Charting Past, Present, and Future Research in Ubiquitous Computing

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Introduction

- Mark Wieser outlined the basic tenets of ubicomp in 1991
- The physical devices proliferated
- The software and infrastructure did not
- Weiser’s vision: Context aware, context capturing devices with natural, robust HCIs

Ubicomp: Inherently Scalable

- Physical scale: Not just the desktop
  - Actually, not even the palmtop
- Human scale: Acceptable any and everywhere, and at critical mass
- Temporal scale: Works 24/7, 365 days a year
  - Invites informal and unstructured use
  - Can deal with tasks that neither begin nor end
- Poster Child: ParcTAB

Natural Interfaces

- Definition: Interfaces that capitalize on expressive ability of humans
  - Speech
  - Gesture
  - Writing
  - Graspable/Tangible
- Multimodality is also part of it

What We Are Missing...

- Primary natural data types: a secondary class right now
  - Example: Convert writing to text
- Error correction of natural data
  - Error reduction
  - Error discovery: understanding the task
- Reusable infrastructure for the above
  - Spend less time reinventing the wheel

Context Aware: Scratching the Surface

- Currently used context:
  - Location: GPS, cell-based, etc
  - Personal info: generally identity + profile
  - Object recognition: bar codes, visual recognition
- But what is the meaning of context?

What is Context?

- Who: not just who the user is, but whom the interaction is with
- What: knowing something about the user's actions (difficult)
- Where/When: well explored, but difficult indoors
- Why: divining intent (affective and substantive)

More Context Considerations

- Context representation
- Context fusion: sensor fusion + context negotiation
- Augmented reality: context + natural interaction
  - Augmented vision/audio can be a pathway for natural interaction

Reality Capture

- Basic theme: continuous event capture → playback on demand
- Extension: Mine extra information from the capture to annotate or enhance playback
- Areas to explore: interactive playback, smart annotation, pervasive capture
- Some hardware issues, but difficulty resides in deriving information

Everyday Computing

- Change in the way humans interact with computers
- From tool to presence
- Support for all activities, without bounds

Aspects of Everyday Computing

- Lack beginning and end
  - Natural consequence human interaction: works via action loops repeated across instances
  - Reverse of classical HCI: does not aim for closure
- Interruptions
  - Many activities are intertwined, sometimes in the background
  - Support needed for these “context switches”

Aspect of EC (continued, 2)

- Multiplexed activities
  - Awareness of background activity
  - Assistance for switching between activities smoothly and with relevance
  - Modulate intrusiveness by background state
- Time discriminate
  - Pay attention to temporal ordering of actions
  - Account for memory degradation over time

Aspect of EC (continued, 3)

- Addressing associative nature of memory
  - People remember and work associatively
  - Information in associative form is more intuitive and relevant in many cases, because we form associative categories mentally
  - Also inherently supports multiple views

Research Directions

- Continuously present interfaces
- Peripheral displays with level of detail
- Smooth transitions between digital and real
- Peripheral/opportunistic HCI methods

Challenge: Evaluation

- Ubicomp projects tend not to pass prototype state
- Research ends up technocentric

Thoughts on Evaluation

- Find a human need
  - Have a compelling scenario for usage – do not design the solution in search of a problem
  - Use user studies to inform the grand vision
  - Working with real users shows the actual limits of technology
  - Realistic scenarios can often inform of particular stumbling points and trade-offs

Thoughts on Evaluation (2)

- Test the system in a real context
  - Need to observe user within routine
  - Actual deployment shows assumptions and mistakes of design
  - Provides feedback on the level of observation needed even at small scales
- Task-centric evaluations are inappropriate
  - Standard usability tests (and settings) are not very useful as well

Challenge: Social Issues

- Control: who watches the watchers, what is being recorded, who has access and when
- Security of information
- Privacy concerns
- Transparency of computer actions (or lack thereof)
- Legal implications of enabling technology
- [Business implications]

Conclusions

- Weiser: Compelling applications will drive technology [too limiting]
- No single application usually drives critical mass acceptance
- General purpose, fluid utility of ubicomp should drive the technology and research