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

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Aware Home Research Initiative

GVU Center / College of Computing Georgia Institute of Technology

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.

? toolkits

? Legal precedent

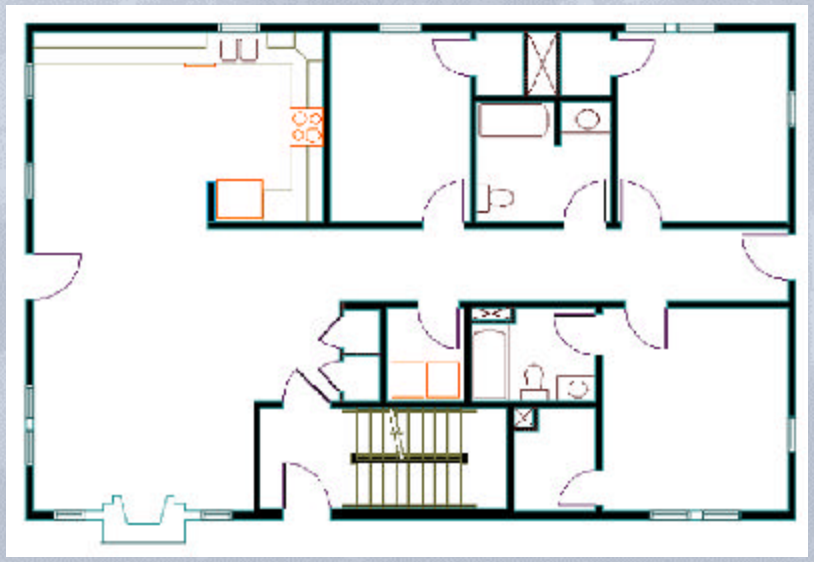
Who is Involved?

- Georgia Tech
  - College of Computing
  - GVU Center / Broadband Institute / GCATT
  - School of Psychology (Cognitive Aging)
  - Electrical and Computer Engineering (Wireless, DSP)
  - Center for Assistive Technology and Environmental Access (CATEA) / NIDDR Centers.
  - School of Public Policy
- Other interested parties:
  - Atlanta VA Hospital
  - Emory Medical / Law School
- U of Rochestor, MIT, etc. Collaborations!

House Basics

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

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



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

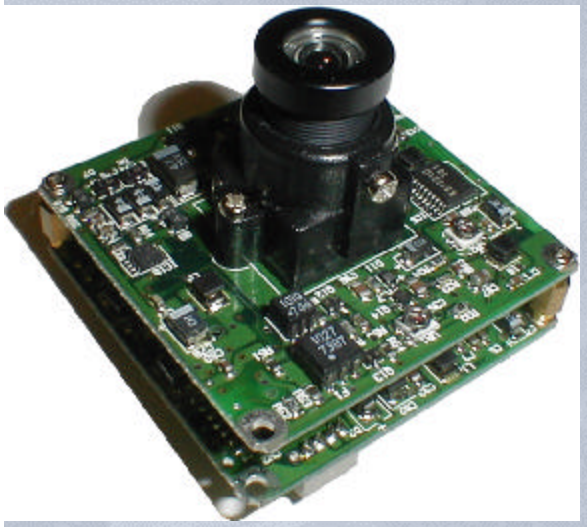
- Sensing and output technology that is transparent to everyday activities.
- Passive
- Anywhere, anytime input/output.
- Provide an ability to sense, interact, display information, communicate, without increasing burden/load on users.
- Aware of residents, sense them!
  - who, what, where, why? (W4)
  - 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
  - " Sitting/Getting up", "Climbing stairs", "Washing dishes", "Reading book", etc.
- Extended action
  - " Eating a meal","preparing a meal",
- Really extended action
  - " Change of mobility", "eating well"

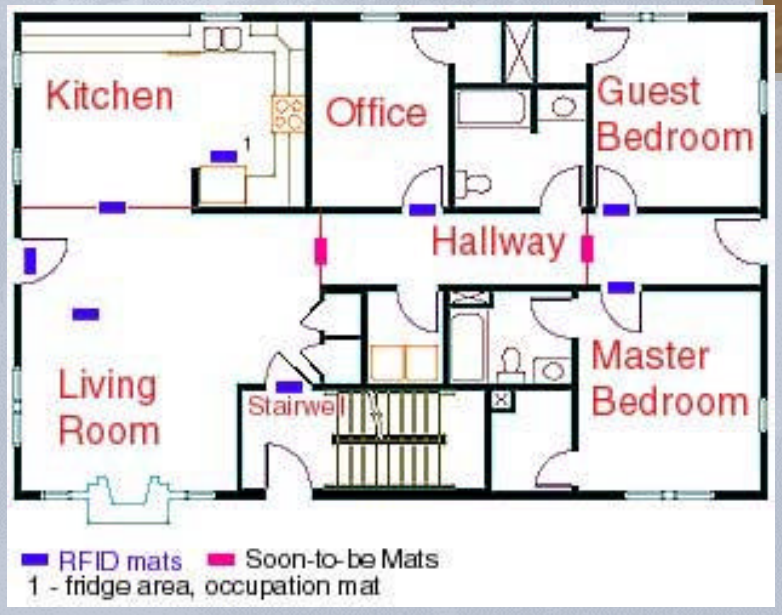
Vision infrastructure

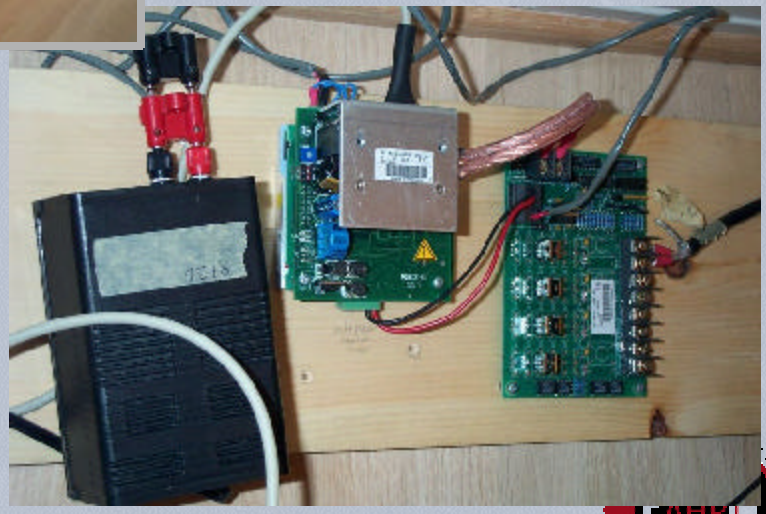


- 20+ Fixed Cameras (Analog & Digital *IEEE 1394*)
- 16+ PIII PCs (2 cameras / PC)
- 8 Pan-Tilt-Zoom Cameras
- Stereo and other special purpose cameras

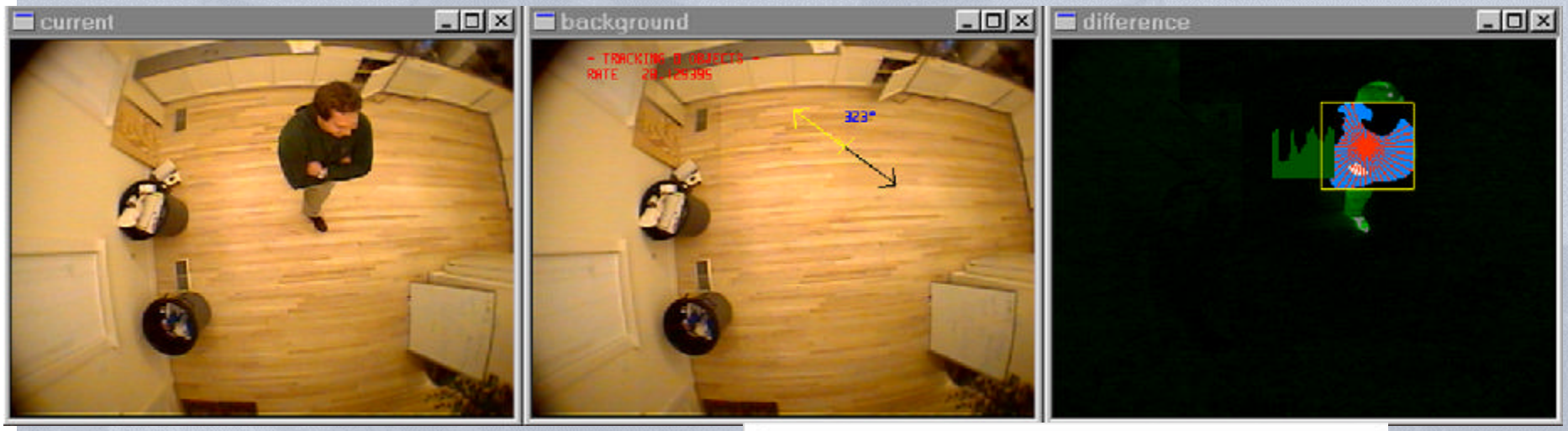
Smart floors

- RF ID instrumentation
- Floor mats
- Below-knee tags
- Room-level positioning

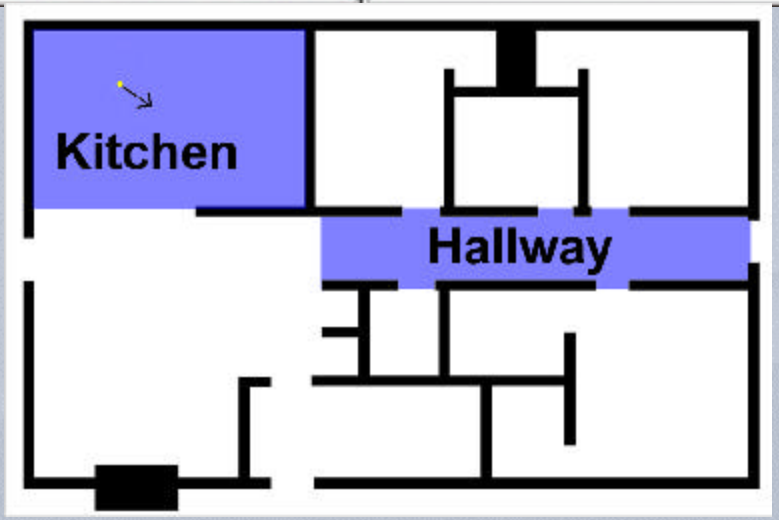




Tracking from ceiling sensors



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

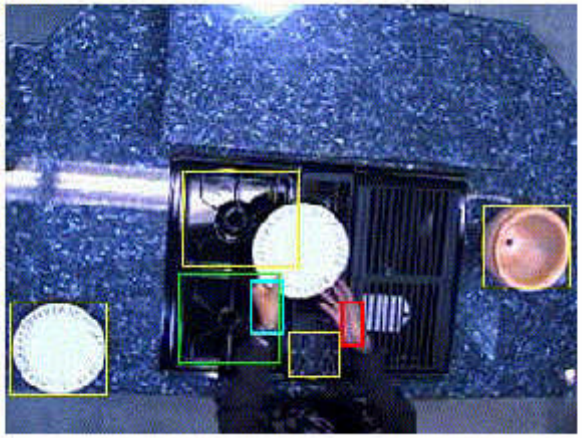
The Gesture Pendant

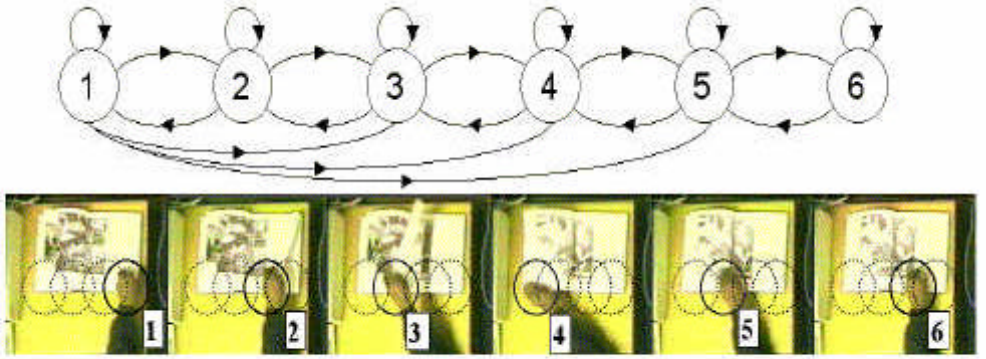
- Simplified home control
  - Original motivation
  - Cool, but from a research perspective less important
- Biometrics (Parkinson et al.)
  - A surprise
  - Even cooler and more important
  - Patented and sought after

Eye/Pupil Tracking

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

What





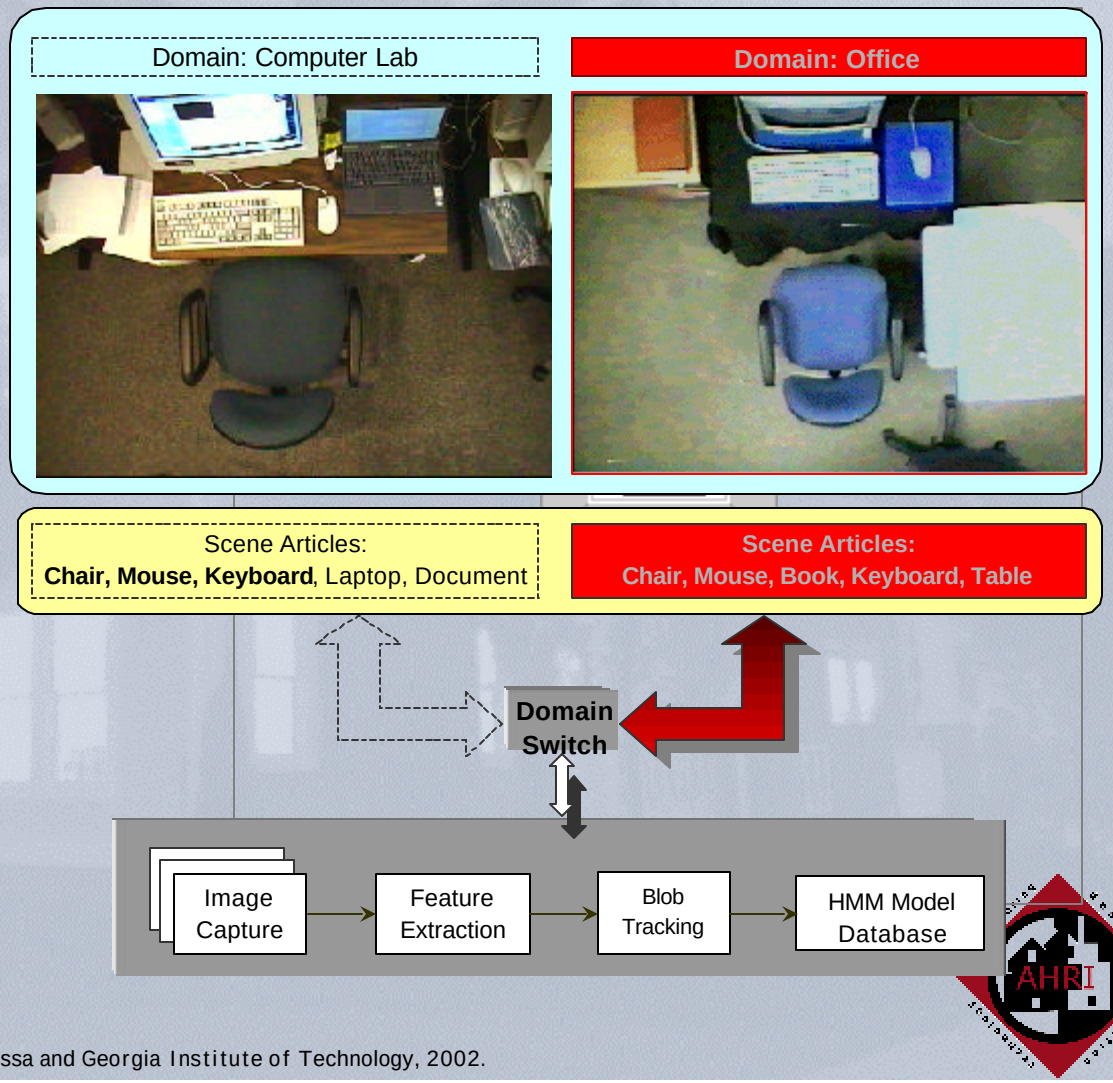
6 states of "flipping forward" action

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

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

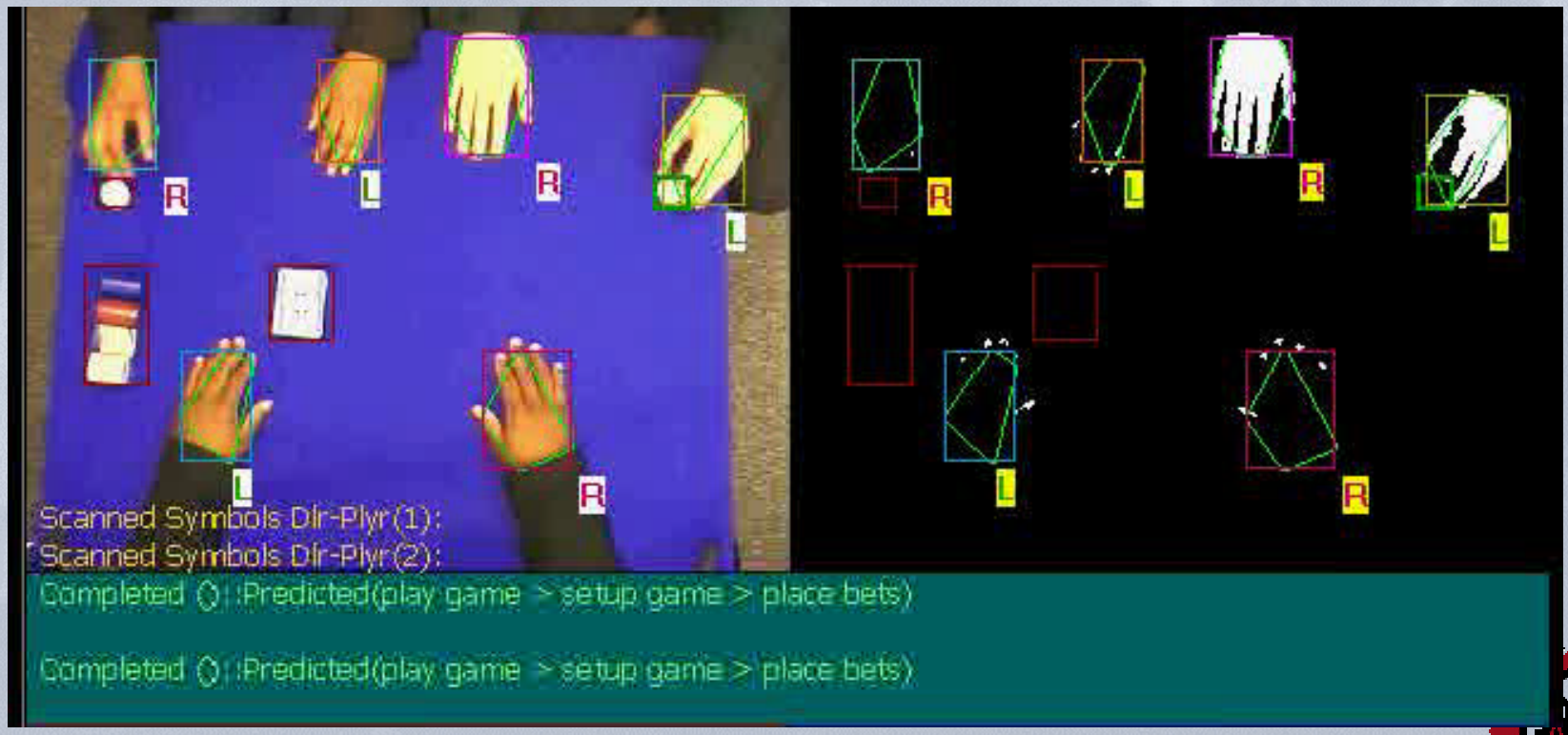
Recognize Complex Interactions [between actions and objects]

- Relate Human motion & object context
- Extend appearance-based representations



Recognizing Multi-actions

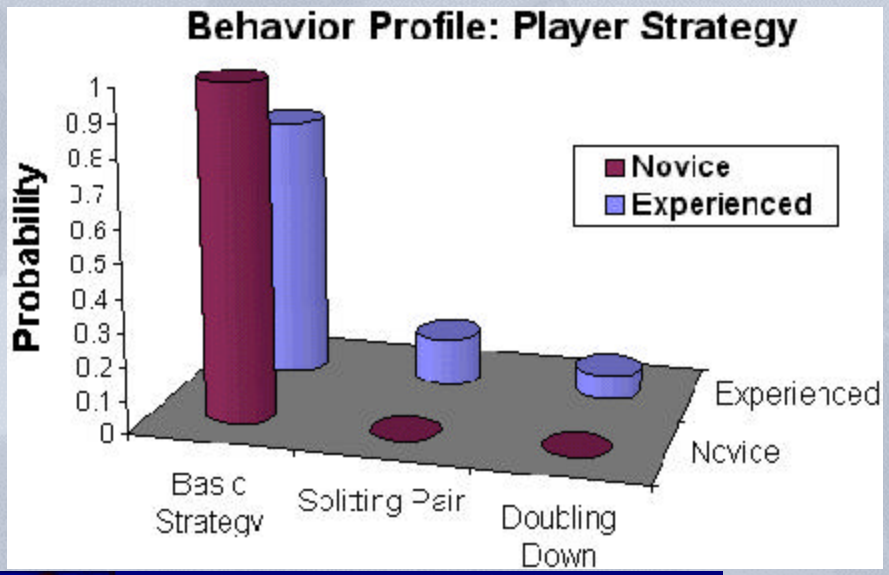
- Use temporal context (and grammar)
  - Structure over time helps
  - Model Behavior!



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

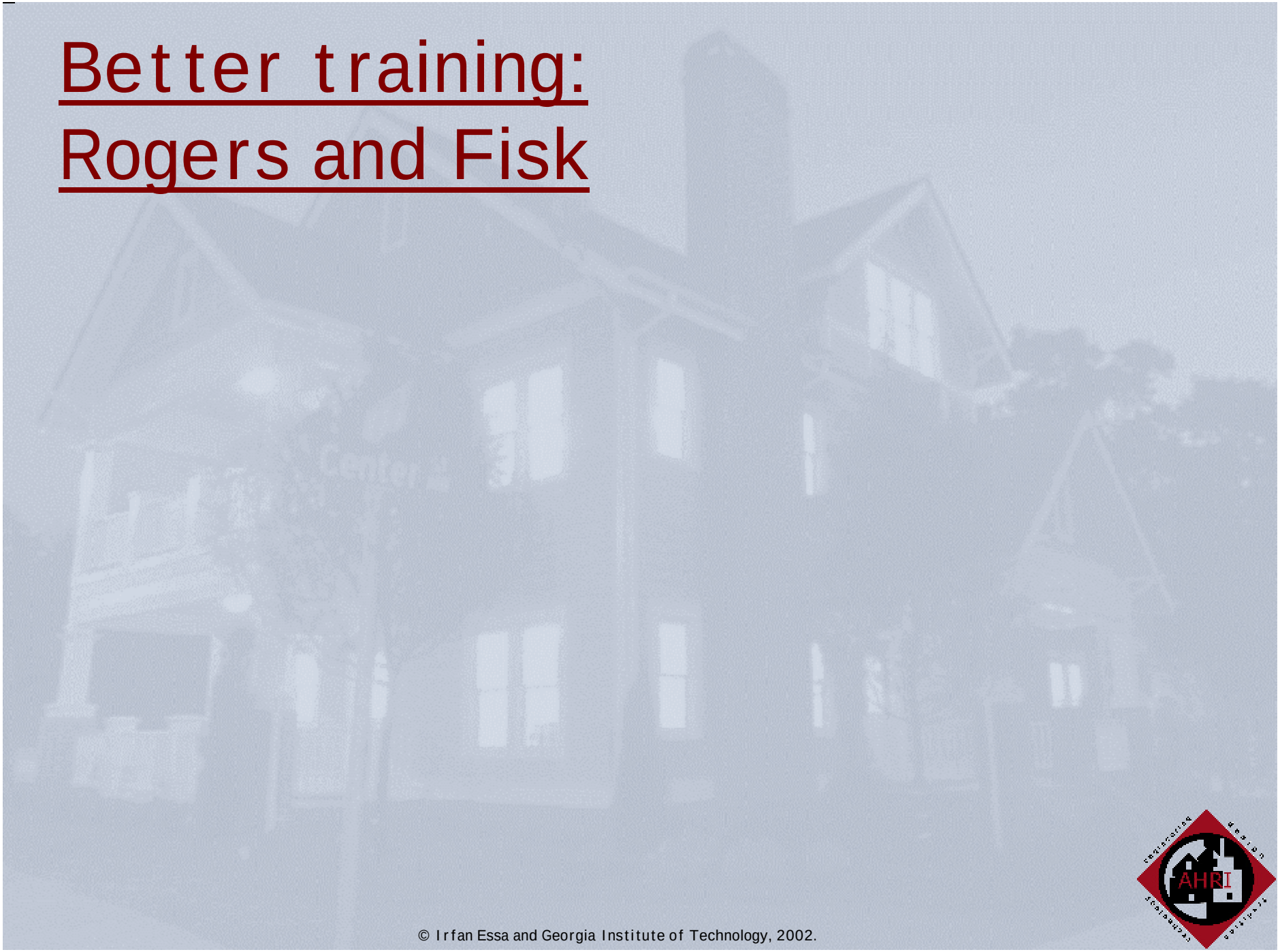
Maybe, but really 52 steps

- set up the meter - 6 steps
- check the system - 22 steps
- test blood - 24 steps

How to improve:

- Better training
- Real-time intervention

Better training: Rogers and Fisk



Real-time intervention

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

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/
- Email:
  - Me, irfan@cc.gatech.edu, OR Gregory Abowd, abowd@cc.gatech.edu.