Leveraging Technology for Independent Living

A NIST Advanced Technology Program

Rand Whillock
whillock_rand@htc.honeywell.com
Automation and Control Solutions Lab
Honeywell International
Agenda

Independent Living Issues
I.L.S.A. Vision
Research Program
System Details
Field Test Plans
Progress to Date
Independent Living Issues

Elder Concerns
- Desire to maintain independence
- Growing population
- Medication Compliance
- Falling
- Costs / Insurance
- Uncomfortable with Technology

Support systems (Caregivers)
- Institutions are Costly
- Remote Families
- Informal Caregiver Productivity
- Caregiver Burnout

Technology developments
- Smarter Sensors and Appliances
- Lower Cost Processors
- Improved Connectivity
- Advanced Reasoning Architectures
The I.L.S.A. Vision & Challenges

Vision:

Leverage technology developments to help older people maintain independent living.

Challenges:

- Open Sensor Communications
- Advanced Reasoning
- Elder User Interfaces
I'm worried about Mom! Can you visit her today?

OK, I'll try.

Lois was in the kitchen at 8:20.

Lois was sick the last time I saw her. I'd better stop by today.

Lois is fine.

10:00 A.M.
Time for medicine

Lois is in the living room.
It's time to take your medicine!

Lois is doing fine. I’ll check on her again this afternoon.

Lois is in the living room.

Lois ate breakfast at 8:20.

Lois is fine.

10:00 A.M.
Time for medicine

It’s time to take your medicine!

Mom’s having a good day!

Lois is OK.
I.L.S.A. in a Nutshell

Program Objective

Develop an intelligent home automation system with situation awareness and decision-making capability that can be easily integrated with a diverse set of sensors, medical devices and "smart" appliances to enable elderly and infirm users to live and function safely at home.

Programmatics:

- ILSA is NIST ATP Program
  - ATP programs are high risk research
  - Honeywell 60%; NIST 40%
- November 2000 through April 2003

Activities:

- Year 1: infrastructure and architecture development
- Year 2: Prototype & Field Tests
- Year 3: Usability evaluation and tuning
What will ILSA look like?

- **Sensors** - A network of integrated sensors, devices, and “smart” appliances
  - Sensors - motion, contact, optical, etc.
  - Devices - thermostat, speaker, telephone, medical, etc.
  - Smart Appliances - communicating refrigerators, stoves, etc.

- **User Interface** - Users interact with the system through familiar devices or simple dedicated devices like:
  - Telephones, Pagers, email, TV
  - Webpad, Digital picture frame, PDAs, speakers/microphones
What will I.L.S.A. do?

- **Gather** information about elder, activity, and home status from devices and sensors
- **Assess** the need for assistance based on the elder’s condition and what activities are going on inside the home
- **Respond** to a situation by providing assistance to the elder and getting help when necessary
- **Share** health and status information with authorized caregivers
Gather Information from a variety of passive and active sensors and integrated devices.

- Temperature is 72
- Lois took medication at 10:15.
- No PERS activation.
- Lois was in the shower at 8:00.
- Stove is on.
- Lois is in the living room now.
Assess individual behaviors and conditions

- Dinner time
- Motion in kitchen
- Refrigerator open
- Silverware drawer open
- Stove is on
- Motion in dining room

Lois ate dinner

I.L.S.A. System
Assess Information
Assess collection of behaviors and conditions with respect to normal patterns

- Got up late
- Skipped Lunch
- Temperature high
- General Activity Low
- Napping increased

Lois is sick
Prioritize conditions and formulate an appropriate response plan

- The Stove’s been left on for 46.3 minutes!
- I’ve fallen!
- It’s time to take your medicine!
- Linda’s calling.
The Stove’s been left on for 46.3 minutes!

I’ve fallen!

Lois, are you all right?

Phone - disconnect Linda and call caregiver.

It’s time to take your medicine!

Reminders - be quiet for now.

Stove - turn yourself off.

Linda’s calling.
Reasoning
Example Assistance Scenarios

- **Safety**
  - PERS Call button is activated
    - Query elder about status and need for assistance
    - Notify caregivers

- **Functional Assessment**
  - Activity monitoring - task completion, duration, and consistency
    - Provide cognitive support for elder by offering reminders or task instructions
    - Notify caregivers of changes in performance over time

- **Health Monitoring**
  - Track data to detect and prevent health crises
    - Query elders about how they are feeling daily
    - Communicate with 3rd-party medical devices
    - Share health data with caregivers to improve diagnosis and treatment
Sensors

Near Term Prototype
- Standard Security System Sensors
  - Motion Detectors, Call Buttons, Door Switches
- Other Easily Integrated COTS Sensors
  - X10, Fall Sensors, Pressure Mats, etc

Future Sensors
- Medical Sensors
- Medicine Dispensers
- ID / Location
- Video - Face ID
Field Tests

- Field Testing - June 02
- Prototype System
- About 20 Sites
- 3 Month Evaluation
- Single Homes
- Independent Living Facilities
- High Priority Functions
## Field Test Functions

<table>
<thead>
<tr>
<th>Detect mobility / lack of mobility</th>
<th>Detect falls</th>
<th>Give Reminders</th>
<th>Verify medication taken</th>
<th>Monitor environment</th>
<th>PERS Call button</th>
<th>To-do lists</th>
<th>Coordinate multiple caregivers</th>
<th>Remote Access</th>
<th>Alerts to clients/caregivers</th>
<th>Reports to clients/caregivers</th>
<th>Intrusion detection</th>
</tr>
</thead>
</table>
Technology Innovations

- **Home automation** - Automate, and integrate control of home functions like security, comfort, lighting, entertainment, etc.

- **Situation Assessment** - Identify and infer specific behaviors and patterns of activity

- **Machine Learning** - Recognize changes in patterns of behavior over time

- **Adaptive Interaction Design** - Dynamically format content and presentation style for different devices, users, tasks, etc.

- **Human-Centered Systems Design** - Design automated systems that match elder abilities & expectations
Program Progress to Date

Accomplishments

- Studied users to understand what leads to institutionalization
- Identified most important assistance needs and opportunities for technology
- Developed infrastructure to support hardware-software communications
- Developed system architecture, situation assessment capabilities, and initial learning capabilities
- Built and tested prototype systems in lab and home settings

Ongoing

- Expand system functionality
- Refine and enhance machine learning capabilities
- Expand system’s ability to communicate with various types of sensors and devices
- Evaluate user interface and interaction designs
- Evaluate overall system in field settings over extended period of time
- Address configuration and set-up issues