What is Context-Aware Computing?

• “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]

• Systems that are able to adapt their operations to the current context without explicit user intervention

• Aim at increasing usability and effectiveness by taking environmental context into account

What is Context?

• “…any information that can be used to characterize the situation of an entity.” [Dey et al. 2000]

• Places, People, Things

  – Location (where?)
  – Identity (who?)
  – Time (when?)
  – Activity (what?)

  why?
**Traditional Computer View**

Context independent: acts exactly the same

**From Abstraction to Context Sensitivity**

- Traditional black box view comes from the desire for abstraction
- This is based on several assumptions:
  - Explicit input/output: slow, intrusive, requiring user attention
  - Sequential input-output loop
- Move away from the black box model and into context-sensitivity
  - Human out-of-the-loop (as much as possible)
  - Reduce explicit interaction (as much as possible)

**Context as Implicit Input/Output**

Context:
- State of the user
- State of the physical environment
- State of the computing system
- History of user-computer interaction
- ...
Context

- Identity (user, others, objects)
- Location
- Date/Time
- Environment
- Emotional state
- Focus of attention
- Orientation
- User preferences
- Calendar (events)
- Browsing history
- Behavioral patterns
- Relationships (phonebook, call history)
- ... the elements of the user’s environment that the computer knows about...

Examples

- Smartphone adjusts the screen to the orientation of the device
  - Orientation is determined by using both a gyroscope and an accelerometer.

Examples

- Phone display adjusts the brightness of the display based on the surrounding area
  - Uses a light sensor
- Device uses GPS to display the user’s location
  - Can use to find nearby stores
  - Get directions
  - Status updates on Facebook!
Examples

• The time is displayed on the phone.
  • Time zone change
  • Daylight savings time

Examples

• Device disables touch screen when the user speaks on the phone
  • How?
  • A proximity sensor!
  • Uses infrared rays to send a signal out. The time it takes to be reflected back is measured and from this, proximity can be detected.

Classification

• External (physical)
  – Context that can be measured by hardware sensors
  – Examples: location, light, sound, movement, touch, temperature, air pressure, etc.

• Internal (logical)
  – Mostly specified by the user or captured monitoring the user’s interaction
  – Examples: the user’s goal, tasks, work context, business processes, the user’s emotional state, etc.
Why Context-Aware Computing?

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Categories of CA Applications

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**Automatic Contextual Reconfiguration**

- Add, remove, or alter components based on context
- SenSay project: context-aware mobile phone
Contextual Commands

• Users can parameterize commands with context-filtered values; execution changes based on context
• Example: universal remote control

Context-Triggered Actions

• Simple if-then condition-action rules, automatically invoked
• Reminder: if I step into the car on weekday morning and don’t have suitcase with me, remind me to get it
• CybMinder:

Context-Triggered Actions

• Challenges:
  – Expressiveness of language for rules
  – Accuracy of context information
• Siren:
Context-Awareness

• Context-awareness helps technology to “get it right”
• But context is hard to sense (quantity, subtleness)
• Computers are not self-aware like humans

• Problems:
  – When the system does the wrong thing
    • auto-locking car doors
    • screen saver during presentation
    • microphone amplifying a whisper

Context-Awareness

• Context data must be coupled with the ability to interpret it, but computers are bad at “common sense”.
• More rules ≠ intelligence
• More rules = more complexity, harder to understand

• “Human in the Loop”:
  – computers can detect, aggregate, portray information
  – allow human users to interpret and act on it
  – Is this a good strategy for all context-aware systems?

Encourage Healthy Dietary Behaviors

• Interactive game to assist teachers to improve dietary behaviors of kindergarten children (“smart lunch tray”)
AudioIndex

• Allowing visually impaired to browse and search audio books. Main device around neck, earpiece with audio feedback, pointing device on index finger.

Parent Pager

• A “child safety product”
• Activates an alarm when a child wanders more than 15 feet from the adult “base” unit
• Also alarms if submerged in water

5 Design Considerations

1. Improving relevance
   – Deciding when a communication is relevant to the person’s current (or near future) situation.
   – For example, getting notification about an email from your travel agent regarding itinerary changes while packing to leave for the airport.
2. Minimizing disruption
3. Improving awareness
4. Reducing overload
5. Selecting channels
5 Design Considerations

1. Improving relevance
2. Minimizing disruption
   - Deciding when and how to notify people that they have a communication.
   - For example, your phone should vibrate and not ring, when you are at the symphony (unless it is truly urgent).
3. Improving awareness
4. Reducing overload
5. Selecting channels
5 Design Considerations

1. Improving relevance
2. Minimizing disruption
3. Improving awareness
4. Reducing overload
5. Selecting channels
   – Deciding which communication device should be used to get in touch with somebody.
   – For example, routing calls to your home phone instead of your cell phone when you are at home and cellular reception is poor.