Pervasive Technology for Healthcare:
Supporting an Aging Population

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The Rising Tide

• Canada’s healthcare system is currently faced with the challenge of caring for an increasing number of older adults.

• A large proportion of these individuals are living with diseases and impairments that are beyond those related to the normal aging process.
  ▪ E.g., neurodegenerative diseases (dementia, Parkinson’s disease), cardiovascular disease, cancer.
But...!

- Most older adults want to live in their own homes for as long as possible.
- Family would like them there, too.
- People want to be “in-control” of their health and environments.
Aging in Place

• “The ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level.” (CDC, 2015).

• Why consider aging in place?
  ▪ More positive health outcomes compared to long-term care;
  ▪ Lower cost of care compared to institutional care;
  ▪ People can make more of their own care decisions; and
  ▪ Quality of life can be improved.
Aging in Place and Technology

• Technology can help support aging in place!

• But what is “Technology”? 
Pervasive Computing
Pervasive Computing
What is Pervasive Computing?

Pervasive computing (also called ubiquitous computing or “everyware”) is...

“…machines that fit the human environment instead of forcing humans to enter theirs.”

“…computing [that] is made to appear everywhere and anywhere”
Pervasive Computing at Home

Steve, don’t forget to use the soap.

Its time for your medication.

You have fallen. Need Help?

Are you feeling ok?
Pervasive Computing & Healthcare
Limitations of Pervasive Computing

• While conceptually interesting, there have been barriers to development and use:
  ▪ It is easy to *be* everywhere but difficulty to *know* everything.

  ▪ Often these technologies are not able to accommodate the changing needs of a user.

  ▪ Many result in an increase in burden for nurses, caregivers, and family members.

• What is missing?
  ▪ Inadequate representation of *context*!
Context
What is Context?

- Context is any information that is relevant to the application, including:
  - Time.
  - Location.
  - User’s preferences.
  - State of people, groups and objects.
  - Actions / behaviours.
  - Patterns of living.

- Context encompasses everything about a person and a person’s environment including the person.
Smart Versus Intelligent Technologies

- **Smart:** Performing actions based on direct input of information or data.

- **Intelligent:** Performing actions based on input, common sense, experience, and the ability to adapt.
  - Understanding context!
Artificial Intelligence
Artificial Intelligence (AI)

• An umbrella term that encompasses many different types of techniques and processes.

• We must collect the necessary data and observations (intelligent sensing).

• A system that makes rational decisions, like a human.

• Techniques for representing and reasoning (learning) about knowledge (planning and predicting).
Artificial Intelligence

- Vision and Sensing
- Machine Learning
- Speech Recognition
- Decision Making
What this can do for us

• Embed systems into the user’s life.

• Learn and adapt to user’s context.

• Provide timely and appropriate help.

• Make data available.

Shadow Robot Hand (www.shadowrobot.com)
Some Examples of Pervasive Technologies
1. Automated Task Support (COACH)

Cognitive Orthosis for Assisting Activities in the Home
Key System Features

• Can autonomously monitor an older adult (e.g., with dementia) during a self-care activity.

• Provides prompts *as needed* and adapts them over time.

• Provides feedback to a caregiver when necessary.

• Is a passive (zero-effort) system.
A Typical COACH Installation

- Overhead camera to track users
- Speakers (in ceiling) to provide audio prompts
- Display to provide visual prompts
- Computer located in adjacent room
2. Intelligent Wheelchair
Key System Features

- Automatically detects objects and other potential hazards.
- Stops the wheelchair before collision.
- Prompts the user on the best way to avoid the hazard.
- Can be installed on a standard powered wheelchair.
Example of Use
3. Fall Detection (The HELPER)

An intelligent hands-free personal emergency response system
Key System Features

• No push-button or manual intervention.

• Intelligently talks with the user using speech recognition and AI.

• Not stigmatizing
  ▪ Respects the privacy and autonomy of the user.

• Can “plug in” to existing infrastructures.
Ceiling Mounted Unit
Example of Use
Why am I Here Today?

• This type of technology requires an interdisciplinary approach!
What Do I Do?

• Biomedical Engineering:
  ▪ Computer Vision and Sensing;
  ▪ Machine Learning;
  ▪ Automated Decision Making.

• Clinical Development and Evaluation:
  ▪ What do the users need?
  ▪ Does it actually work?

• Two Main areas:
  ▪ Ambient Assisted Living.
  ▪ Automated assessment.
Technology Design Philosophy

• Develop for real-world using real-life problems and motivations.

• Involve the user from the start to the finish of the design process.

• Test new technologies as often as possible throughout the design process.
Thanks!

Questions?

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