Aware Home: Sensing, Interpretation, and Recognition of Everyday Activities

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Aware Home Research Initiative
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Research Goals

1. How can your house help, if it is aware (of your whereabouts, activities, needs, intentions, etc.)?

2. How to construct such a house (research lab!)
The Research Agenda
A four pronged approach.

Paradigm: Use real needs to drive which research problems we (the technologists) pursue. Then build, test, evaluate, and LIVE ‘em.

Obviously needs a multidisciplinary team with engineering, computing, medical, eldercare, legal, etc.

? handle
? toolkits
? Legal precedents

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Who is Involved?

? Georgia Tech
  ? College of Computing
  ? GVU Center / Broadband Institute / GCATT
  ? School of Psychology (Cognitive Aging)
  ? Electrical and Computer Engineering (Wireless, DSP)
  ? School of Public Policy
? Other interested parties:
  ? Atlanta VA Hospital
  ? Emory Medical / Law School
  ? U of Rochester, MIT, etc. Collaborations!
House Basics

- 2-story new house
- 2 identical “apartments” (3 bedroom)
- Basement meeting area & machine room

Initial Funding 1998 (by GRA), Occupancy 5/2000. Initial Demos 7/2001 (ACM01)
History

- July '98: Georgia Research Alliance (GRA): Promote economic growth in GA
- GRA sold on idea of Broadband to the home; but “Aware Home” became compelling
- April '99: groundbreaking
- May '00: occupancy
- January '01: ACM1 in San Jose: Focused primarily on Application design
- Feb '01: 2 NSF Mid ITRs (Devey mentioned!), (Have 2 others too).
- May '01: AH Research Initiative (Industrial Funding Consortium)
- Growth Overwhelming.
A Current Focus: Aging in Place

How can we support senior adults in maintaining an independent lifestyle in their own home?

- Safety
- Compliance
- “Maintaining a vigilant watch”
  - Supporting Daily Routines by focusing on cognitive declines and providing useful assistance
- Routines
- Family Communication
Video

- ACM 01: Applications Video
- Video by GT’s IMTC (these guys are professionals!)
- Well ...
Important Goals: Ubiquity

- Sensing and output technology that is transparent to everyday activities.
- Passive
- Anywhere, anytime input/output.
- Provide an ability to sense, interact, display information, communicate, without increasing burden/load on users.
- Aware of residents, sense them!
  - who, what, where, why? (W4)
  - noninvasive, unobtrusive, perceptual, ubiquitous, natural interface
Sense, Measure, Monitor?

? Issues of location: Where are people?
? Identity: Where are which people?
  ? What about new people?

? Local action

? Extended action
  ? “Eating a meal”, “preparing a meal”,

? Really extended action
  ? “Change of mobility”, “eating well”
Vision infrastructure

- 20+ Fixed Cameras (Analog & Digital *IEEE 1394*)
- 16+ PIII PCs (2 cameras / PC)
- 8 Pan-Tilt-Zoom Cameras
- Stereo and other special purpose cameras
Smart floors

- RF ID instrumentation
- Floor mats
- Below-knee tags
- Room-level positioning
Tracking from ceiling sensors

A person is tracked and his activities are reported on the map.
Location

- Awareness of a resident is crucial!
- Claims of reliable location sensing are somewhat exaggerated.
- Vision can help (so can audio), but we need something reliable (24/7).
- Room-level accuracy a major requirement.
Room mapping

- 2D descriptions
- Overlapping cameras
The Gesture Pendant

? Simplified home control
  ? Original motivation
  ? Cool, but from a research perspective less important

? Biometrics (Parkinson et al.)
  ? A surprise
  ? Even cooler and more important
  ? Patented and sought after
Eye/Pupil Tracking

QuickTime™ and a YUV420 codec decompressor are needed to see this picture.
What

? Location
? Objects
? Simple actions
? Complex actions
? See paper in AAAI 02.

? Immediate
? Short-term
? Long-term
? Routines
? Working with Domain Experts

6 states of “flipping forward” action
Recognize Complex Interactions [between actions and objects]

- Relate Human motion & object context
- Extend appearance-based representations
Recognizing Multi-actions

- Use temporal context (and grammar)
  - Structure over time helps
  - Model Behavior!
Behavior Analysis

Detection Behavior | Accuracy
--- | ---
Low-Risk | 92%
High-Risk | 76%
Novice | 100%
Expert | 90%

After ~10 trials per person
Example: What was I cooking?

Ordinary cooking task
Semi-structured activity
Sequential recipe, but not really
Different interruptions occur, causing retrospective memory faults

Can a visual reminder help?
The Cook’s Collage, or Déjà vu Displays (DVD)
Mynatt, Tran & Rogers
The Cook's Collage
WWIC: Design influencing technology

Design
Timely renditions of recent activities provide useful reminders

Technology
Sensing countertop activities
Sensing countertop activity

Instrument utensils
  ? RF ID (bad resolution)
  ? Wireless sensors (tilt, accelerometer)
  ? Fine detail of countertop makes these difficult.

Vision
  ? We already have instrumented with cameras.
  ? Great potential, but is it too hard?
  ? Hold that thought.
Medical aids

Blood Glucose Meter (BGM):
It’s as easy as 1, 2, 3...
- simply set up the meter
- check the system
- and test your blood
Maybe, but really 52 steps
- set up the meter - 6 steps
- check the system - 22 steps
- test blood - 24 steps

How to improve:
Better training
Real-time intervention

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Better training: Rogers and Fisk
Real-time intervention

Design
If you can recognize behavior with BGM, then you may be able to provide real-time assistance.

Technology
Recovering structured activities from video
Routine Household Activities

- Activities of Daily Living (ADLs) [dressing, bathing, etc.]
- Instrumental Activities of Daily Living (IADLs) [house cleaning, laundry, cooking].
- Enhanced Activities of Daily Living (EADLs).

ADLs, IADLs, and EADLs can potentially be aided by Aware Environments.
But Wait: Few “Thorny” Issues

- Critical mass of computing infrastructure
- Privacy
- Pre-crisis installation
- Technical support
- How “smart” is smart enough?

- Have begun real research into privacy, ethics, policy, and legal issues.
To Conclude:

“It is just the beginning”

? From a technologists perspective the purpose of the application is to establish context, prioritize issues, and create collaborative opportunities.

? From the application side, the goal of the Aware Home project is to design interfaces and services that enhance the quality of life by properly matching needs to capabilities.

? One example of where we want to use technology and design to prevent changes in capabilities from becoming disabilities.
More!

? We are interested in building useful (important) “Living Laboratories” (and learning how to build them too).
? We will build, test, evaluate, and rebuild.
? Welcome European Partners

? See www.awarehome.gatech.edu/
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