



Ambient Displays 2

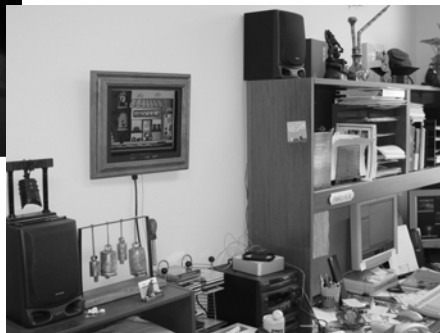
- Information Percolator
 - <http://www-2.cs.cmu.edu/~hudson/bubbles/>
- Ambient Trolley
 - <http://www.gvu.gatech.edu/ii/trolley>



Peripheral Displays

SideShow

Kimura



InfoCanvas



2. Automated Capture & Access

- Use of computers to preserve records of the live experience for future use —allowing the human user to engage in the activity with knowledge that details will be available later
(Abowd & Mynatt 2000)
- Motivation
 - Record-taking is hard
 - Multiple streams of information need to be captured
 - Machines are better at some of these things than we are
- Points of consideration:
 - Capture needs to be natural
 - User access is important
 - Details of an experience is recorded as streams of information



Examples

- Meeting capture (scribe at Xerox PARC), Mark Weiser
- Classroom 2000/eClass at GT
- IBM TeamSpace



LiveBoard



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eClass / Classroom 2000



- Captures:
 - presentation slides
 - annotations
 - audio/video
 - URLs visited

Automatically generates
Web accessible notes

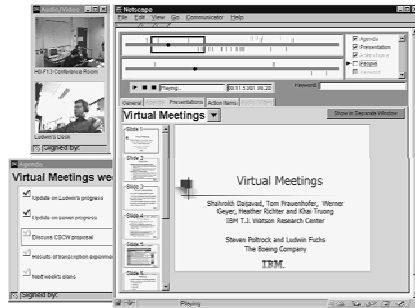
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IBM TeamSpace

- Create and manage meetings, users, agendas, action items, presentations
- Conduct meetings using synchronous tools:
 - slide annotation
 - low-bandwidth video
 - agenda viewer
 - action item viewer



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Issues

- Stream integration -- At what level?
 - Very finest level of actions or more coarse?
- Modifying a record after the fact
 - Can student notes be added later?
- Networked interaction
 - Why can't your notes be put up on the Liveboard?

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3. Context-Aware Computing

- Computing services sense aspects of environment (location, user emotion,...) and tailor provided services
 - Precursor: Soap dispensing
 - Idea: Walk into conference room, my email is projected on a big screen there
 - ...But what if other people can see?
 - We need a broad an operational definition of "context"



What is Context?

- Any information that can be used to characterize the situation of an entity
 - *Who, what, where, when*
- Why is it important?
 - information, usually implicit, that applications do not have access to
 - It's input that you don't get in a GUI



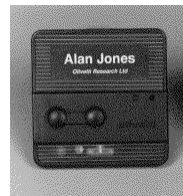
How to Use Context

- To present relevant information to someone
 - Mobile tour guide
- To perform an action automatically
 - Print to nearest printer
- To show an action that use can choose
 - Want to phone the number in this email?

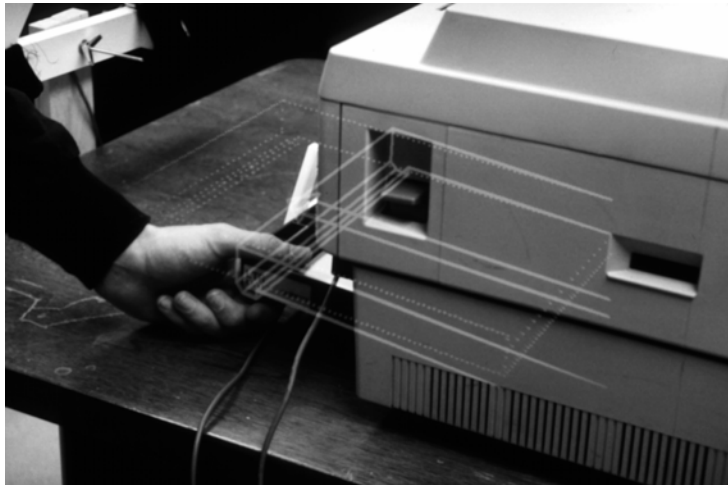


Examples

- Active Badge & PARCTab
- Shopping assistant
- Cyberguide
- Perception system for recognizing user moods from their facial expressions
- House where position is sensed and temperature adjusted automatically



Augmented Reality



Issues

- Registration, registration, registration
- How to integrate all the different aspects of context?
 - The people
 - The place
 - The situation
 - Activities going on and their status
 - Mood and emotion??
- What about the loss of privacy?



4. Ubiquitous Services

- Care about *service*, not application
- Example: messaging
 - You want to receive a message using whatever device is handy nearby
 - Message is tailored to work according to device (e.g. bandwidth, modalities, form factor)



Issues

- What is software infrastructure for integration?
- Do we get it by just adopting some standard?
- Meta-issue: These are not obvious usability issues, but they are HCI design issues, because their resolution affects experience of place and (e.g.) work



Evaluation

- How do we evaluate these technologies?
 - The system *is* a lab, so you can't take it into one.
 - You can't evaluate CA computing except in a context.
 - The context may be too critical to experiment with (e.g. a design project)
 - The context may be too drawn-out to permit changes in evaluation question/strategy (e.g. an entire semester).
 - Ethical/consent issues in multi-person environments
 - Above all, *what are the usability/usefulness objectives?*
How can they be measured?
- Example: Challenge in Classroom 2000



Interested in More...

- CS 7470
- Readings, discussion, research-oriented
- '08-'09



Project

- Presentation order (TuTh)
- What to put in presentation
 - 15 minutes
 - Make sure your presentation mode works
 - Content suggestion
 - Brief intro to problem (2 mins)
 - What's important about users, task, etc. (2 mins)
 - Present design and system (6 mins)
 - Overview of evaluation findings (5 mins)
- P4 reports due Friday 27th 4pm



Upcoming

- Project presentations 1
- Project presentations 2 & Final exam

