Intro to Context-Aware Computing

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05-899

Special Topics in Ubiquitous Computing
Readings

- **Context-Aware Computing Applications**, by Bill Schilit, Norman Adams, and Roy Want
- **Ask not for whom the cell phone tolls: Some problems with the notion of context-aware computing**, by Tom Erickson
- **Challenges in Implementing a Context-Aware System**, by Satya
- **WhereWare**, by Eric Pfeiffer
Context-aware computing is:

“software that **examines** and **reacts** to an individual’s changing context.”

- Schilit, Adams, & Want 1994

“...aware of its user’s **state** and **surroundings**, and help it **adapt** its behavior”

- Satyanarayanan 2002
What is context?

“any information that can be used to characterize the situation of an entity.” (Dey et al., 2000)

- Identity (Who)
- Activity (What)
- Time (When)
- Location (Where)

Who + What + When + Where ➔ Why
<table>
<thead>
<tr>
<th></th>
<th>manual</th>
<th>automatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>information</td>
<td>proximate selection &amp; contextual information</td>
<td>automatic contextual reconfiguration</td>
</tr>
<tr>
<td>command</td>
<td>contextual commands</td>
<td>context-triggered actions</td>
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Table 1: Context-Aware Software Dimensions

From Schilit, Adams, & Want 1994
Proximate Selection / Contextual Info

- Manually retrieve information based on context

<table>
<thead>
<tr>
<th>Name</th>
<th>Room</th>
<th>Distance</th>
</tr>
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<tbody>
<tr>
<td>caps</td>
<td>35-2200</td>
<td>200ft</td>
</tr>
<tr>
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<td>35-2108</td>
<td>30ft</td>
</tr>
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(c) (d)

Table 2: UI Techniques for Proximate Selection
Proximate Selection / Contextual Info

- Bluetooth

**Discovery Results**

- **Show:** Nearby devices

**Select a PC:**
- L00059ZVF51
- PALMONE-OW36V7I
- Jim's PC
- PALMONE-71ZAA5
- StenDellBlue
- Bonnie

**Devices**
- M2500 by Plantronics
- DELL AXIM X50
- iPAQ 2215
- MacMini

**Menu**
- 1 New
- 2 Edit
- 3 Delete
- 4 Set as Hands-free

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Proximate Selection / Contextual Info

- Geonotes (http://geonotes.sics.se)
Automatic Contextual Reconfiguration

- Add, remove, or alter components based on context

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Automatic Contextual Reconfiguration

- Add, remove, or alter components based on context

- SenSay (Siewiorek et al, 2003)
Automatic Contextual Reconfiguration

- CyberGuide (Abowd et al., 1997)
Contextual Commands

- User can parameterize commands with context-filtered values
- Execution changes based on context

- Example: truly universal remote control
Context-triggered Actions

- Simple if-then condition-action rules, automatically invoked
- Contextual Reminders: if I go walk by kitchen, remind me to get coffee

Active Badge (Want et al., 1992)

CybreMinder (Dey & Abowd 2000)
Context-triggered Actions

- **Challenges:**
  - Expressiveness of language for rules
  - Accuracy of context information

**Siren** (Jiang et al., 2004)

IF (firefighter F1 IN room A) AND (surrounding temperature > 1500F) THEN (generate_alert(firefighter F1 in danger)) AND (generate_alert(room A is a dangerous place))
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Context-awareness as a cushion

- Pervasiveness of technology
- Context-awareness helps technology “get it right”

But...
- Context is hard to sense
  - Lots of it
  - Subtle

- Computers are not “self-aware” like humans
Errors

- When the system does the wrong thing
  - Auto-locking car doors
  - Screen saver during presentation
  - Microphone amplifying a whisper

- In these examples, is the system or the user at fault?
All About Actions

Claim:
context-awareness is *not useful itself* but
only useful for *automatically triggering an action*
Anti-A.I.

Claim: context data must be coupled with the ability to interpret it, computers are bad at common sense

- More rules ≠ Intelligence
- More rules = more complexity, harder to understand
Human in the Loop

- Computers can detect, aggregate, and portray information
- Allow human users to interpret and act on it.

Q: Is this a reasonably strategy for all context-aware systems?
  - What will this strategy be good for?
  - What will this strategy be bad for?
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Challenges in Context-Aware Computing (Satya)

- How to represent context internally?
  - Storage
  - Data structures and algorithms

- How frequently does the system need to be updated on context changes?
  - How often to poll?
  - How often to change behavior?

- What sensors, infrastructure, or sensors are necessary?
  - What is the fallback condition?

- How to sense location information?
  - Technical details
  - History of location?
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Location-tracking technologies

- GPS
- GSM
- Assisted GPS
- WiFi
- Ultrawideband

- Metrics
  - Accuracy, reliability, security

- Considerations
  - Buying new devices?
  - Business issues (coordinating service with infrastructure)
  - Killer app?
**Location stack**

"You Are Here"

A combination of technologies such as the global positioning system, cellular triangulation, Wi-Fi data networks and ultrawideband triangulation will create the outdoor/indoor tracking infrastructure of the future.
Discussion

• How would you describe the context you are in now?
  – location, physiological state, emotional state, etc
  – What is the most “important” context at the moment?

• What are some types of context that people have not thought of before?

• What new or existing application can use this context?
Discussion

• How does context-aware computing fit in with ubicomp?

• Ubicomp
  – Mobile
  – Ambient
  – Tangible