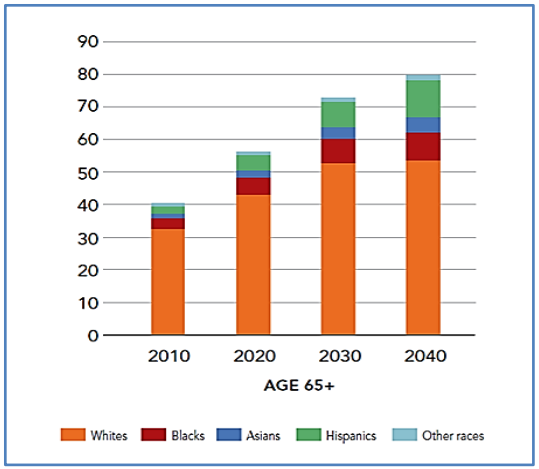
Selected Topics Communications and Mobile Computing (Smart Health)

TU Graz

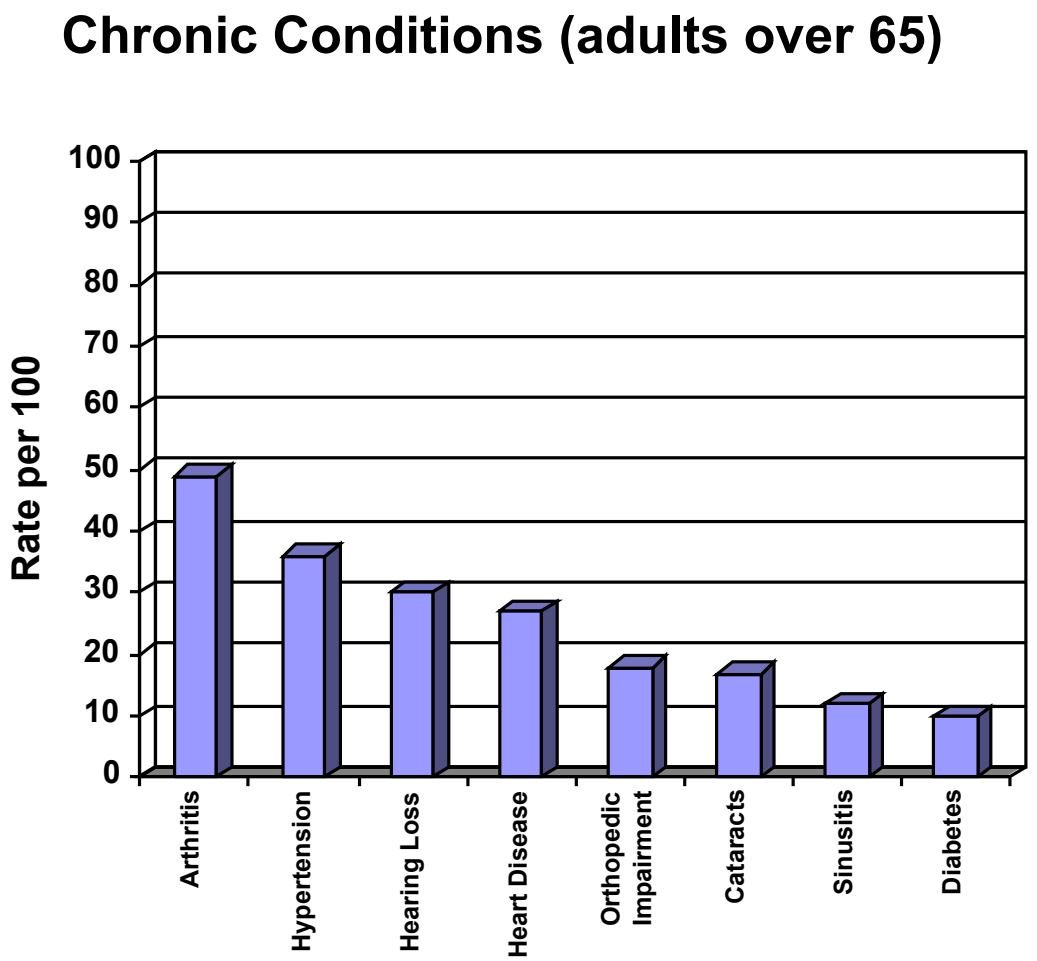
University of Notre Dame

Aging Society

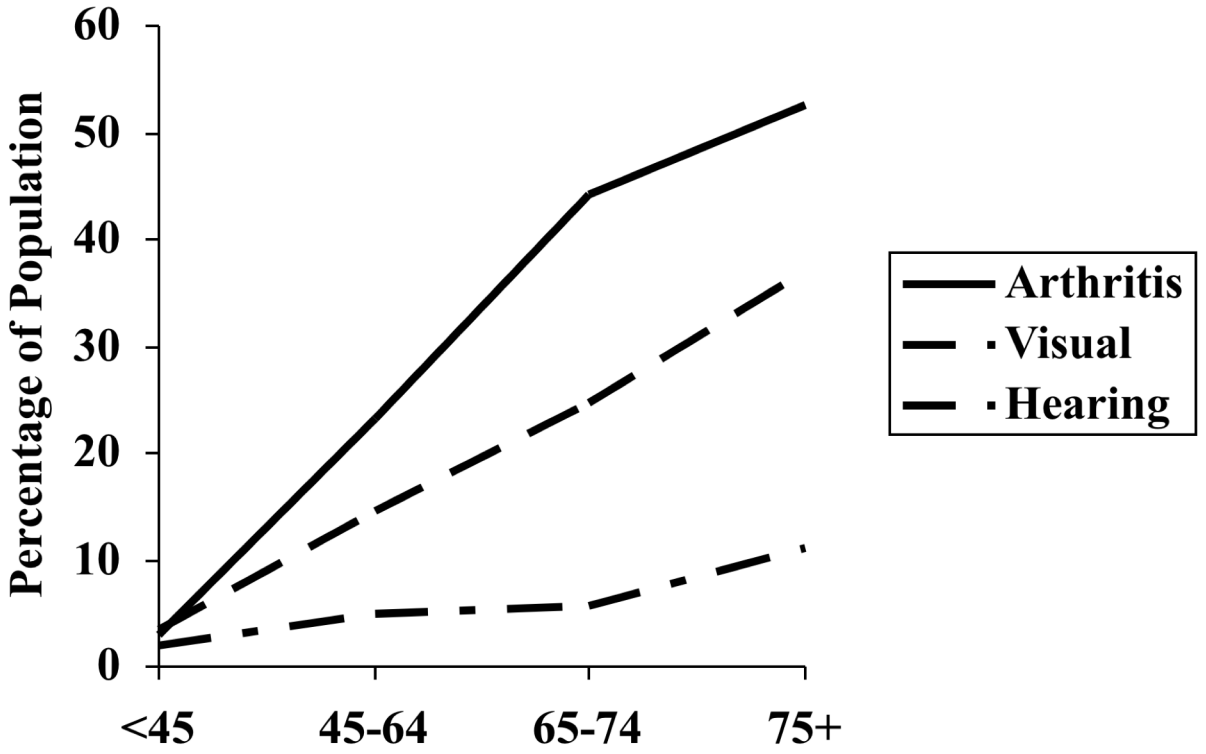
- Historic demographic changes
  - In 2012, 43.1 million adults age 65+ (13.7% of U.S. population)
  - By 2030, 72.7 million adults age 65+ (>20% of U.S. population)
- Fastest growing cohort of older adults are those age 80+
  - When people are most likely to have a physical or cognitive impairment
  - As a result, the demand for caregivers is growing rapidly
- The gap between the demand for and supply of family caregivers is increasing
  - The size of American families is shrinking and the makeup of families is changing



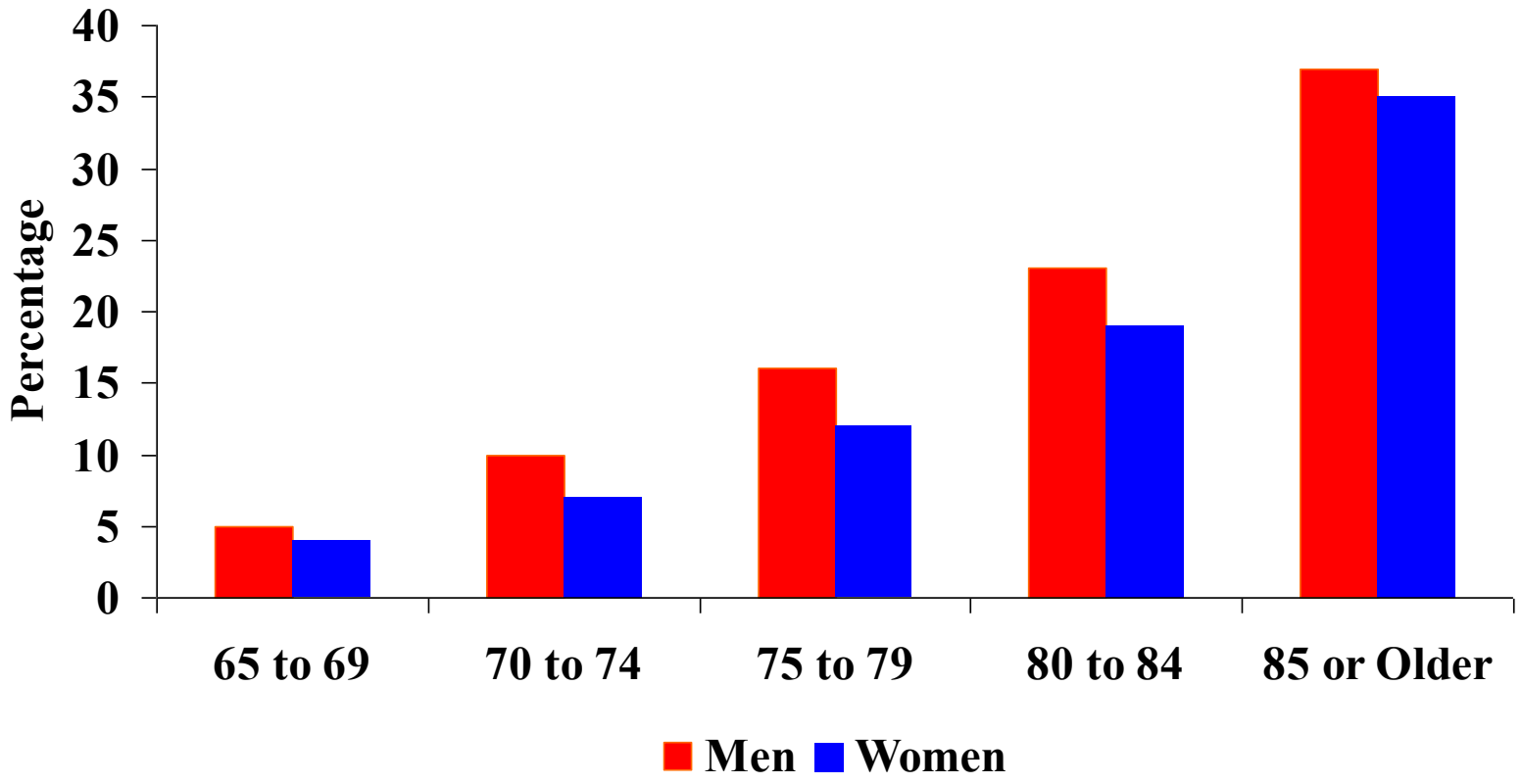
Aging Society



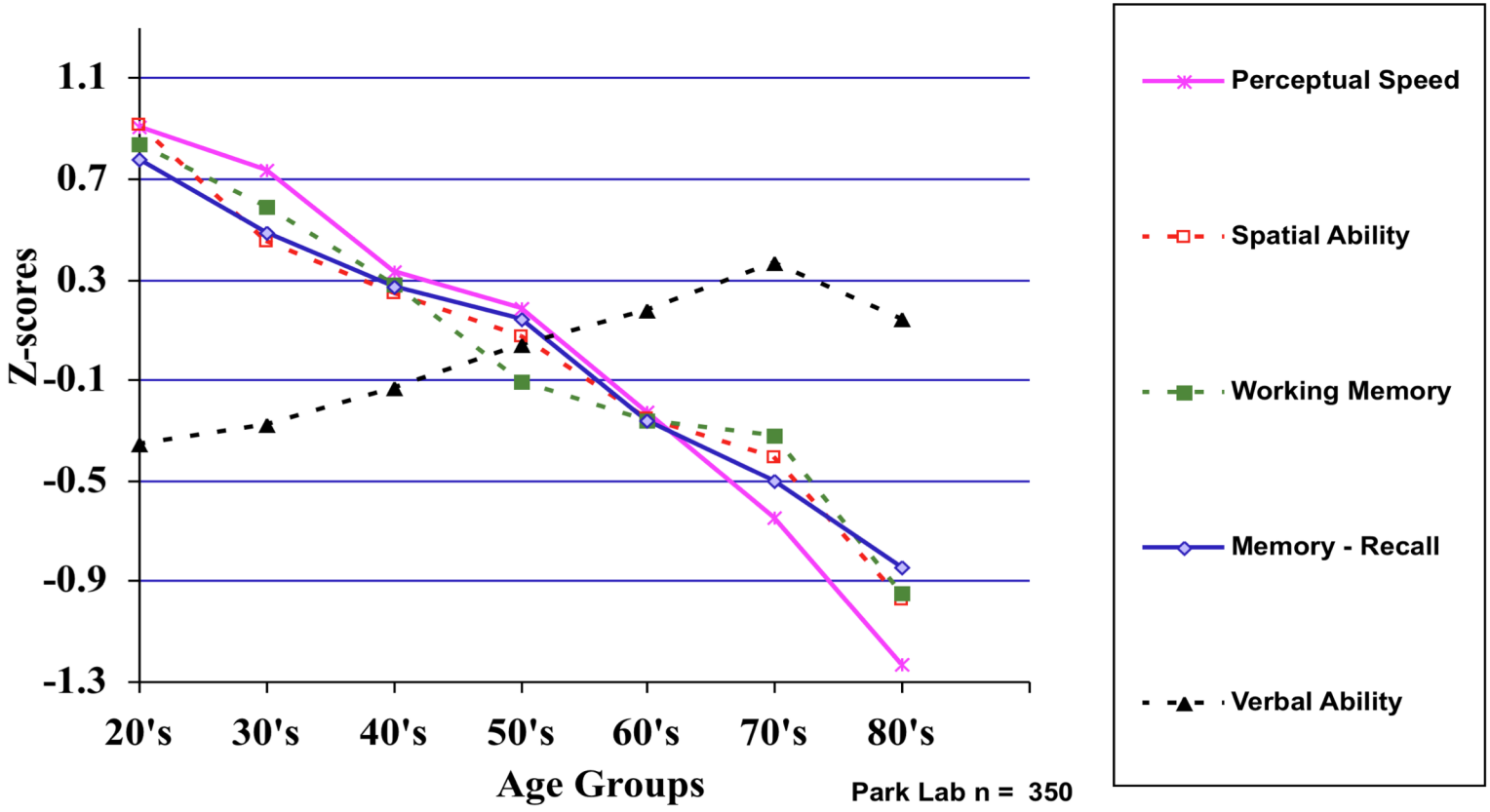
Perceptual/Motor Impairments



Moderate or Severe Memory Impairment of Age 65 or Older



Age-Related Cognitive Changes



Consequences

- Normal age related challenges
  - Functional limitations
  - Cognitive challenges
  - Memory problems
- Health problems
  - Chronic age related diseases (Alzheimer's)
- Rising healthcare costs
- Shortage of professionals
- Shortage of caretakers
- Increase in number of individuals unable to live independently (facilities cannot handle coming "age wave")

ADL

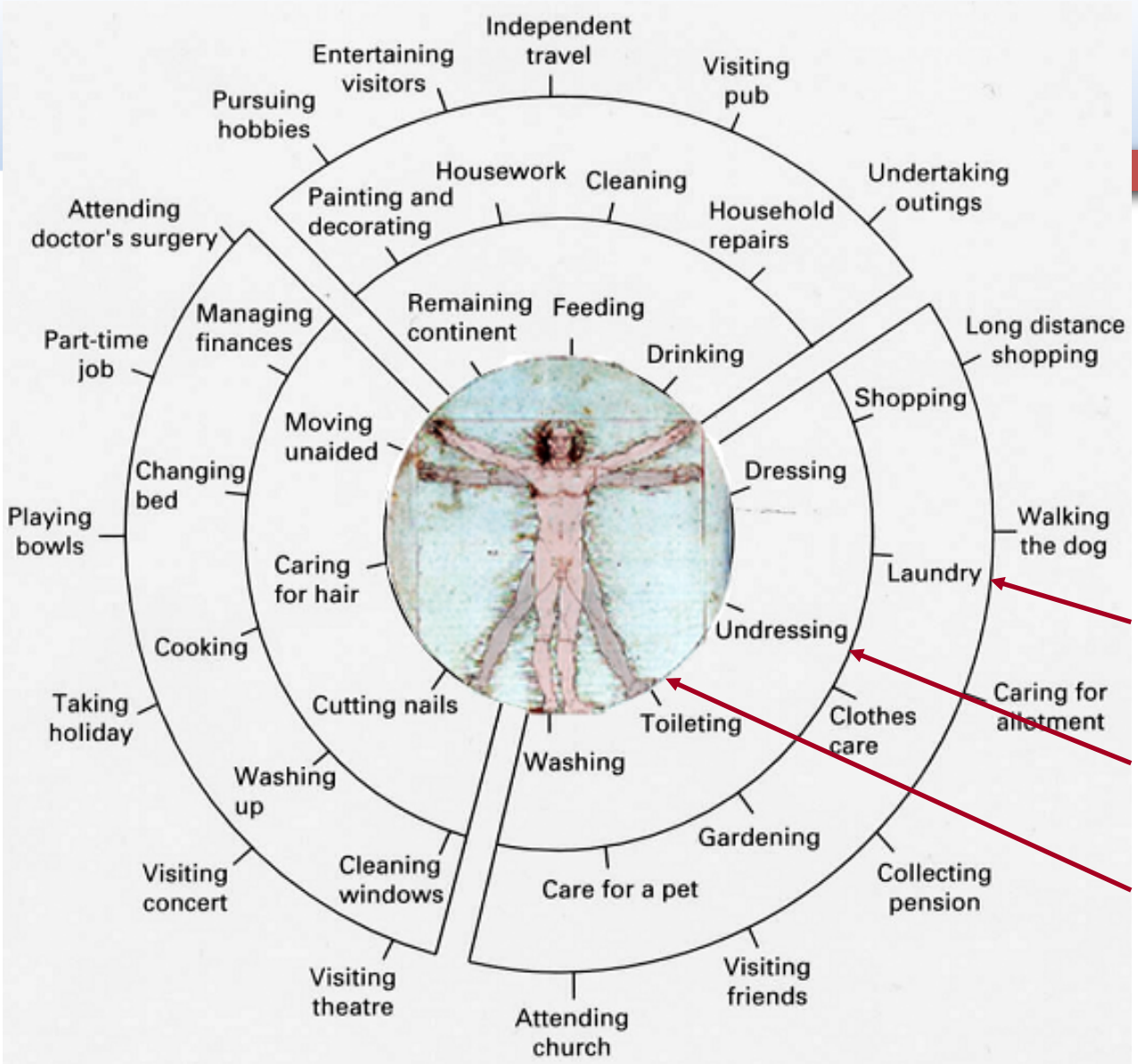


Figure 106-1 A model of social performance levels in older people. (From Williams EI: A Model to Describe Social Performance Levels in Elderly People. Br J Pract; 36:422–3.)

Activity in the community

Activity in the household

Activity related to body

Independence Is Important

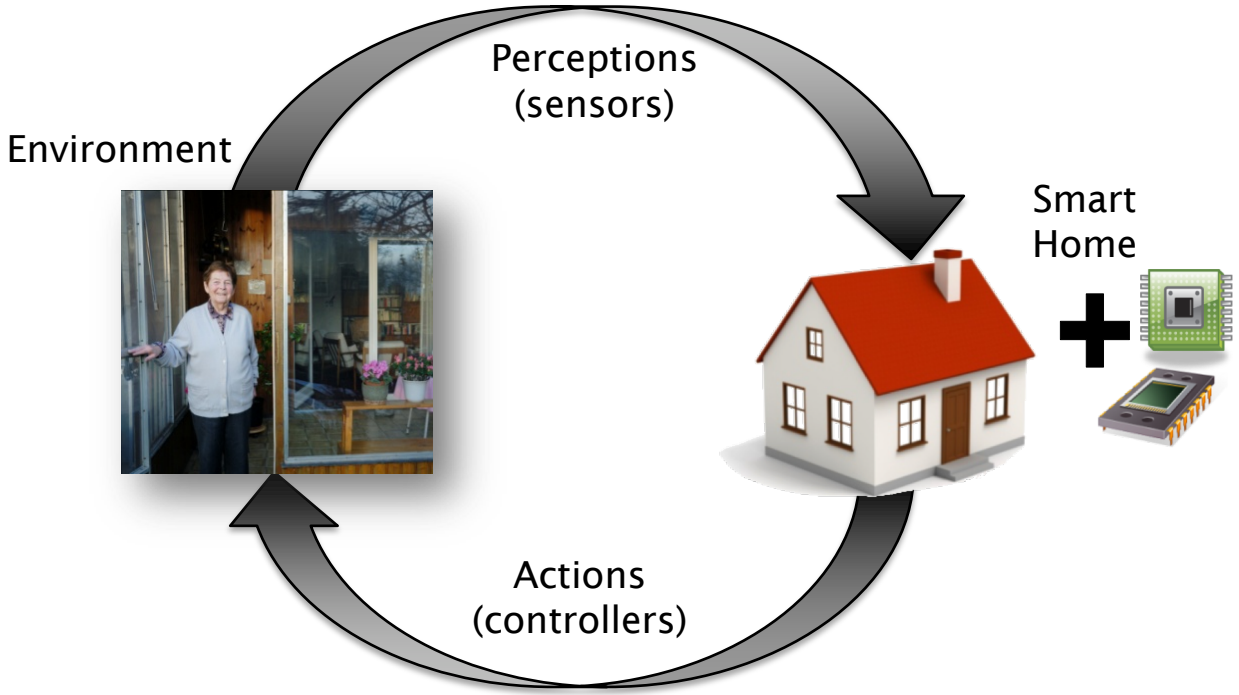
- "A primary goal of many older individuals is to maintain an independent lifestyle in their own home" (Willis, 1996)
- "Aging successfully will be difficult in homes not designed to meet changing needs and without access to appropriate technologies" (Coughlin, 1999)
- "Staying put is contingent on the livability of the dwelling unit" (Lawton, 1997, p. iii)

Independent Living

- Enablers of Ambient Assisted Living (AAL)
  - Smart homes
  - Mobile devices
  - Wearable sensors
  - Smart fabrics
  - Assistive robotics

Smart Homes

- Sensors & actuators integrated into everyday objects
- Knowledge acquisition about inhabitant



Examples of Smart Homes

- US
  - TigerPlace (U. of Missouri), Aware Home (Georgia Tech), CASAS (Washington State U.), Elite Care (OHSU, OR), House_n (MIT)
- Asia
  - Welfare Techno House (Japan), Ubiquitous Home (Japan)
- Europe
  - iDorm (University of Essex), HIS (France)

Takaoka Welfare Techno House

CASAS, WSU

Aware Home, GaTech

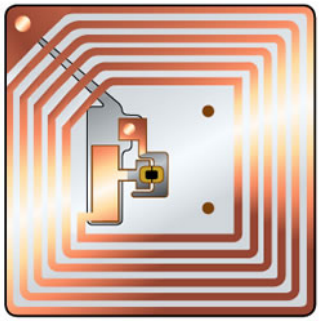
Smart Homes: Tracking Inhabitant

- PIR (Passive Infrared Sensor)
- RFID
- Ultrasonic
- Pressure sensors (in beds, floor)
- Contact switch sensors
- …

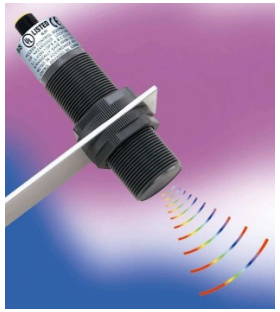
A) A photo of the floor B) Floor Sensor Data

Floor Pressure Sensor.
Noguchi et al. 2002

PIR



RFID

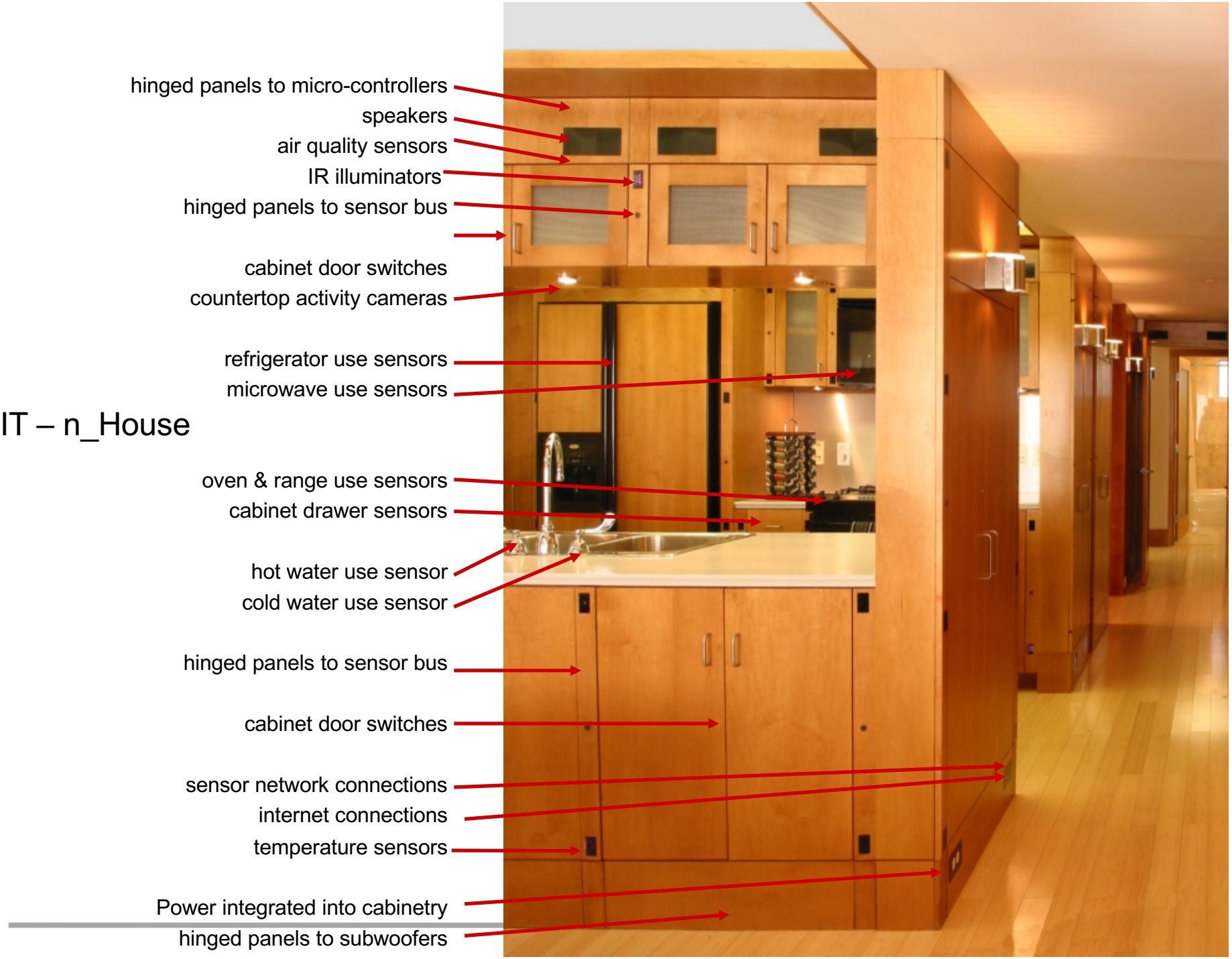


Ultrasonic

Indoor Localization

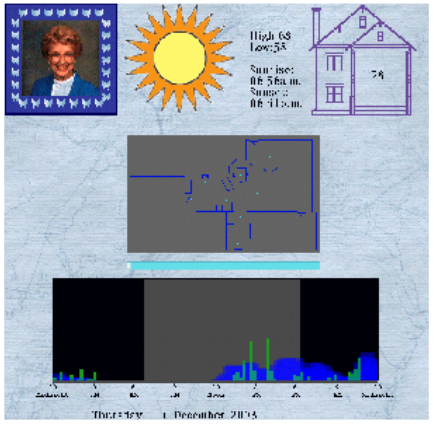
Method	Disadvantage
Smart floor	Physical reconstruction
Infrared motion sensors	Inaccurate, sensing motion (not presence)
Vision	Privacy
Infrared (active badge)	Direct sight
Ultrasonic	Expensive
RFID	Range
WiFi	Interference, inaccurate

MIT – n_House


hinged panels to micro-controllers
speakers
air quality sensors
IR illuminators
hinged panels to sensor bus
cabinet door switches
countertop activity cameras
refrigerator use sensors
microwave use sensors
oven & range use sensors
cabinet drawer sensors
hot water use sensor
cold water use sensor
hinged panels to sensor bus
cabinet door switches
sensor network connections
internet connections
temperature sensors
Power integrated into cabinetry
hinged panels to subwoofers

Digital Family Portrait

- Supports family communication
  - Peace of mind for remote family members
- Share just enough data
  - Activity detection using motion sensors
  - Weather conditions
  - Sunrise / Sunset



Cook's Collage

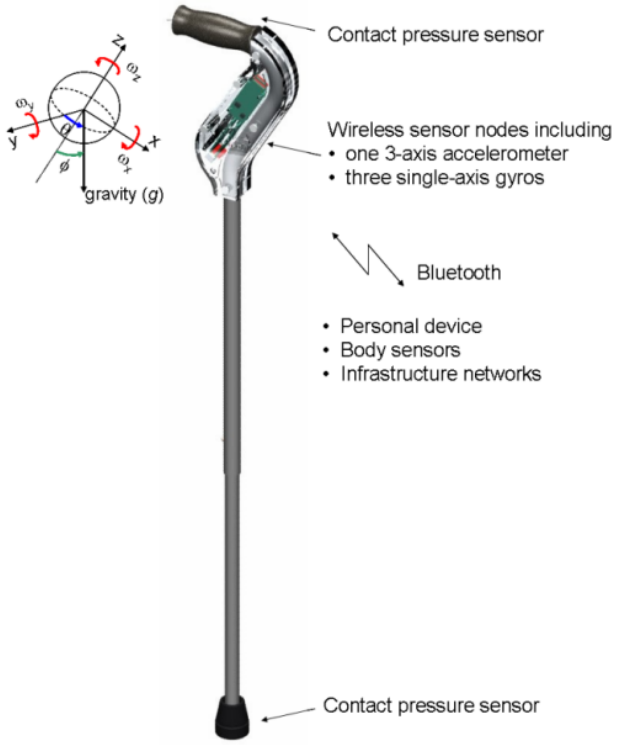
- Record of recent past

- Mitigate interruption and distraction

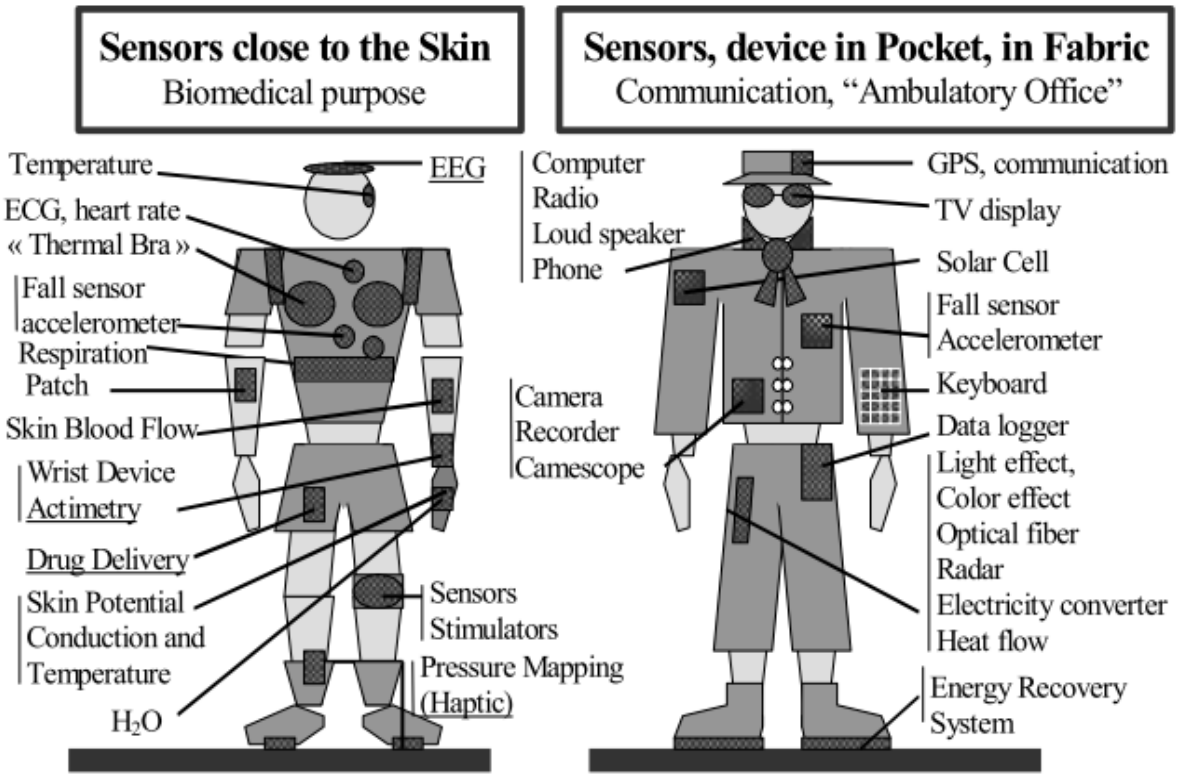
What Was I Cooking?

Wearables and Mobile Sensors

- Applications
  - Health monitoring
  - Navigation and stray prevention
  - Mobile persuasive technologies



Wearables Devices



Wearable Medical Devices

- Pros
  - Anywhere, anytime
  - Portable
  - Continuous recordings rather than “snapshot “
  - Avoid “white coat” syndrome
- Cons
  - Anywhere, anytime
  - Should be worn/carried all the time
  - Wearing a visible tag/device can be regarded as stigma
  - Privacy concern, 24/7 monitoring

Assistive Robots

- Helpful in physical tasks
- Communication, social interaction

Care-O-bot® by Fraunhofer IPA: grasping items and bringing them to resident

RIBA , Japan: Transferring patients, 2009

PARO by U Penn, 2011

http://www.care-o-bot.de/en/care-o-bot-3/download/videos.html#video2en

https://www.youtube.com/watch?v=oJq5PQZHU-I

Socially Assistive Robots

- Autonomous, interactive machines
- Aid with intellectual, social and emotional care
- Encourage physical activity
- Provide entertainment
- Offer companionship
- Generate safety reminders
- Facilitate intellectual stimulation

Rehabilitation

- Help recover from physical injuries
- Assist in daily activities
- Robear:
  - A bear-like, experimental nursing care robot
  - Lift patients out of beds and into wheelchairs
  - Assist to stand up

Assistive Robotics

- Feeding systems
  - Mealtime Partner
  - Neat Eater
  - SECOM MySpoon System
- Robotic arms (voice controlled)
  - Meal preparation, grooming
- Fetching items in home environment

Robots Helping With ADL

Task	# Robots
Support movement	35
Reducing need for movement	34
Feeding	7
Grooming	6
Bathing	4
Toileting	3
Dressing	2

Data from Understanding the potential for robot assistance for older adults in the home environment (HFA-TR-1102). Smarr, C. A., Fausset, C. B., Rogers, W. A. (2011). Atlanta, GA: Georgia Institute of Technology, School of Psychology, Human Factors and Aging Laboratory.

Robots Helping With ADL

Task	# Robots
Housekeeping	53
Meal preparation	14
Medication Management	13
Laundry	7
Shopping	5
Telephone use	4
Money Management	0
Transportation	0

Data from Understanding the potential for robot assistance for older adults in the home environment (HFA-TR-1102). Smarr, C. A., Fausset, C. B., Rogers, W. A. (2011). Atlanta, GA: Georgia Institute of Technology, School of Psychology, Human Factors and Aging Laboratory.

Robots Helping With ADL

Task	# Robots
Social Communication	46
Hobbies	29
New Learning	16

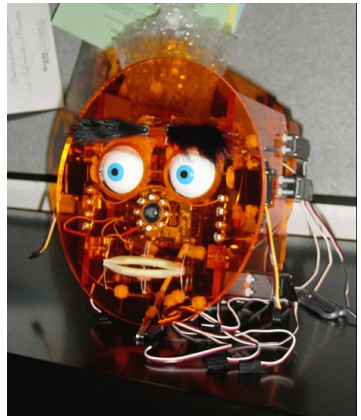
Data from Understanding the potential for robot assistance for older adults in the home environment (HFA-TR-1102). Smarr, C. A., Fausset, C. B., Rogers, W. A. (2011). Atlanta, GA: Georgia Institute of Technology, School of Psychology, Human Factors and Aging Laboratory.

Challenges: Privacy & Ethics

- Ethics
  - Perfect transparency
  - Control over the system
  - Lack of regulations
- Privacy
  - Encryption of data
  - Patient authentication
- Insurance and Reimbursement

Challenges: Assistive Robots

- Marketing and price
- Lack of reliable technology
- A robot fully capable of helping with all ADLs
- Adaptive robots
- More user studies needed
- User acceptance concerns



Challenges: Adoption

Category	All	Boomers (50-64)	Seniors (65+)	Comment
Online	79%	78%	42%	% of all adults
Use search daily	59%	52%	37%	% adults w/Internet
Use video sharing site	71%	54%	31%	View YouTube, % adults use of video
Seek Health info	59%	58%	29%	% adults w/Internet
Social network	61%	47%	26%	% adults w/Internet

Challenges: Adoption

Category	All	Boomers	Seniors (65+)	Comment
Have cell phone	85%	85%	58%	% all adults
…Smart phone	35%	24%	11%	% all adults
Internet calls	24%	19%	18%	% all adults
Have E-Reader	12%	13%	6%	% all adults
Have a tablet	8%	8%	2%	% all adults
Have mobile health app	9%	6%	5%	% adult cell phone users

Assistive Technologies

- 35% of all assistive technologies purchased are abandoned
- Waste of resources, time, and funds for users and disability services
- Bad experiences lead to disillusionment about assistive technologies

Reminder Written Report

- Paper-style (e.g., IEEE/ACM format)
- Max. 5 pages (incl. references/images/etc.)
- Submit via email by end of day of final exam
- Sample structure:
  - Title, abstract
  - Introduction, motivation, background
  - Describe technology (or health problem(s))
  - Describe how technology is used to address health problem(s) or how health problem(s) can be addressed using technology
  - Discussion, challenges, opportunities, future directions, etc.
  - Bibliography