MAS 961 - Ambient Intelligence

Pattie Maes

Ambient Intelligence: Vision

- Ambient Intelligence envisions a world where people are surrounded by intelligent and intuitive interfaces embedded in the everyday objects around them. These interfaces recognize and respond to the presence and behavior of an individual in a personalized and relevant way.

Merging of different bodies of work

- Ubiquitous Computing
- Intelligent Interfaces
- Context-aware Computing

Some Scenarios (1)

- **Ambient semantics (H. Liu)**
  "enriching your every day experience"
  - **Book tells you about friends/famous people that read/loved it**
  - **Book tells you about particularly interesting passages**
  - **Touching 2 books makes their connections appear**

Some Scenarios (2)

- Objects with memory
  - Readwear/writewear
  - Objects that act as medium for messages
  - Objects that can tell you their relevant stories/history

Some Scenarios (3)

- Augmented physical environments
  - Walking around town, system points out buildings/places of particular interest to a user (based on user's interests)
  - Books on a bookshelf can "speak out" to you (or posters in infinite corridor)

Vision (continued)

- Ambient Intelligence Technology is:
  - “Invisible”:
    - Use/functions are immediately apparent
  - Ubiquitous:
    - Available anywhere, integrated in physical environment & objects around us
  - Intelligent:
    - Relevant to user & context-aware
    - Unobtrusive
    - Providing meaning (vs. knowledge vs. information)

Vision (continued)

- **Radically rethink the human-computer interactive experience:**
  - **Integrate digital world (information & services) and physical world (physical objects/environment)**
  - **Make interfaces more responsive and proactive (objects & environment monitor user and (proactively) present information & services relevant to user's current needs/interests)**

Challenges

- Augment objects/environments with sensing, computing & networking capability
- Sense & model the user's behavior (offline/online)
- Infer the user's current interests/intentions
- Design (proactive) interfaces that offer value without being obnoxious, while being highly relevant
- Integrate these interfaces in user's physical environment in seamless, natural way:
  - On the body: cell phones, wearables
  - In the environment: architecture, ether, objects

Goals for this Course

- Provide an overview of this new vision for HCI
- Read and discuss the most relevant articles in related areas: Smart Environments, Smart Networked Objects, Augmented & Mixed Realities, Ubiquitous Computing, Pervasive Computing, Tangible Computing, Intelligent Interfaces, Context-based Systems, Personalization and Wearable Computing.
- Focus on understanding enabling technologies and studying applications and experiments. To a lesser extend address the socio-cultural impact.
- Come up with new ideas, start innovative projects in this area

How does this class differ from related Media Lab classes?

- Hiroshi Ishii's "Tangible Interfaces"
  - Giving physical form to digital information so that it becomes more easily manipulable and perceivable
- Joe Paradiso's "Sensor Technologies for Interactive Environments"
  - Focus on sensor technologies (& performance/events)
- Ted Selker's ", Context-Aware Computing"
  - Focus on context-aware systems in general (desktop as well as ubiquitous systems)

Requirements for the students

- Students are required to participate extensively in literature research and class discussions
  - Read required readings ahead of class & prepare ½ page of questions & interesting points for discussion
  - Review & present +- 3 papers in class
  - Write 1 short “scenarios” paper (by Class 3)
  - Suggest additional papers to read
  - Suggest experiments & technologies to look at
- Students are required to design and implement an original project in this area and describe their project in a 3-page paper as well as make 2 presentation to the class
  - Class 10 update
  - Class 13 final presentation

Schedule

- **Class #1** Introduction to Ambient Intelligence
  Pattie Maes
- **Class #2** Intelligence Augmentation & Software Agents
  Pattie Maes
  LIST OF 3 TOPICS/READINGS DUE
- **Class #3** Location Based & Context-Aware Systems
  Pattie Maes & students
  SCENARIOS PAPER DUE
- **Class #4** Interfaces with Common Sense
  Invited speakers Henry Lieberman and Pushpinder Singh

Yellow means requirements for students

Schedule (continued)

- Class #5 Ubiquitous Computing
  Pattie Maes & students
  PROJECT PROPOSAL DUE
- Class #6 User Modeling, Personalization & Recommender Systems
  Pattie Maes & students
- Class #7 Tangible & Ambient Interfaces
  Pattie Maes & students
- No Class (Spring Vacation)

Yellow means requirements for students

Schedule (continued)

- Class #8 The meaning of Things
  Invited Speaker Judith Donath
- Class #9 Augmented Reality/Mixed Realities
  Pattie Maes & students
- Class #10 Intelligent Environments
  Pattie Maes & students
  PROJECT UPDATE DUE (1 page)
- Class #11 Embedded Intelligence/Smart Objects
  Pattie Maes & students

Yellow means requirements for students

Schedule (continued)

- Class #12 — Pervasive Computing & Wearables
  Pattie Maes & students
- No Class — Kresge event & sponsor week
- Class #13 — PROJECT PRESENTATION & PAPER DUE

Yellow means requirements for students

Reading List

- Ambient Intelligence (Class 1)
  - Ambient Intelligence, Fraunhofer Institute
    http://www.iuk.fhg.de/embedded_systems_eng.html
  - Ambient Intelligence in Home Lab, Philips Research
    http://www.research.philips.com/Assets/Downloadablefile/ambientintelligence-2456.pdf
  - Scenarios for Ambient Intelligence in 2010

Reading List (continued)

- Intelligence Augmentation (Class 2):
  - Required reading: Maes, P., Schneiderman, B., "Direct Manipulation vs. Interface Agents: a Debate." Interactions, 4 Number 6, ACM Press, 1997
    http://www.cc.gatech.edu/ccg/paper_of_week/shneiderman-maes.pdf
  - Required reading: The Wearable Remembrance Agent: A system for augmented memory, Rhodes (required reading)
  - Agents that reduce work and information overload, Maes
    http://portal.acm.org/citation.cfm?id=176792
  - Douglas C. Engelbart, "Augmenting Human Intellect"
  - Andy Clark, *Natural-Born Cyborgs: Minds, Technologies, and the Future of Human Intelligence*

Reading List (continued)

- Location-based & Context-aware systems (Class 3):
  - Special issue on Context-Aware Computing, IEEE Pervasive Computing, 2002 ***
  - Context-based city & museum tour guides (Abowd, Cheverst, Reinhard, Petrelli) ***
  - “Ubiquitous Systems in Interactive Museums” , Fleck et. Al. IEEE Pervasive Computing ***
  - Reminder systems (Rhodes, Pentland & Devaul, Lamming...) ***
  - “Virtual Graffiti" systems (Geonotes, HangingMessages, Ether Threads) ***

Reading List (continued)

- Interfaces with Common Sense (Class 4)
  - Required reading: Beating some Common Sense into Interactive Applications, Lieberman et. Al.
  - Selected readings on Interfaces with Common Sense (Lieberman)
  - Selected readings from IUI Proceedings

Reading List (continued)

- Ubiquitous Computing (Class 5):
  - **Required reading: papers by M. Weiser**
    http://www.ubiq.com/hypertext/weiser/UIST94_4up.ps.
    http://www.ubiq.com/hypertext/weiser/ACMInteractions2.html
    http://www.ubiq.com/hypertext/weiser/UbiCompHotTopics.html
  - "Open House", Weiser M., 1996 ***
  - "Designing Calm Technology", M. Weiser and J. Seely Brown http://www.ubiq.com/hypertext/weiser/acmfuture2endnote.htm ***
  - "The Human Experience", Abowd, IEEE Pervasive Computing ***
  - "Slow Technology", Hallnas & Redstrom, http://civ.idc.cs.chalmers.se/projects/slowtech/papers/slowtech.pdf ***
  - "Ambient Agoras" project, www.AmbientAgoras.org, Fraunhofer Institute ***
  - Selected papers from proceedings of Ubicomp 2001, 2002, 2003 ***

Reading List (continued)

- User Modeling, Personalization & Recommender Systems (Class 6)
  - Required reading to be announced
  - Recommender Systems by Ungar http://www.cis.upenn.edu/~ungar/CF/
  - Empirical Analysis of Predictive Algorithms for Collaborative Filtering http://www.research.microsoft.com/users/breese/cfalgs.html
  - Recommender Systems by Resnick & Varian http://www.acm.org/pubs/cacm/MAR97/resnick.html

Reading List

- Tangible Interfaces (Class 7):
  - Required reading: "Tangible Bits", Ishii H., CHI97
  - other papers by Ishii et. al.
- Ambient Interfaces (Class 7):
  - Required reading: “Ambient Interfaces: Design Challenges and Recommendations”, Fraunhofer Institute
    http://www.uni-weimar.de/~gross/publ/hcii03_gross_amb_int.pdf
  - papers by H. Ishii

Reading List (continued)

- **The Meaning of Things (Class 8):**
  - **Required reading to be announced**
  - **"The meaning of Things", Csikszentmihalyi**
  - **"The Cultural Biography of Things", I. Kopytov**
  - **"Culture and Consumption", "Mc Gracken, G**
  - **"The Social Life of Things" Apadurai, A.**

Reading List (continued)

- Augmented Reality/Mixed Realities (Class 9):
  - Required Reading: Augmented Reality: A New Way of Seeing, Steven K. Feiner, 2002
  - Introduction to Augmented Reality by J. Vallino
    http://www.cs.rochester.edu:80/u/vallino/research/AR/introduction.html ***
  - Presence Journal special issue on AR, 1997 ***
  - CACM Special issue on AR, 1993, Vol 36, #7 ***
  - Animated & Electronic Paper Experiments (e.g. Wellner) ***

Reading List (continued)

- Intelligent Environments (Class 10):
  - Required readings to be announced
  - Concept Homes
    http://www.research.philips.com/Assets/Downloadablefile/ambientintelligence-2456.pdf
  - Selected papers from "Intelligent Environments", P. Froege
  - Papers on Georgia Tech "Aware Home"
    http://www.cc.gatech.edu/fce/ahri/projects/index.html
  - Papers on MIT Media Lab Smart Room experiments
  - Papers of MIT AI-lab Smart Room experiments

    _____ and _____
  - Papers on Stanford iRoom http://iwork.stanford.edu
  - Papers on MIT's House-N

Reading List (continued)

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  - Required readings to be announced
  - Concept Homes
    http://www.research.philips.com/Assets/Downloadablefile/ambientintelligence-2456.pdf
  - Selected papers from “Intelligent Environments”, P. Froege
  - Papers on Georgia Tech “Aware Home”
    http://www.cc.gatech.edu/fce/ahri/projects/index.html
  - Papers on MIT Media Lab Smart Room experiments
  - Papers of MIT AI-lab Smart Room experiments
  - Papers on Stanford iRoom http://iwork.stanford.edu
  - Papers on MIT’s House-N

Reading List (continued)

- **Pervasive Computing and Wearables (Class 12):**
  - **Pervasive Computing Handbook, U. Hansmann**
  - **Me++, W. Mitchell *****
  - **Papers from IEEE pervasive computing journal *****
  - **Wearable Computing Papers, MIT, CMU, UNC, Sony CSL *****
  - **Proceedings of the wearables conferences *****

Some of my work in this area

- Software Agents Group (till 2001):
  - Remembrance agent
  - Periscope
  - Impulse
  - Hanging Messages
- Ambient Intelligence Group (ongoing, since 2003):
  - What would they think?
  - Ether Threads
  - Ambient Semantics
  - Photowhere
  - …

Remembrance agent (on Wearable)

- Bradley Rhodes (2001)

Context-specific reminders of previous notes taken
(based on location, day, time of day, other people present, conversation topics, …)

Periscope: A virtual Browser for the Real World – Jim Youll (2001)

Camera with compass and range finder shows webpages about the location the user is focused on.

(currently being implemented on mobile phone with GPS & possibly compass by Dan Relihan)

Impulse: Information Exchange with Entities in the Physical Vicinity - Joan Morris & Jim Youll (2000)

The Coop Bookstore
out of stock

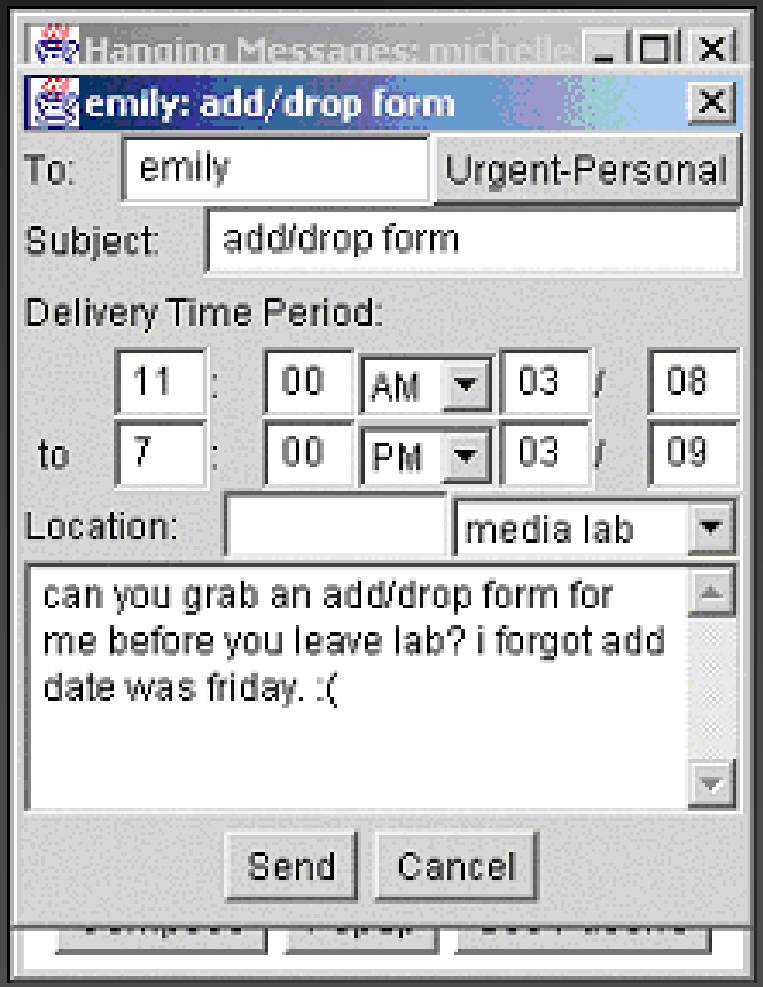
Harvard Univ. Bookstore
lowest price $55

Brad's Agent

Wordsworth Bookstore
lowest price $45

beep!

Hanging Messages – Emily Chang (2001)

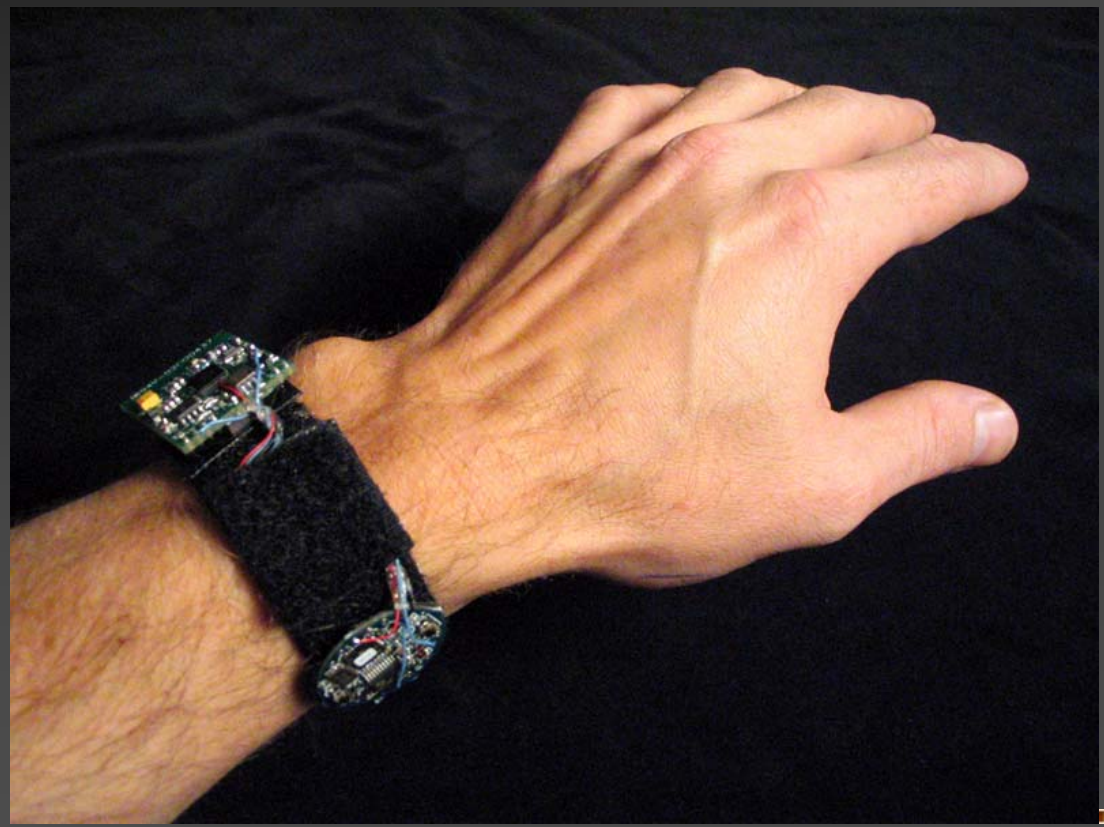


Using PDA + GPS, users can leave or receive location-based messages

Project “Touch & Play”: Accessing information and services related to objects – Assaf Feldman & Sajid Sadi

- **Touching an object results in a menu of services and information being presented on a nearby display**
- **E.g. touching a book, results in options to:**
  - Buy a copy of that book
  - Read reviews of that book
  - Leave a message in that book
  - Retrieve messages left in the book
  - Do a keyword search in the book
  - …

Wireless RFID reader wristband used in Ambient Semantics project - Assaf Feldman, Sajid Sadi, Emmanuel Munguia Tapia



RFID tags embedded in objects are read by a wireless RFID reader wristband.

Project “Ambient Semantics”: Personalized information gems about object you currently focus on - Hugo Liu, Assaf Feldman, Sajid Sadi (current)

- Example: when you pick up a book, a nearby display shows:
  - Prediction of how much you will like it
  - which passages are relevant to your interests
  - how it relates to other books you recently read
  - who of your friends loved/hated it
  - …

Project “Ambient Semantics”: Personalized “information gems” about the person you currently focus on

- Hugo Liu, Assaf Feldman, Sajid Sadi (current)

- Example: shaking someone’s hand, a nearby display shows:
  - which interests you have in common
  - which friends you have in common
  - which objects/locations you have in common

“Intelligence” methods used in Ambient Semantics project - Hugo Liu (current)

- Mining the web:
  - people’s homepages
  - social networks sites (Friendster, LinkedIn, Orkut)
  - Amazon & Google
- Using Natural Language Processing techniques and Common Sense knowledge
- To find relevant connections (between 2 people, between person & object)

Project “Attentive Devices”: Sensing & responding to visual focus of attention - David Merrill (current)

- User wears baseball cap with IR emitter/receiver
- Augmented (parts of) objects in environment sense the user’s focus of attention
- Relevant & personalized information is presented in audio format

Project “Object Awareness”: Drawing the person’s attention to objects of interest in the immediate environment - David Gatenby (current)

- Bluetooth-enabled cell phone communicates user’s interests to augmented objects in user’s vicinity
- Relevant objects can draw the user’s attention by blinking their LED’s

Functions:
-Keyword search
-Recommendations
-Similarities
-Finding an object…

Ether Threads

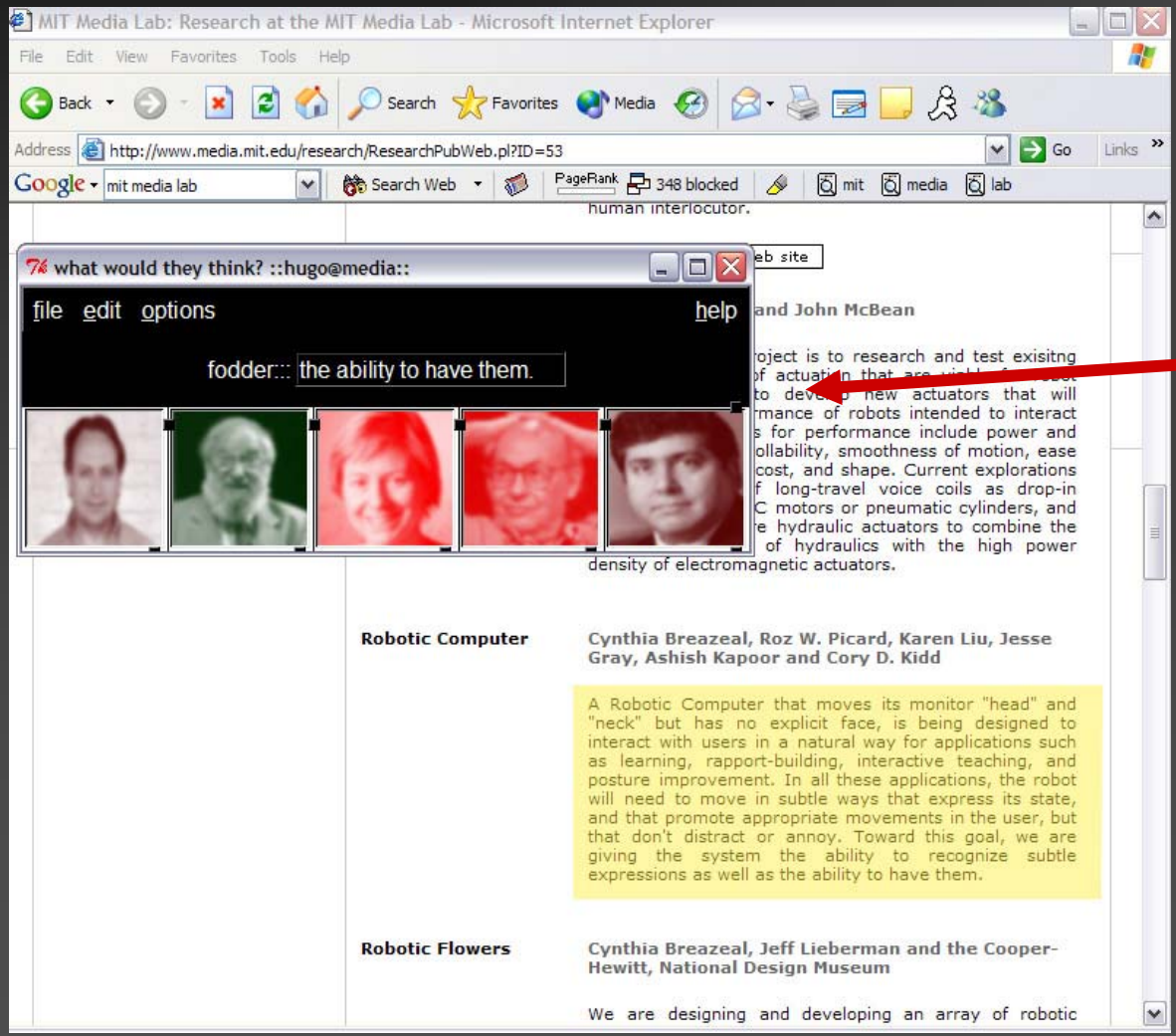
- Brad Lassey (2004)

- Infrastructure for annotating the physical world (leaving location-specific messages)
- Threads and filtering mechanisms
- Can be used as personal or collective “distributed memory”

Blue-tooth and GPS data trigger location-based messages relevant to the user & thread s/he is interested in

What Would they Think?

- Hugo Liu (2003)



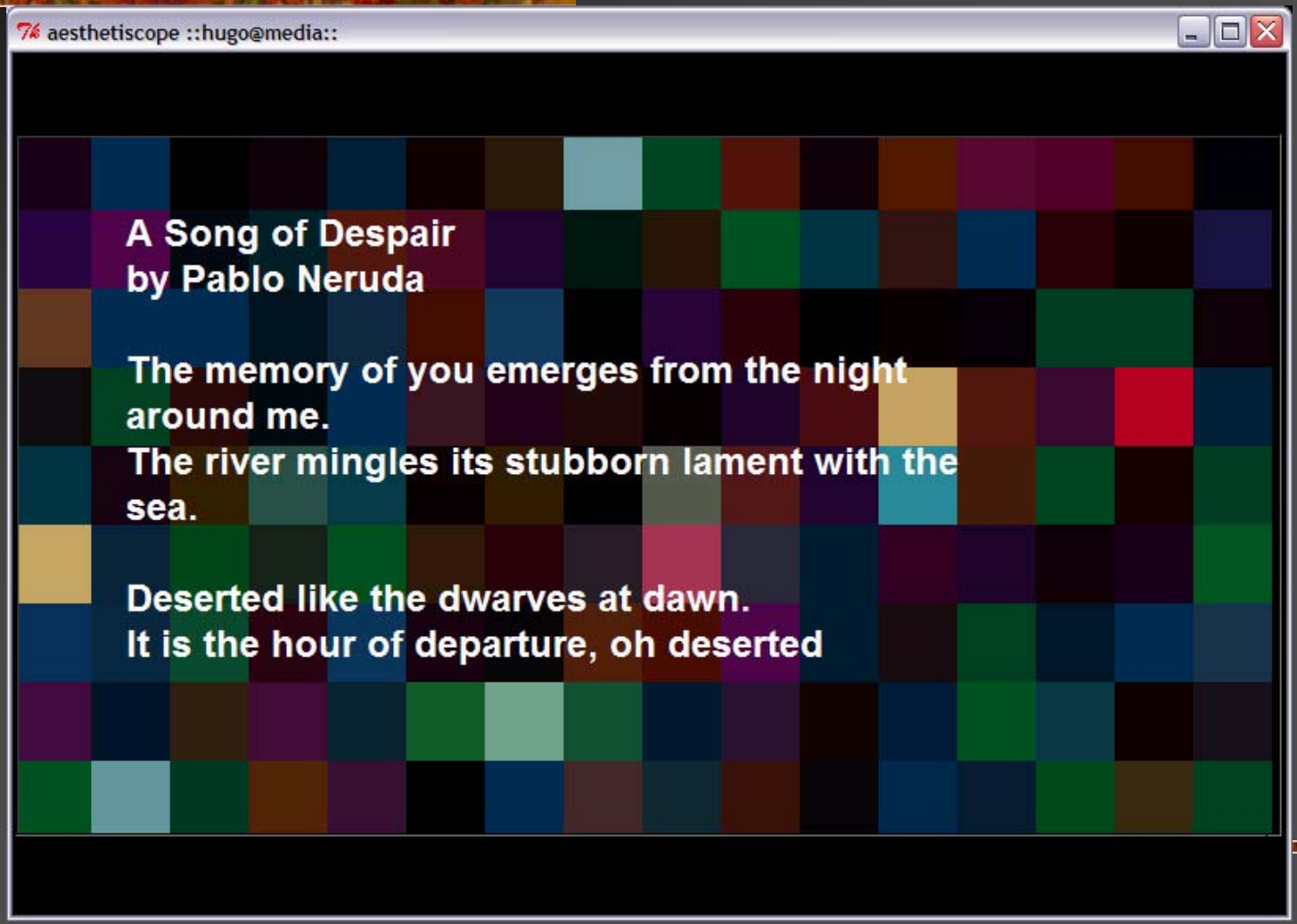
panel of mentors react proactively to text that a reader is currently viewing/writing (speaking)

Automated Annotation of Photographs - Dan Relihan (2004)

Phone Camera communicates with GPS device via bluetooth to record location of picture taken. Phone interfaces to www.metacarta.com to find urls about that location. Extracts and offers keywords for the picture taken (to be edited by the user).

Aesthetiscope

- Hugo Liu (2004)



Impact

- Always-present, pro-active, highly responsive interfaces make people more efficient, better informed. Examples:
  - Better memory (environment/objects around us “remember” and recall information)
  - More effective learning (just-in-time information is presented when user is most motivated to learn)
- Traditional computer interface disappears (replaced by augmented bodies & augmented environments)

To Do's Next Two Weeks

- By tomorrow: return class form
- By next week (Class 2):
  - Check out class website (url will be mailed)
  - Read required readings and prepare ½ page questions & comments
  - Decide which topic(s)/papers you want to research & present
- By week after (Class 3):
  - Write scenarios paper (2 pages)