

Application-driven research in ubiquitous computing

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My principal message

- We aren't the only researchers
- There are people actually doing research in the application domains
- They understand the apps and the value proposition behind them
- We need to team up

Technology research (what we do)

- Hypothesize a new capability
 - Domain of capability: location, sensors, displays, low-power, wireless communication, etc.
- Determine components and architecture that can realize the capability
 - Find potential applications to help set constraints
 - Make architecture compatible with applications
- Implement, measure, and iterate

Example



- Location-sensing with commodity devices (Place Lab)
- Some applications:
 - Location-based search
 - Navigation assistance
- How much resolution do I need?
- Can architecture support user privacy?
- Implement by passive listening to RF beacons
 - Start with 802.11, compare to GPS, consider coverage, add GSM, compare again, try fingerprinting for more accuracy, compare again, and keep iterating . . .

Application research (what others do)

- Hypothesize there is value to an application
 - Domain of value: financial, personal, social, art, entertainment, military, political, etc.
- Determine capabilities needed to make application a reality
 - Find technologists that provide these capabilities
 - Adapt technology to the task
- Implement, measure, and iterate

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5

Example

- Lessen dependence of handicapped users on door-to-door public bus service (too expensive)
- Need device that will track position of user on busses – correlate with actual bus – inform helpers at either ends of route
- Use mobile phones that don't stigmatize user and assist without compromising privacy
- GSM-based localization is key capability that is needed



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6

Examples

- Technology-led
 - Augmented reality
 - Vision-based tracking
 - Activity inferencing from sensors
 - Sensor networks
- Application-led
 - Aircraft maintenance
 - Autism therapy scoring
 - Computer-supported cooperative care
 - Improving vineyard yield
- Both approaches are valuable
 - Develop new technological capabilities
 - Solve real users' application problem



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7

If both are valuable, what are the issues in the ubicomp community?

- Research approach isn't always clear
 - Affects how work is evaluated and appropriate venues
- Applications are often just window-dressing
 - Applications fabricated to match technology
 - Imagined by technologists, not informed by real needs
- Need apps to evaluate incremental improvements to capabilities
 - Why improve resolution from 5m to 3m?
 - The more incremental, the more it needs to be app-motivated
- Technologists need to provide parameters for designers
 - Enable others to evaluate a technology for an application
- Measurable progress
 - Technology – as constrained/required by applications
 - Applications – measure beneficial effects depending on domain
- Time constant of research
 - CS research (and ubicomp) is geared toward $\tau <$ time in PhD program
 - Most applications research is $\tau >$ time in PhD program
 - Implications for publication, project management, continuity

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8

Take-Aways

- Applications **drive** requirements
 - How accurate should the location system be?
 - How often should the sensors report in?
 - How long do the batteries need to run?
 - How much weight will people tolerate around their neck?
- Applications are **critical**
 - **Ground** technology developments
 - Demonstrate ultimate **benefits** of ubicomp
 - We need to talk to researchers in those areas