AGING IN PLACE

National Institutes of Health

September 9-10th, 2014

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PANEL 3

Health transition trajectories: Data to action

Dan Siewiorek, Jeff Kaye,

Maureen Schmitter-Edgecomb

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TECHNOLOGIES TO SUPPORT PHYSICAL HEALTH

Dan Siewiorek
Buhl University Professor
Computer Science and
Electrical and Computer Engineering
Carnegie Mellon University

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PHYSICAL THERAPY

A growing need

- By 2030, 4% of the population will experience a stroke at a cost of over $180 billion
- In 2004 there were 450,000 total knee replacements and 230,000 total hip replacements
- In 2006 250,000 rotator cuff surgeries
- In 2009 250,000 anterior cruciate injuries
- Six or more months of rehabilitation commonly required

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BLOOD PRESSURE CUFF

Is it on correctly

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GENERATION SMARTPHONE: IEEE SPECTRUM 9/12

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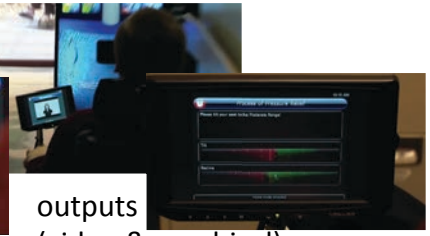
Quality of Life Technology Center
a National Science Foundation Engineering Research Center

Iterative, Multi-Perspective Users-Centered Design

Example: **Seating Coach**

output (avatar)

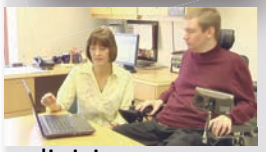
user preferences panel



outputs (video & graphical)

user's social context settings

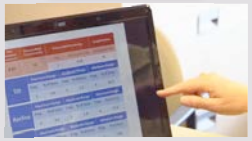
wheel chair user



clinician

Focus groups

Wizard of Oz studies

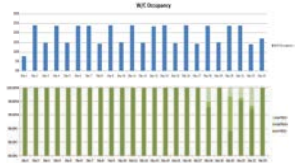


Usability testing

Home deployment

spreadsheet-based prescription input

Kiviat graph summary output



graphical trend feedback

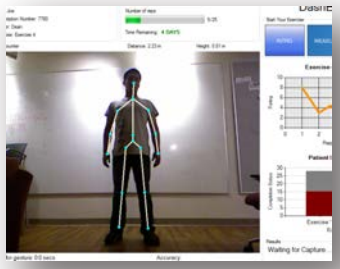
QoLT project pipeline

User Centered Design Prototype → **Robust Prototype** → **Laboratory Prototype** → **Field-deployed System** ⇢ **Commercial Product**

User Centered Design Prototype	Robust Prototype	Laboratory Prototype	Field-deployed System	Commercial Product
Smart Orthotics	Woodworking Angle Gage	Ergobuddy	IMPACT	First Person Vision
Gastro-enterology	Office Ergonomics	Wheelchair Propulsion	MemExerciser	Seating Coach
Vital Clip		PT Coach	HeadCoach	
Walker stride coach		Carpal Tunnel Coach		
		Stroke Rehabilitation Coach		

Walker Stride Coach

Physical Therapy Coach



Stroke Therapy Coach

HeadCoach

Seating Coach

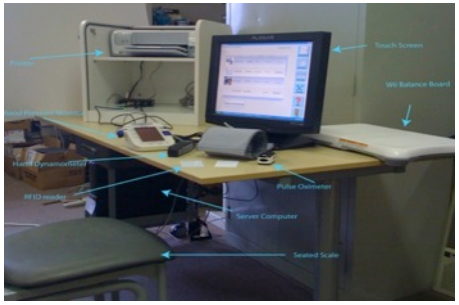
Health Kiosk

VINCENTIAN COLLABORATIVE SYSTEM

Presbyterian SeniorCare Positively Living

JEWISH ASSOCIATION ON AGING

physical form and user interactions



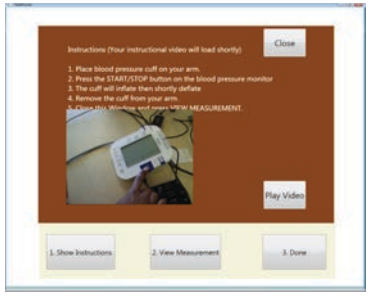
Early *prototype*
(for proof of functionality)

Developing *prototype*
(for usability testing)

Mature *prototype*
(for field deployment)

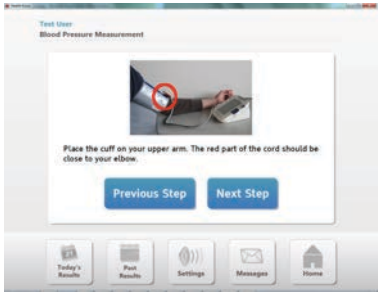
time

blood pressure measurement instructions



video loop

single screen with multiple steps



sequence of screens with 1 step each

STOKE REHABILITATION EXERCISES

- Normalized Hidden Markov Model recognizes correct and erroneous exercise movements
- Encouragement and corrections are provided by audio and textual feedback

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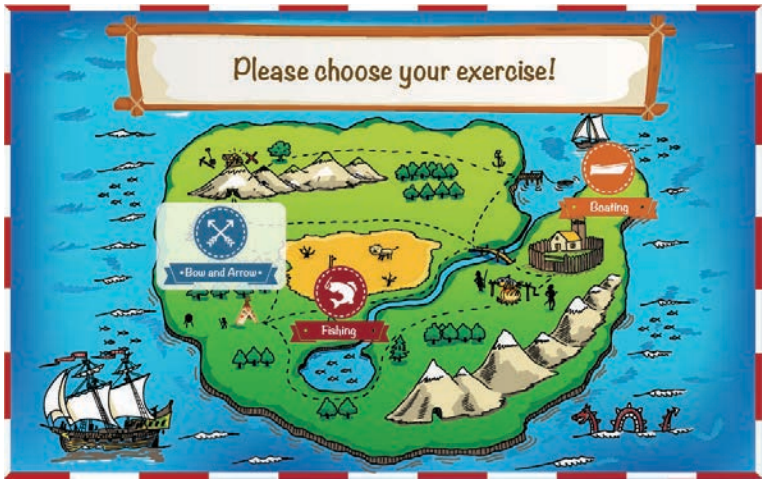
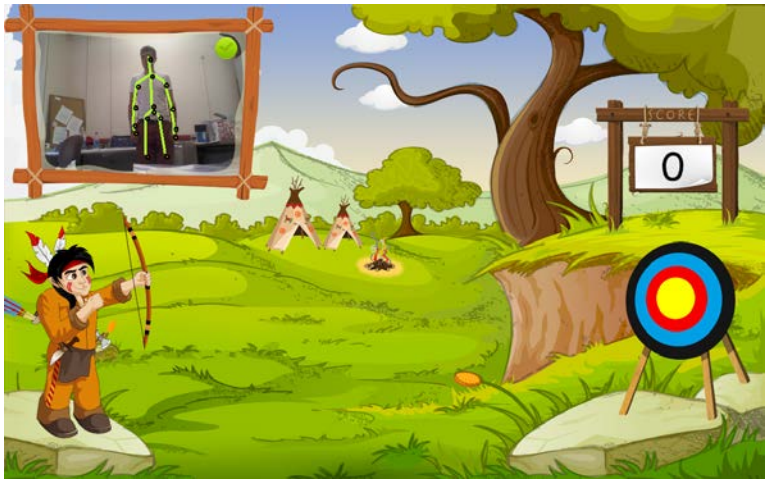
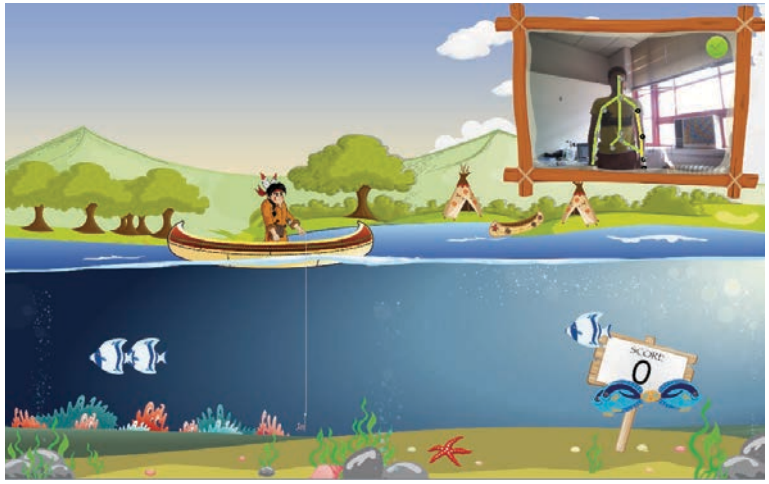
Game Suite for Stroke Rehabilitation



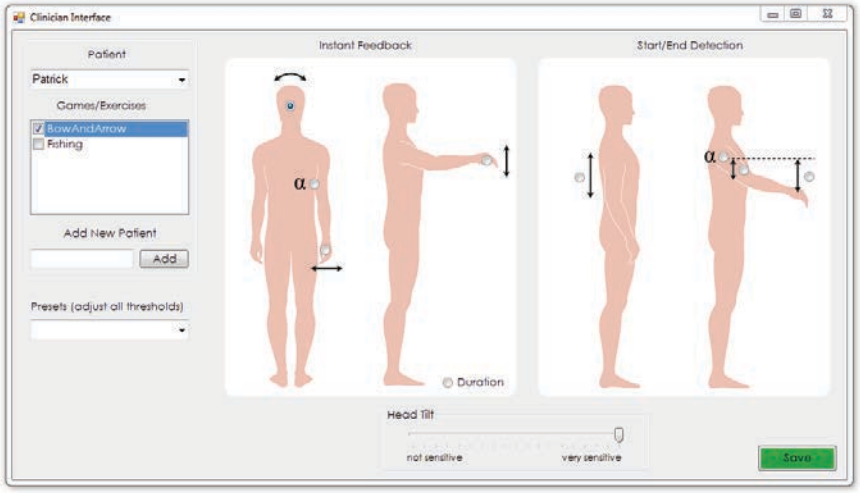
Combination of several games



"Bow and Arrow": relates to the Reach a Light Switch exercise

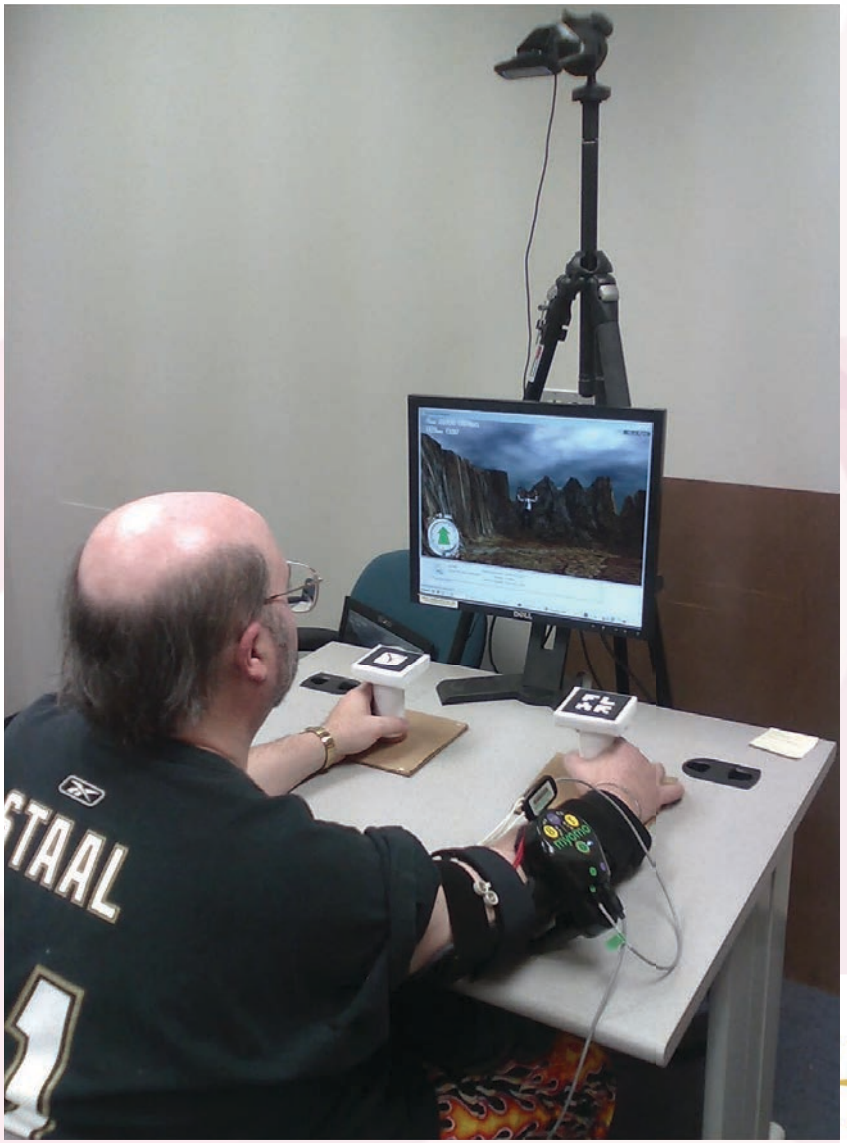


"Fishing": relates to Bring a Cup up to the Mouth exercise



Clinician interface for adjustment of thresholds

STROKE REHABILITATION VIRTUAL REALITY GAMES



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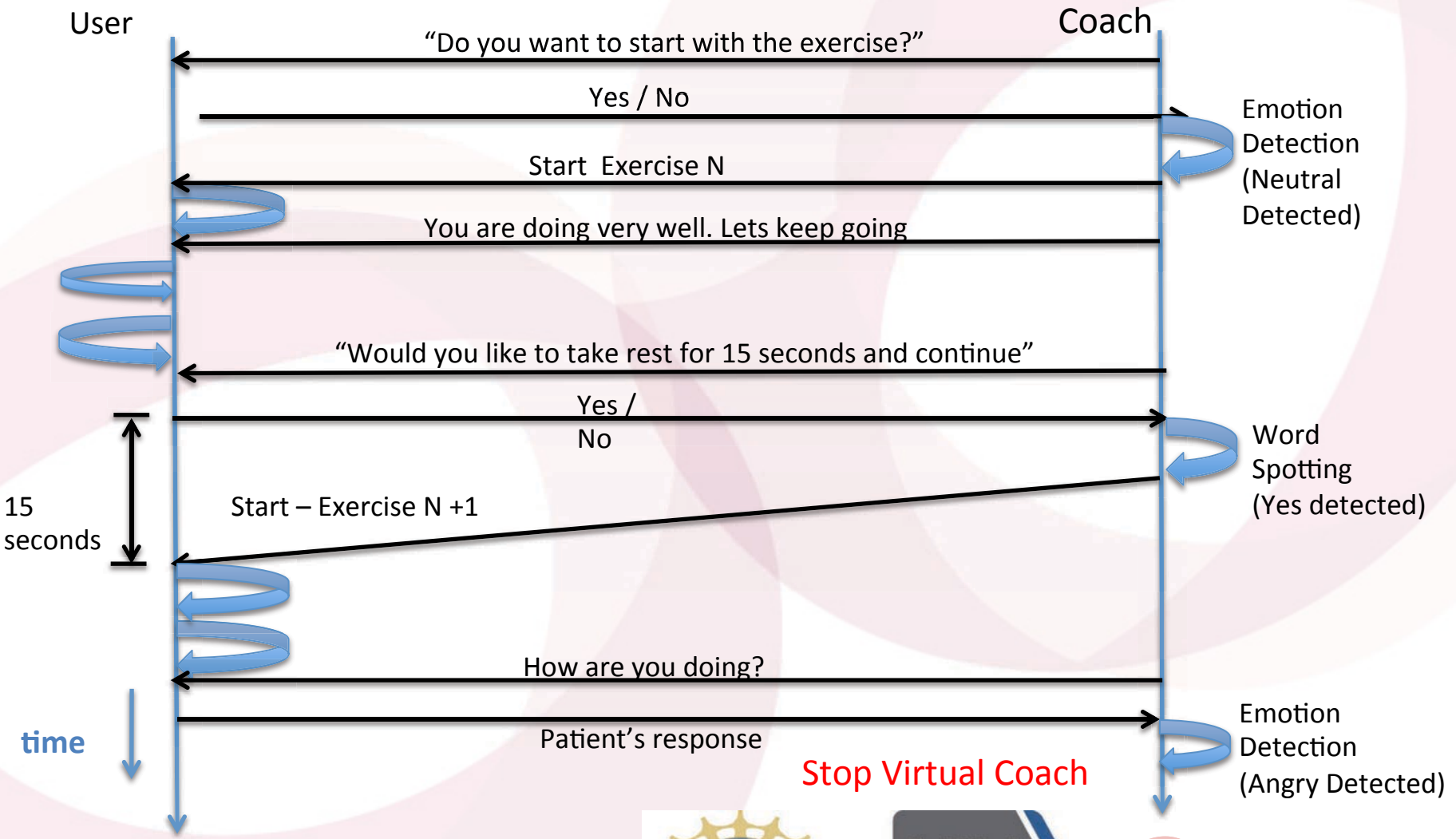
STROKE REHABILITATION WITH EMOTION DETECTION



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VIRTUAL COACH TEAM COMPOSITION

- Biomedical Engineering
- Computer Science
- Electrical and Computer Engineering
- Human-Computer Interaction
- Nursing
- Occupational Therapy
- Physical Therapy
- Psychology
- Rehabilitation Engineering
- Robotics

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A TALE OF TWO PASSAGES

Nursing Home, CHF

- Medications – doctors did not check each others list
- Model of what going on in body not conveyed
  - Confusing to be told one day to drink as much as you like, next day no water
- Extraordinary Measures
  - Dialysis to remove water
  - Doctor told him going to amputate both legs without checking with family – passed away six hours later

Independent Living, Hospice

- Loss of control
  - Once in nursing home under nursing home doctor who did not return calls
  - Had to work with physical therapist to get release
  - Blood sugar reading – if can not do herself have to go into nursing home
  - Wanted to do feeding tube
- Lack of sensitivity
  - Placed in room next to where her husband died, roommate pleading to die
- Hospice
  - Removed IV, medications, talking and sipping ice chips in 24 hours
  - Did not know of home care possibility – passed away in a home setting with children, community events

A TALE OF TWO PASSAGES – POTENTIAL TECHNOLOGIES

Nursing Home, CHF

- Medications - Communications
- Model of what going on in body not conveyed – Descriptive Models
- Extraordinary Measures
  - Dialysis to remove water – Descriptive Models
  - Doctor told him going to amputate both legs without checking with family – Communications

Independent Living, Hospice

- Loss of control
  - Under nursing home doctor who did not return calls- Communications
  - Had to work with physical therapist to get release - Communications
  - Blood sugar reading – if can not do herself have to go into nursing home – Virtual Coaches
- Lack of sensitivity
  - Placed in room next to where her husband died, roommate pleading to die - History
- Hospice
  - Removed IV, medications, talking and sipping ice chips in 24 hours- Descriptive Models
  - Did not know of home care possibility – Match

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RESEARCH BARRIERS

- Fundamental Knowledge
  - Individual differences and unpredictability
  - Models of noise and uncertainty
  - Contextual variability
  - Complex Interactions
- Technology
  - Safety assurance
  - Robustness and Generality
  - Interoperability
  - Multidisciplinary collaboration challenges
- Technology Integration
  - Privacy concerns
  - Market factors
  - User acceptance
  - Demonstrating value

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RESEARCH QUESTIONS

- How can technology be made more engaging thereby avoiding early abandonment
- How can complexity of interactions be simplified
- How can technology adapt as my ability changes
- How can technology interactions be personalized
- How can technology motivate to change behavior
- How can interactions be more like exchanges with humans
- How can the technology interactions modify interaction within a session as my mood changes
- How can technology ease the burden of caregivers
- How can the support team (doctors, nurses, engineers) be unified and synchronized from design to implementation to development

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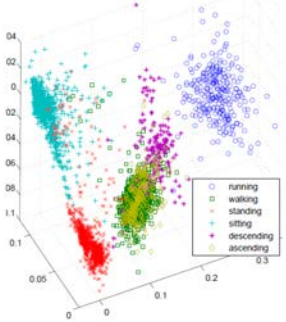
Daniel Siewiorek/ Carnegie Mellon University

Quality of Life Technology Center
a National Science Foundation Engineering Research Center

How to make technology adapt to my needs as my abilities change

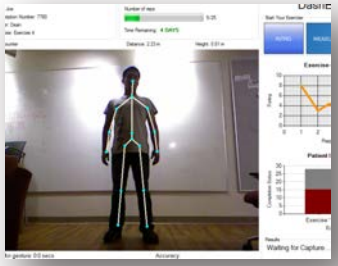
Machine Learning



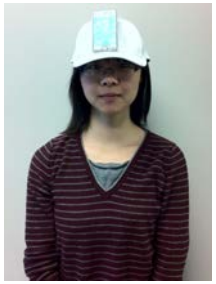
Virtual Coaches

Physical Therapy Coach

Seating Coach



Stroke Therapy Coach



HeadCoach

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