Gerontechnology in Smart Home Environments

Assistive Technology

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Definition of Assistive Technology (AT)

- Any product, instrument, equipment or technical system used by a disabled person, especially produced or generally available, preventing, compensating, monitoring, relieving or neutralizing the impairment, disability or handicap. (ISO 9999)

- An umbrella term for any device or system that allows individuals to perform tasks they would otherwise be unable to do or increases the ease and safety with which tasks can be performed. (WHO)

- Assistive technology encompasses all systems designed for persons with special needs, and that attempt to compensate the handicapped.
Classification of AT (WHO)

WHO AT
International Classification
ISO 9999

03
Aids for the treatment and the training

04
Aids for personal medical treatment

05
Aids for training in skills

06
Orthoses and prostheses

09
Aids for personal care and protection

12
Aids for personal mobility

15
Aids for housekeeping

22
Aids for communication, information

24
Aids for handling products and goods

27
Aids for equipment for environmental improvement, tools, and machines

18
Furnishing and adaptation to homes and other

FIGURE 1.6 Categories of AT: ISO 9999 international classification system.
Stakeholders

- **Who are the users of AT?**
  - The older adults or person with special needs
  - Caregivers
  - Medical professionals
  - Families
  - Friends
  - Other people (building managers, coworkers, neighbors, visitors)
Compensation

- Using technology, device or service to compensate for the functional deficiencies through
  - **Enhancement** of the user’s own capability
  - Enabling of *alternative* approaches
- Improve the quality of life by enhancing the person-environment fit and congruence
- Multiple impairments
  - The difficulty for compensation grows exponentially
Low-tech Assistive Technology

Top four assistive devices being used:

- Eyeglasses
- Wheelchair or cane
- Grab bars
- Bath mats
How Does Aging Affect People?

- Sensory Functions
- Motor Functions
- Mobility Issues
- Cognitive Functions
- Social & Communication Capabilities
- Body Functions as a whole
Sensory Functions

- Olfactory
- Gustation
- Vision
- Hearing
- Touch
Examples of Vision Impairments

- Cataract
- Colorblindness
- Diabetic Retinopathy
- Glaucoma
- Macular Degeneration

**FIGURE 8.8** Macular degeneration.
AT for Vision Impairments

Low-tech

- Glasses
- Color-coded organization
- Talking clock/ kitchen scale
- Magnifier/ reading glasses
- Large-font book
- Embossed marking for dangerous items

High-tech

- Multi-modal communications system
- Screen Reader
Hearing Loss

- Loss of Volume
- Not all frequency are affected the same way
  - High frequency sound usually suffer more severe loss
- Noise reduction capability
AT for Hearing Impairments

Low-tech
- Vibration Alarm Clock
- Flashing Alarm (Smoke detector/ door bell)
- Captioned TV

High-tech
- Hearing Aids
- Implants
Cognitive Functions

- memory,
- association,
- concept formation,
- language,
- attention,
- perception,
- action,
- problem solving,
- mental imagery,
- learning and
- reaction time
Common Types of Cognitive AT

- Reminder
- Procedural assistant
- Information organizer
- Auxiliary information provider
- Reminiscence technology
AT for Cognitive Impairments

Low-tech
- Pictorial communication board
- Photo-button phone
- Lists and Calendar
- Pill organizer and dispenser
- Safety alert and alarm

High-tech
- Personal Digital Assistant (PDA)
- Electronic organizer
- GPS tracker
Motor Functions

- Ambulatory
- Dexterity
- Stability
- Strength
AT for Motor/Physical Functions

Low-tech
- Rubber-handle Utensil
- Jar opener
- Straw Holder
- Reacher
- Lazy Susan Desktop

High-tech
- Robot
- Electrical Wheelchair
- Robotic Walkers
Mobility Issues

- Bedridden
- Unable to Walk
- Unable to Walk Without Aid
- Unable to Drive
- Unable to Navigate

- Sense of Loss of Freedom and Independence
- Usually result of a compound
Social and Communications

- Loss and Grief
- Changing Roles and Perceived loss of social status
- Declined health conditions
- Care giving

- Reclusiveness
  - Social factors
  - Geographical factors
  - Sensory factors
  - Psychological factors
  - Mobility factors
Effects of Aging on Body Systems

- Heart and Arteries
- Lung
- Kidney
- Bladder
- Muscle
- Bone
Advanced AT for Vision Impairments

- Multi-modal communications system
- Screen Reader
- Text-to-speech
- GPS with speech interface
- Backlit buttons on the remote controls
- Vision Enhancement
- Speech command interface
- Augmented reality
Advanced AT for Hearing Impairments

- Hearing aids
  - Magnetic induction
  - RF/IR
  - Hardwire
- Implants
- Speech recognition/caption
- Multi-use flashing alarm
- TTY
- Telephone relay
Advanced AT for Cognitive Impairments

- Personal Digital Assistant (PDA)
- Electronic info organizer
- 3-button Interface
- Touch screen and more intuitive interfaces
- Smart Home
  - MISS (Medication Info Support System)
- Cognitive Coach (Multimedia Procedural Assistants)
Cognitive Coach

The v2.3 SenseCam shown close up and as typically worn by a user. The model pictured here has a clear plastic case that reveals some of the internal components.

Example images captured by SenseCam.
Advanced AT for Motor/Physical Functions

- Robot
- Electrical Wheelchair
- Robotic Walkers
- Ergonomic Keyboards
Advanced AT for Mobility

FIGURE 20.6  Robotic hoists: (a) First (2002), (b) second generation (2008).
Advanced AT for Mobility
Advanced AT for Social/Communication

- Virtual/Social dining
- Video phone
- Robotic companion
- Email/Messaging
Compensation

- Using technology, device or service to compensate for the functional deficiencies through
  - **Enhancement** of the user’s own capability
  - Enabling of **alternative** approaches
- Alternatively, one can also modify the environment or the objects to improve users’ functions.
## AT for Other Assistive Functions

<table>
<thead>
<tr>
<th>Sensory</th>
<th>Cognitive</th>
<th>Motor/Physical</th>
<th>Mobility</th>
<th>Social/Communication</th>
<th>Bodily Function</th>
<th>Others (e.g. financial)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vision</td>
<td>Memory</td>
<td>Perception</td>
<td>Hygiene App</td>
<td>Electrical Walker</td>
<td>Electrical Harness</td>
<td>Social Dining</td>
</tr>
<tr>
<td>Hearing</td>
<td>Caption</td>
<td>SenseCam</td>
<td></td>
<td></td>
<td></td>
<td>Assorted transplants</td>
</tr>
</tbody>
</table>
Seven Assistive Functions

- Compensation
- Monitoring
- Assessment
- Prevention
- Intervention
- Rehabilitation
- Enhancement
Monitoring

- Monitoring involves measurement over time of specific human conditions and features known to indicate changes in users’ functions.

- Data on these indicators are collected to reveal change and trends.

- **What instruments do people use to gather data continuously or regularly to identify signs of health-related troubles?**
Fig. 1. Experimental set-up for investigation of the full field pattern shift reversal Visual Evoked Potential (VEP). Electrode site employed was Oz.

Fig. 3. Dry electrodes with onboard amplification. Centre electrode used in this study.
Assessment

- Assessment uses data from users’ activities to derive assessment outputs.
- It is important to recognize that assessment requires the manipulation of data and uses specialized methodologies and techniques.
- Assessment involves some sort of judgment, comparison or prediction. This information is often used to recommend priorities for preventive, interventive or rehabilitative measures.
- Objective assessment: based on collected quantitative data
- Subjective assessment: based on the report and judgment by the user or caregiver
- **What instruments do experts use to diagnose a condition?**
<table>
<thead>
<tr>
<th>Test</th>
<th>Age Range (y)</th>
<th>Largest Sample</th>
<th>Administration</th>
<th>Domains*</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANAM</td>
<td>22–77</td>
<td>191</td>
<td>Mouse/keyboard; self-administered</td>
<td>Memory, attention, psychomotor speed, language, reaction time</td>
</tr>
<tr>
<td>CANS-MCI</td>
<td>51–93</td>
<td>310</td>
<td>Touch screen; self-administered</td>
<td>Memory, language, executive function</td>
</tr>
<tr>
<td>CANTAB</td>
<td>8–80</td>
<td>771</td>
<td>Touch screen/keyboard; technician administered</td>
<td>Working memory, attention, visuospatial memory</td>
</tr>
<tr>
<td>CNS Vital Signs</td>
<td>7–90</td>
<td>1069</td>
<td>Keyboard; self-administered</td>
<td>Memory, psychomotor speed, processing speed, cognitive flexibility, sustained attention</td>
</tr>
<tr>
<td>CNTB</td>
<td>21–87</td>
<td>209</td>
<td>Keyboard; technician administered</td>
<td>Language, information processing, motor speed, attention, spatial, memory</td>
</tr>
<tr>
<td>COGDRAS-D</td>
<td>67–103</td>
<td>190</td>
<td>Yes/no button; technician administered</td>
<td>Memory, attention, reaction time†</td>
</tr>
<tr>
<td>CogState</td>
<td>18–40; 46–82</td>
<td>113</td>
<td>Keyboard; self-administered</td>
<td>Working memory, executive function, attention, reaction time</td>
</tr>
<tr>
<td>CSI</td>
<td>18–89</td>
<td>284</td>
<td>Keyboard; self-administered</td>
<td>Memory, attention, response speed, processing speed</td>
</tr>
<tr>
<td>MCIS</td>
<td>&gt;65</td>
<td>215</td>
<td>Technician records responses, or via telephone</td>
<td>Memory, executive function, language</td>
</tr>
<tr>
<td>MicroCog</td>
<td>18–89</td>
<td>810</td>
<td>Keyboard/# pad; self-administered</td>
<td>Memory, attention, reaction time, spatial ability, reasoning/calculation</td>
</tr>
<tr>
<td>Mindstreams</td>
<td>&gt;50</td>
<td>213</td>
<td>Mouse/# pad; technician administered</td>
<td>Memory, executive function, visuospatial, verbal fluency, attention, motor skills, information processing</td>
</tr>
</tbody>
</table>

* Cognitive domains as identified by authors; subtests intended to measure those domains vary.
† Domains assessed by COGDRAS-D were not identified; eight subtests listed appear to assess these domains.
Prevention

- Prevention is different from intervention and treatment in that it is aimed at general population groups with various levels of risk for any problem.
- The goal is to reduce risk factors and enhance protective factors.
- **What do people do/use to improve their health to prevent major risks from happening?**
(Early) Intervention

- A process for recognizing warning signs that individuals are at risk for any problem and taking early action against factors that put them at risk.
- Can help individuals get better more quickly and prevent problems from becoming worse.

What instruments can be used to help people showing the first sign of trouble?
To maintain function and promote independence and quality of life for people with this devastating and incurable disease.

To cope with memory impairment, language difficulties, and impairment of visuospatial function

To suggest ways for caretakers to help AD patients cope with and compensate for memory impairment

To foster the utilization of AD patients' remaining cognitive abilities and support their independence
The v2.3 SenseCam shown close up and as typically worn by a user. The model pictured here has a clear plastic case that reveals some of the internal components.

Example images captured by SenseCam.
Rehabilitation

- Rehabilitation is the process of assisting someone to improve and recover lost function after an event, illness or injury that has caused functional limitations.

- Rehabilitation is a huge field within health, promoting recovery for people or animals after events.

- **What do people do/use to regain their functions after they suffer from the disease?**
Cognitive Rehabilitation Therapy often focus on
- Attention Skills
- Executive Skills
- Memory Skills
- Visuospatial Skills
- Problem Solving Skills
- Communication Skills
Enhancement

- Any attempt to temporarily or permanently overcome the current limitations of the human capabilities through natural or artificial means.
- The use of technological means to select or alter human characteristics and capacities, whether or not the alteration results in characteristics and capacities that lie beyond the existing human range.

- **What do people use that allow them enhanced capabilities that they were otherwise unable to perform without the instruments?**
Other Types of Support

- Support for the caregiver
  - Support group
  - Older adult tracker
  - Calendar and reminders
  - Especially important when patients suffer severe impairments
- Education
  - Information (new treatment, experimental treatment) sharing
  - Nurse, nurse’s aids, and caregivers’ continuous training
- Enhancing Older Adult’s Life – Experience Sharing
  - Volunteering
  - Provide information/experience
  - Leadership and Judgment
Many assistive technology provide multiple assistive functions (not mutually-exclusive)

Depending on who, when and how the assistive technology is used, for instance, the memory exercise games

- When user is still healthy
  - Prevention
  - Assessment
- When user plays daily and keeps track of scores
  - Monitoring
- When user shows early sign of cognitive function decline
  - Intervention
- When user suffers acute and serious impairment
  - Rehabilitation
Reminder on Project

- Start posting weekly meeting minutes on PBWorks this week (everyone should be registered by Thursday)
- Check out a sample project website from last year for ideas on your project website

- Proposal due today
- Sign-up for rehearsal time for tomorrow
- Proposal presentation this Thursday
Imagine a person suffers severe impairment from one of the category of functions just discussed,

Consider from the moment this person wakes up in the morning until goes to bed at night, and identify the difficulties this person may encounter throughout the activities of the entire day

Find or devise at least three high-tech assistive technology/devices that could help to improve the user’s life
Announcement (September 22)

- Twitter Discussion 2: Assistive Technology Survey
  - Same rules: 5 products/services with links, 5 responses and 25 quality points
  - Original tweets about products or services should include:
    1. a link to a product webpage/research paper;
    2. a short description about what the product/service does
  - NEW: Daily cap of 4 tweets and 9 points
  - NEW: Bonus points available to top 4 only if satisfied both 5+5 minimal tweets and 25 quality points requirement
  - Ends on October 6
- Reading Assignment: chap 9, 10, 12 in the textbook
Look Ahead

- Proposal
  - September 27  Project Proposal Due
  - September 28  Rehearsals
  - September 29  Proposal Presentation
  - October 4  Peer Review

- Midterm
  - October 6  Midterm exam – in class, 80 minutes