# Computing for Health and Wellness: Pervasive Healthcare

People-Oriented Computing

25.11.2019

# Agenda

- Announcements
- Pervasive health
  - Background
  - Pervasive health domains and technologies
    - Preventative care
    - Hospital care
    - Chronic care
- Course evaluation

# Announcements

- Course evaluation today (after break)
- Exercise this Wednesday (27.11.2019)

# Clarifications for Project Assignment #2

- The evaluator has the script but is answering the question of whether Abby would be able to carry out the interaction WITHOUT a script
- There is no role playing - the evaluator is not pretending to be Abby or pretending to be like Abby
- If you choose to edit the persona, edit it to be more like the target user, not the evaluator

# Clarifications for Project Assignment #2

- Newer versions of the personas are available for download on the GenderMag website - you can use them if you like - just specify in your report
- You can have your participant fill out the form on paper or on the computer, but not on the same device on which they are completing the task walkthrough

# Learning Goals

After this lecture, you should

- Be familiar with Pervasive Healthcare as a subset of health technologies
- Be familiar with three primary domains of pervasive healthcare
- Be familiar with several classes of technology support associated with pervasive healthcare
- Be aware of several examples of technologies that embody these classes of technology support
- Have a basic understanding of the challenges to the design and success of pervasive healthcare technologies

# COMPUTING FOR HEALTH AND WELLNESS

# Computing and Health

Computing is revolutionizing healthcare on many fronts, e.g.

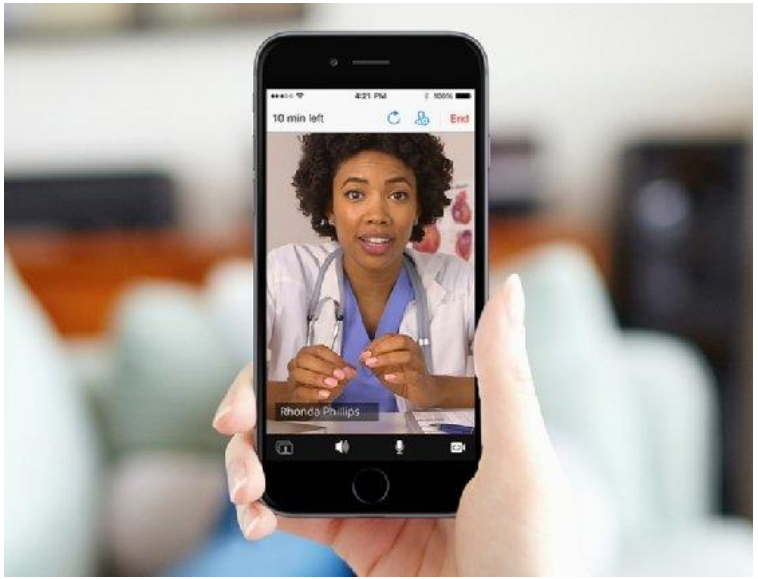
- Advances in medical imaging
- Cloud computing for data storage and access
- Big data for health research
- Medical informatics for health information systems
- Computer-aided diagnosis
- Telemedicine
- Etc.

# Pervasive Healthcare

*"Pervasive healthcare refers to the set of technologies designed to seamlessly integrate health education, interventions, and monitoring technology into our everyday lives, regardless of space and time."* – Tentori et al., 2012

# Pervasive Healthcare

- Interactive systems in support of healthcare
- Can increase coverage and quality of care
- Increasing area of focus in both research and industry



# Pervasive Healthcare

Offers solutions including applications and mechanisms to:

- Ease **recording, tracking, and monitoring** of health information
- Allow **communication, collaboration, and coordination** among stakeholders
- Encourage **clinical adherence** and **disease prevention**
- Support nomadic work of clinicians and **integration of digital and physical worlds**
- Enable the development of **novel medical devices**

# Pervasive Healthcare

Builds upon Mark Weiser's vision and the field of ubiquitous computing

- Takes advantage of the increasing availability of heterogeneous interconnected devices
- Employs approaches including
  - Context-Aware Computing
  - Automated Capture and Access
  - Artificial Intelligence
  - Wearable and Embedded sensing
- "Anytime and anywhere" healthcare

# Pervasive Healthcare

- Has impact on a variety of stakeholders, including patients, healthcare providers, family members, other caretakers
- Most systems involve multiple stakeholders (e.g., a patient captures her heart rate, later reviewed by her relatives and healthcare providers)
- Primary stakeholder is the person who primarily interacts with and benefits from the system

# Human-Centered Model of Healthcare

Preventative Care

Hospital Care

Chronic Care

# Human-Centered Model of Healthcare

Preventative Care | Hospital Care | Chronic Care

- Targets behavior and lifestyle choices (e.g., smoking, diet, inactivity) to prevent disease or injury, rather than treating or curing them
- Many chronic diseases and premature deaths are linked to common preventable risk factors
- Preventative care reduces burden on hospitals and healthcare sectors

# Human-Centered Model of Healthcare


- Supports coordination and collaboration to care for patients
- Technology for managing and sharing health information and supporting decision-making
- Making hospital workflows more efficient to improve patient care and reduce costs

# Human-Centered Model of Healthcare

Preventative Care | Hospital Care | **Chronic Care**

- Considers impairments or deviations from the norm that last three or more months
- Most common among elderly people, but affect all ages
- Prevalence of chronic diseases is growing, straining healthcare workers, family members, pharmaceutical industry, medical technology, and insurers

# PERSONAL INFORMATICS AND WELLNESS MANAGEMENT FOR PREVENTATIVE CARE

# Human-Centered Model of Healthcare

Preventative Care | Hospital Care | Chronic Care

- Targets behavior and lifestyle choices (e.g., smoking, diet, inactivity) to prevent disease or injury, rather than treating or curing them
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- Preventative care reduces burden on hospitals and healthcare sectors

# Preventative Care

- As life expectancy increases, prevention of chronic illnesses becomes a greater priority
- Preventative care programs encourage healthy behaviors in attempt to reduce healthcare costs on a large scale
- Focus on issues such as medication compliance, health monitoring and documenting, and social health issues
- Goals to prevent cognitive decline, and maintain physical and psychological well being

# Preventative Care Technologies

- Automated and selected capture and access
- Persuasive and self-monitoring technologies
- Social support for health

# Automated and Selective Capture and Access

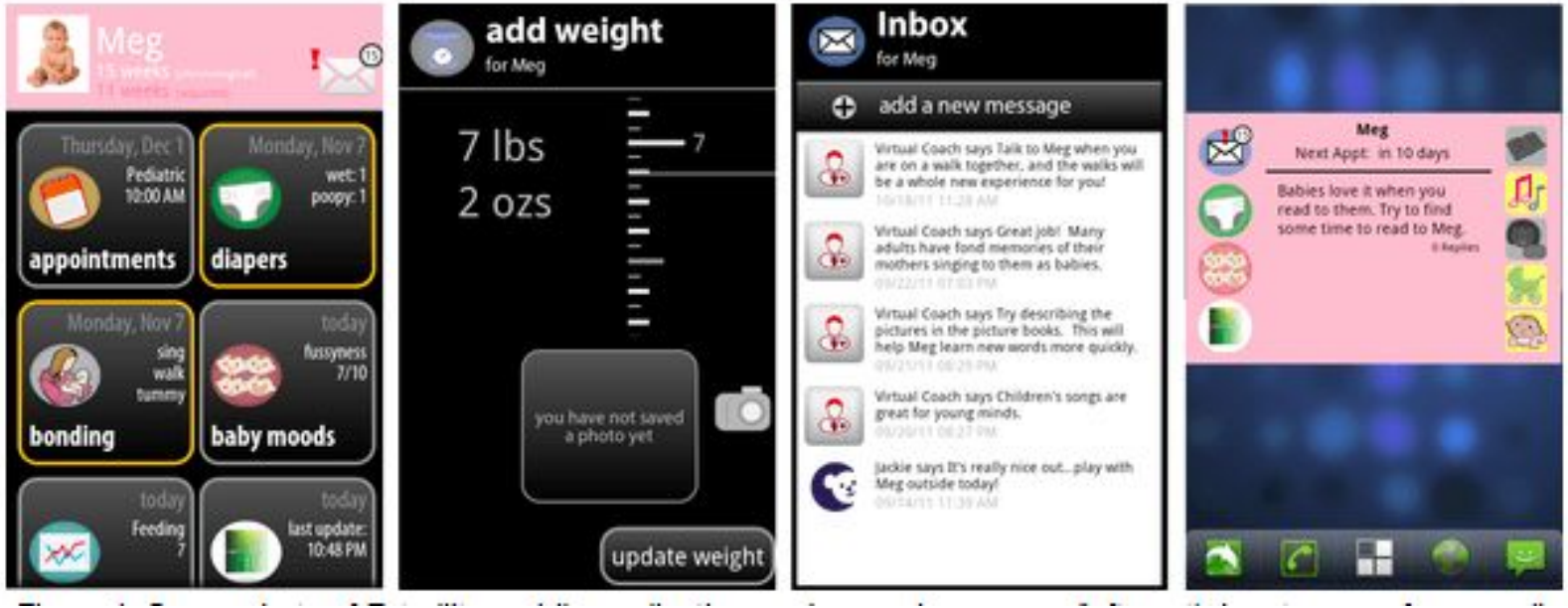
- Takes advantage of computing to record relevant health information
- Makes information available and accessible to important stakeholders
- Can use fully-automated capture of information (e.g., activity trackers) or user-triggered capture of information

# Estrellita

# Estrellita (Hirano et al.)

- Selective capture and access system for parents of premature infants
- Allows sharing of relevant health information with health providers, relatives, and friends
- Parents update baby’s health information and flag points of concern
- Professionals can access and analyze data
- Parents and professionals can communicate via the system

# Estrellita (Hirano et al.)




Source: star-uci.org

# Foodprint (Chung et al.)

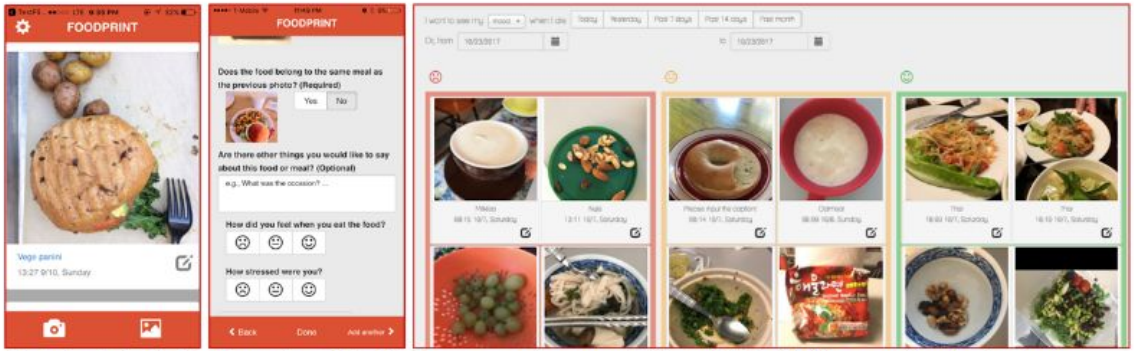



Fig. 1. Foodprint for healthy eating. Left: Mobile app presenting recorded food. Middle: Mobile app asking for (optional) additional details about food. Right: Web app presenting food and mood relationships.

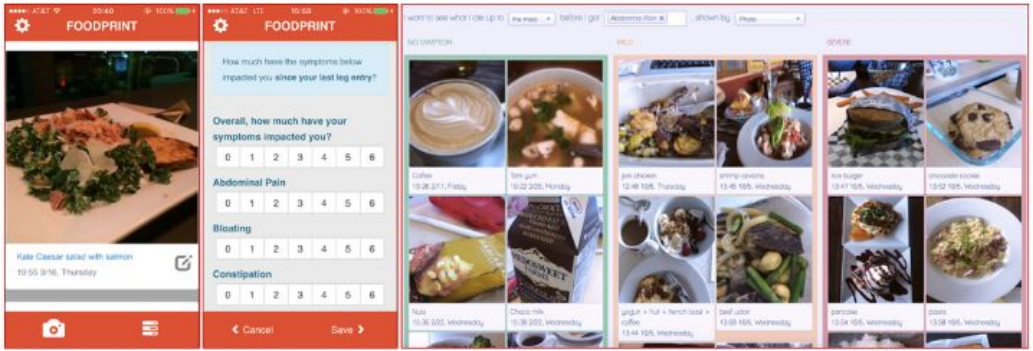



Fig. 2. Foodprint for IBS. Left: Mobile app presenting recorded food. Middle: Mobile app asking for symptom severity. Right: Web app presenting food and symptom relationships based on symptom severity.

# Foodprint (Chung et al.)

- Supports lightweight photo-based food journaling via mobile app
- Supports communication between patients and experts based on eating goals
- Allows for visualizations to support reflection on eating habits

# Persuasive Technologies and Self Monitoring

- Technologies encourage people to take responsibility for setting health goals or making positive changes in behavior
- Many commercial applications and devices available for fitness and wellness
- Persuasive games can be used to discourage unhealthy behaviors or encourage healthy behaviors
- Focuses on behaviors such as exercise, diet, smoking, alcohol consumption, physical activity, leisure activity

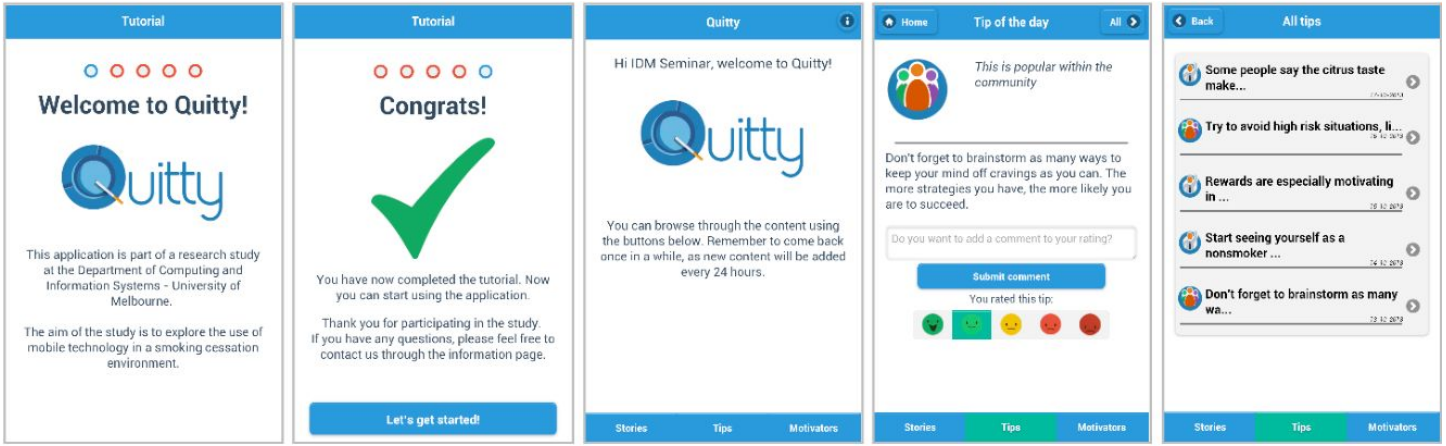
# UbiFit Garden (Consolvo et al.)

- Designed to encourage regular physical activity through aesthetic images
- Made use of sensors on mobile phone to infer levels of physical activity
- New physical activities were represented on a visualization of a garden
- Lack of physical activity could lead to death of garden

# UbiFit Garden (Consolvo et al.)


Source: ieeecomputer.org

# Quitty




- Mobile application to support smoking cessation
- Serves as continuous interaction support for ongoing task
- Tailors messaging to cessation progress

# Detecting Mood Disorders

Using data collected from mobile phones and wearable devices to detect potential mood disorders and predict changes in mood (Laura E. Barnes, et al.)

e.g. social anxiety, seasonal affective disorder

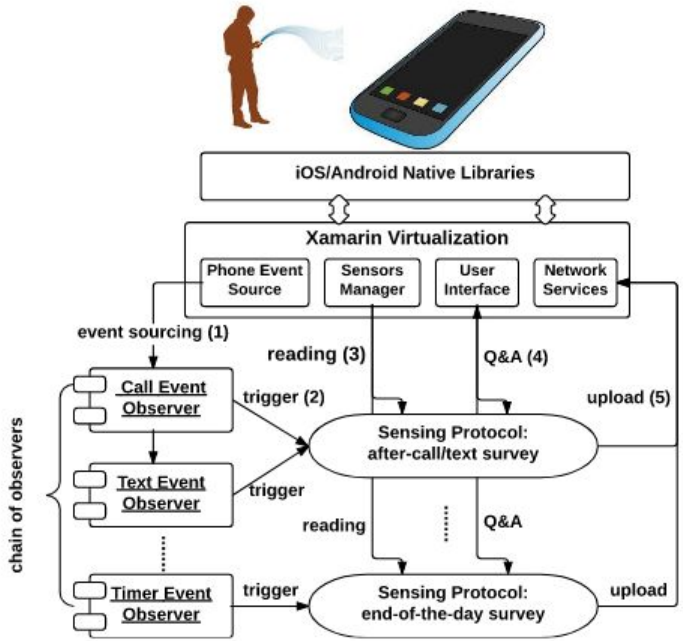



**Figure 1. SAD Framework Design**

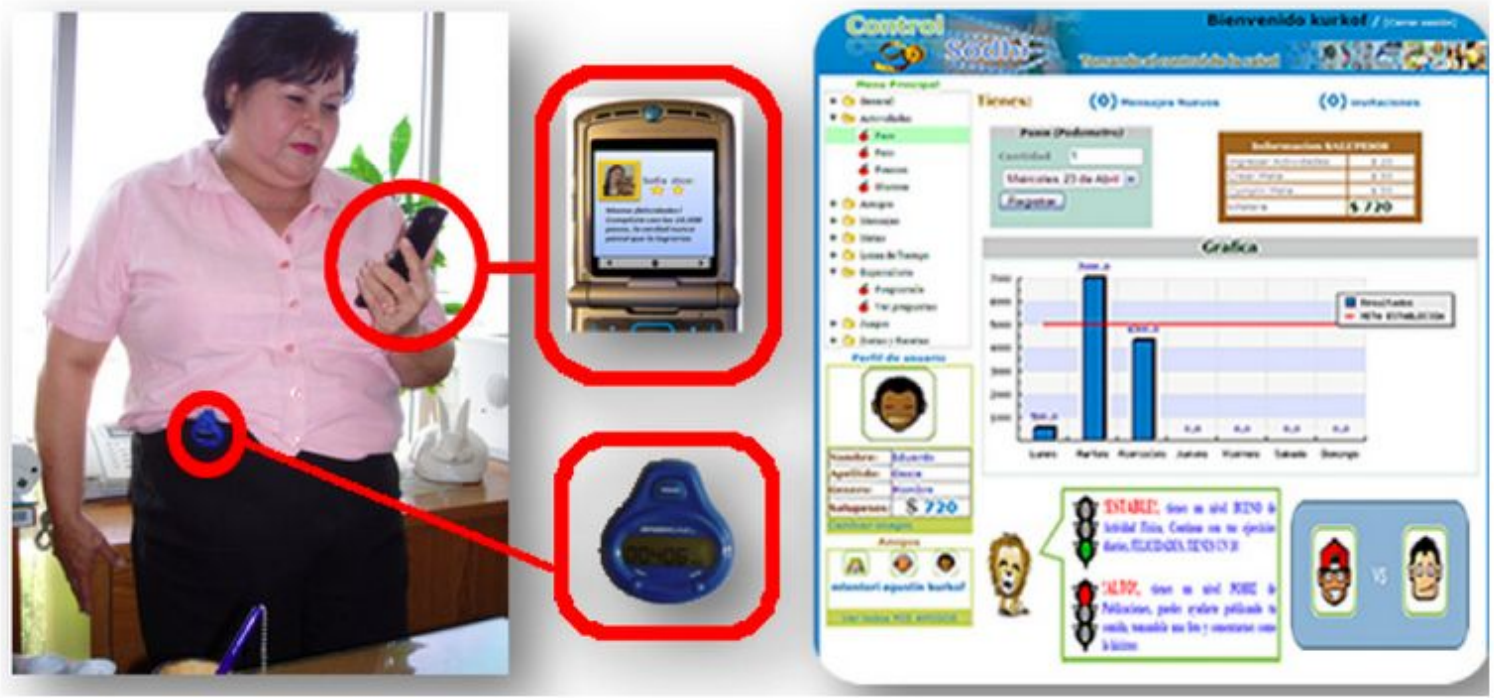
# Social Health

- Research shows that social ties and social integration are beneficial in maintaining physical and psychological well-being
- Virtual communities can support communication among patients, or between patients and clinicians
- Can lead to reduced stress, social satisfaction, increased access to information, and increased communication

# pHealthNet

- Virtual community to support communication between patients and specialists
- Aimed at promoting healthy lifestyle for people with chronic degenerative diseases to prevent further disease
- Allowed users to exchange messages, videos, and exercise logs
- Helped patients change eating habits and increase physical activity

# pHealthNet


Control
Bienvenido kurkof
Tienes:
(0) Mensajes Nuevos
(0) Invitaciones
Grafica
$ 720

# Spaceship Launch (Saksano et al.)


- Leverages FitBit data
- Social “exergame” targeted at low-income families to encourage physical activity
- Based on the idea that children often don’t see parents modeling physical activity

# PERVASIVE COMPUTING FOR HOSPITAL CARE

# Human-Centered Model of Healthcare


- Supports coordination and collaboration to care for patients
- Technology for managing and sharing health information and supporting decision-making
- Making hospital workflows more efficient to improve patient care and reduce costs

# Pervasive Computing for Hospital Care

- Healthcare is often slower than other industries in adopting new information technologies
- Hospitals are deploying technologies to improve patient care, reduce costs, and prevent errors

# Pervasive Computing for Hospital Care

Hospital work conditions are substantially different from typical office conditions

# Pervasive Computing for Hospital Care

Hospital work conditions are substantially different from typical office conditions

- Demands close coordination and collaboration among specialists distributed over space and time
- Clinicians continuously move around the space to access people, knowledge, and resources
  - E.g., seeing patients, accessing clinical information such as patient records or medical images
- Information is often distributed in different locations

# Technology Approaches for Supporting Hospital Care

Primary goal is to make information available and allow people to access relevant information when and where they need it

- Context-Aware Services and Awareness
- Pervasive Groupware and Collaboration Support
- Record-keeping and Note Taking
- Handling Multiple Activities and Supporting Rapid Context Switching

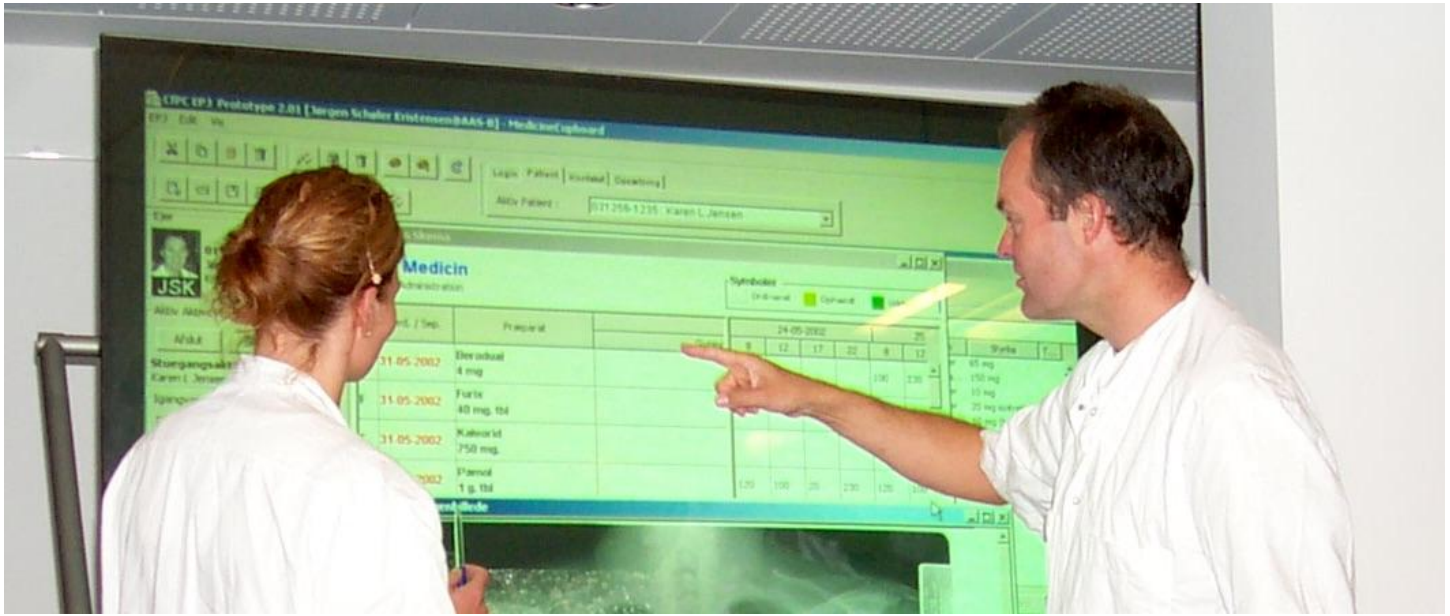
# Context-Aware Services and Awareness

- Make use of computing to collect context information to determine how a system should behave
- Focus on keeping clinicians aware of current situation and work status and providing information where and when it is relevant

# FlowerBlink

- Ambient display and wearable bracelet to help monitor ADL, specifically patient urination
- Patient urination triggers blinking light on nurse's bracelet that indicates which patient is urinating
- Ambient display has flowers that blink when patient is urinating or has a full urine bag, flowers display location of each patient

# Pervasive Groupware and Collaboration Support



# Pervasive Groupware and Collaboration Support

- Supports collaboration between colleagues for patient care
- Can support cross-department or even cross-hospital interaction
- Can enable synchronous or asynchronous meetings and shared access to medical information

# ABC (Activity-Based Computing, Bardram et al.)

- Project supported teleconferences between clinicians that allowed them to physically “roam” while engaged
- Organized by “activity” rather than by application or document
- Transferred user sessions and ongoing tasks among appropriate devices as clinicians move in the space
- Provided shared display for activities
- Allowed activities to be shared among participants

# ABC (Activity-Based Computing)

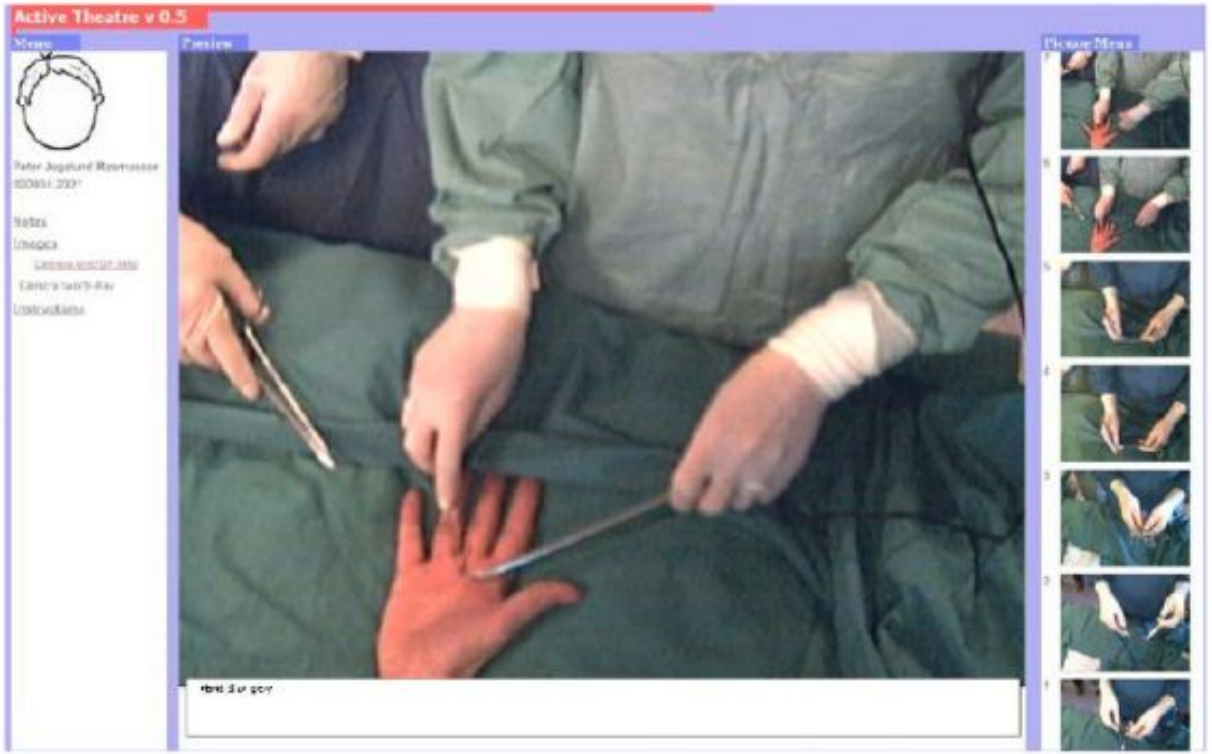
# Record-Keeping and Note-taking

- Support recording of data with minimal interference to the ability to engage in an activity or interaction
- Challenging because clinician activities often require the use of both hands so they cannot use them to record information
- Often uses automated capture and access approaches

# Activity Theater (Hansen)

- Enables automatic capture of relevant events during a health procedure
- Events can be captured as audio notes, pictures, or video clips
- System is voice activated
- Events are saved to a palette and items from the palette can be used to create necessary documents

# Activity Theater (Hansen)



# Handling Multiple Activities and Context Switching

- Hospital work is highly fragmented
- Clinicians switch activities every 90 seconds on average
- Requires switching between several systems frequently, many interruptions

# ABC (Activity-Based Computing)

- Also helps with context switching
- Organized by activity rather than by application or document
- Consolidates several functions into a single system, reducing the need to switch between systems while engaged in an activity

# CHRONIC CARE MANAGEMENT TECHNOLOGIES

# Human-Centered Model of Healthcare

Preventative Care | Hospital Care | Chronic Care

- Considers impairments or deviations from the norm that last three or more months
- Most common among elderly people, but affect all ages
- Prevalence of chronic diseases is growing, straining healthcare workers, family members, pharmaceutical industry, medical technology, and insurers

# Chronic Care Management

- Focuses on health conditions or diseases with long-term effects
  - E.g. Cancer, asthma, diabetes, high blood pressure
  - E.g. Alzheimer's, autism, affective disorders
- Often require a variety of pharmaceutical and behavioral interventions to monitor and maintain patient health over time
- Remote patient monitoring often more desirable than hospital care

# Chronic Care Management

- Chronic conditions can lead to lower perceived quality of life and self-care abilities
- Can lead to the need for regular assistance for performance of Activities of Daily Living (ADL) (e.g., feeding, bathing, or dressing oneself, walking, etc.)
- Extensive support from caregivers can help, but also hamper independence, engagement in society, and self-image
- Caregivers can experience strain and decreased quality of life as well

# Technology Approaches for Supporting Chronic Care

Focus on supporting ADLs, self management, communication with health providers, and caregiver support

- Pervasive Monitoring
- Social Connectedness and Communication Support
- Assisted Navigation and Wayfinding Support
- Prompting and Reminders

# Pervasive Monitoring

- Monitoring systems that can track basic metabolic and behavior information
  - Vital signs
  - Activities
  - Social interactions
  - Sleep patterns
  - Etc.
- Often make use of wearable or embedded sensors

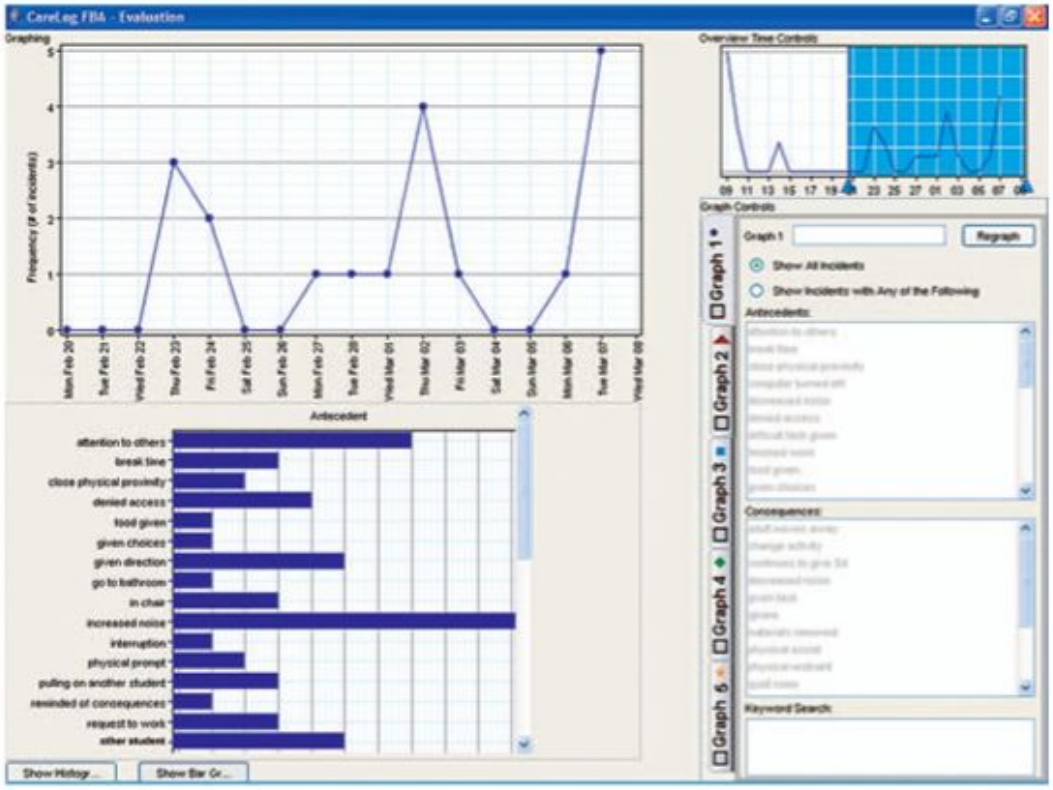
# CareLog

- Capture and access application to help caregivers assess the behaviors of children with autism
- Uses audio and video buffers and selective (manually triggered) archiving of significant incidents
- Provides access to information and analytic tools for behavior assessment

# CareLog


CareLog FBA - Incident Review
Student: Doug
Evaluator: Allison
Start Date: 2006-02-07
Time of Incident: 15:08:14-15:23:14
Label:
Antecedent
Edit List
in chair
increased noise
interruption
physical prompt
pulling on another student
reminded of consequences
request to work
rest time
other child
simple task given
told to get up
told to start
Behavior: Hitting
Consequence:
Edit List
adult moves away
change activity
continues to give bit
decreased noise
given task
ignore
materials removed
physical assist
physical restraint
quiet room
redirect
reinforcer removed
Comments:
Reaction: Continues; Lays down to escape instead
Video
Cancel
Save Changes

# CareLog


CareLog FBA - Evaluation
Graphing
Frequency (# of incidents)
Antecedent
attention to others
break time
close physical proximity
denied access
food given
given choices
given direction
go to bathroom
in chair
increased noise
interruption
physical prompt
pulling on another student
reminded of consequences
request to work
other student
Show Histogr...
Show Bar Gr...
Overview Time Controls
Graph Controls
Graph 1
Regraph
Show All Incidents
Show Incidents with Any of the Following
Antecedents:
Consequences:
Keyword Search:
Graph 1
Graph 2
Graph 3
Graph 4
Graph 5

# Monarca

- Focuses on management of affective disorder, specifically bipolar disorder
- Uses manual and automated collection of information by patient
- Communicates information to caretakers and clinicians
- Allows for self-reflection and analysis

# Monarca

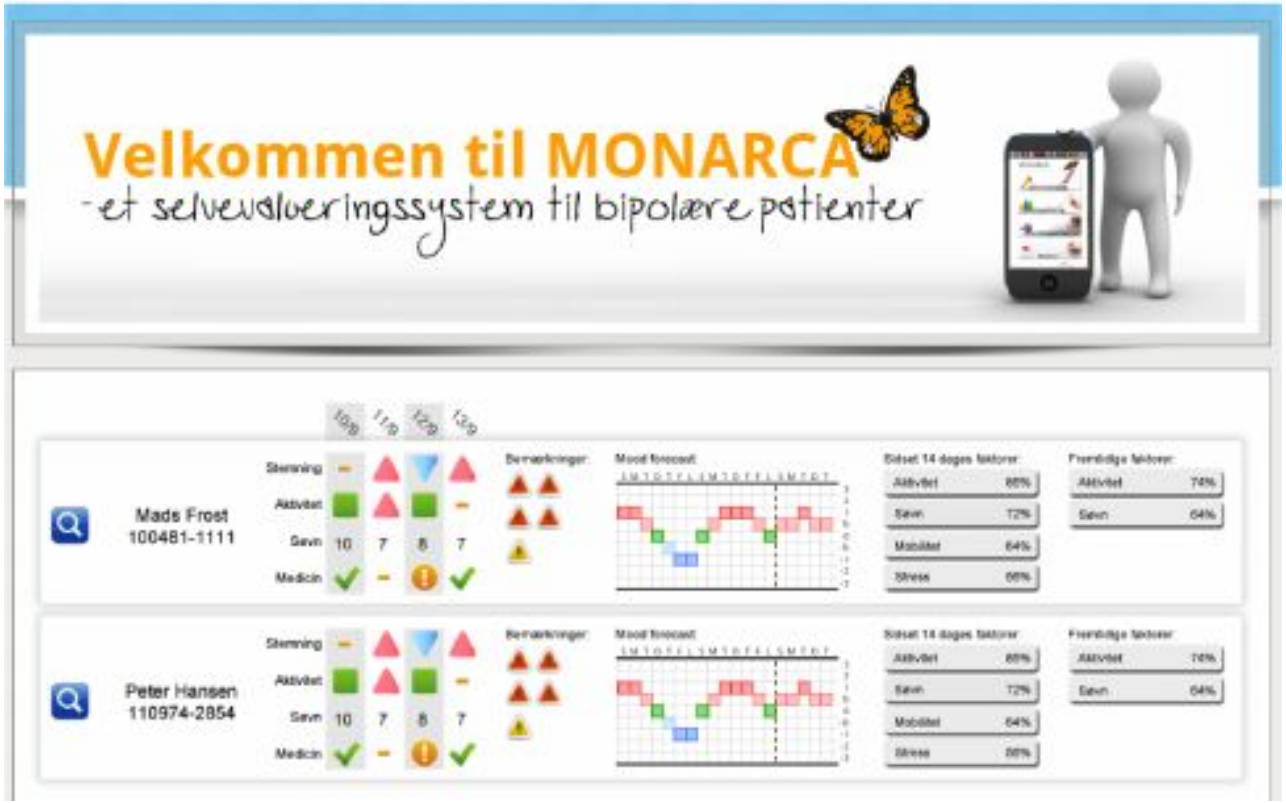

14:58
Selfassessment [Today]
Mood
3 Severe mania
2 Moderate mania
1 Mild mania
½ Elevated mood
0 Neutral mood
-½ Lowered mood
-1 Mild depression
-2 Moderate depression
Cancel


15:03
Grafer
Triggers
Noter
Mood
T F L S M T O T F L S M T O
Retrospekt
Sleep
T F L S M T O T F L S M T O


11:28
The nearest future's impact factors
Alcohol 79%
Sleep 47%
Past 14 days' impact factors
Physical activity 81%
Mobility 69%
Alcohol 63%


18:56
18 56
Copenhagen
Mostly Cloudy
16°
Monarca
Gmail
Mail
Clock
Internet
Phone

# Monarca


Velkommen til MONARCA
-et selvevalueringssystem til bipolære patienter
Mads Frost
100481-1111
Peter Hansen
110974-2854

# Monarca

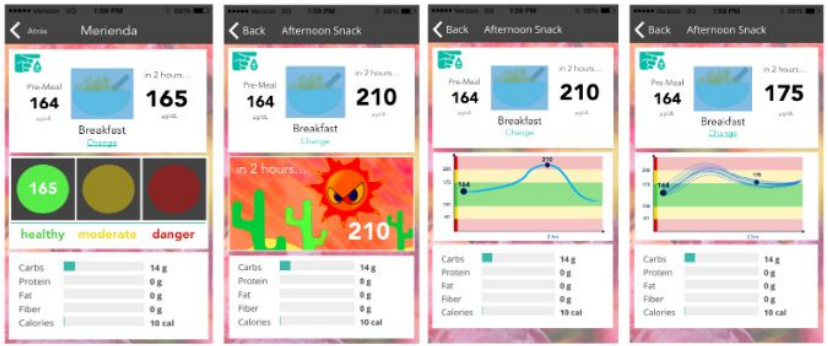
Serves multiple purposes

- Collection of vital data
- Provides clinician with access to more data
- Helps patient learn about condition and patterns
- Supports prediction of mood

# Visualization for Glucose Monitoring (Desai et al.)

- Support for patients with Type II diabetes
- Study of various information visualizations of glucose information
- Varied context information, text, symbols, colors to help patients better understand and manage the disease

# Visualizations for Glucose Monitoring (Desai et al.)

# Social Connectedness and Communication Support

- Strong social networks may enhance quality of life for people with chronic illnesses
  - Improves health
  - Reduces chances of developing cognitive decline
  - Prevents earlier death
- But people with chronic conditions experience additional challenges in accessing and maintaining social networks, increasing isolation

# Digital Family Portrait (Rowan et al.)

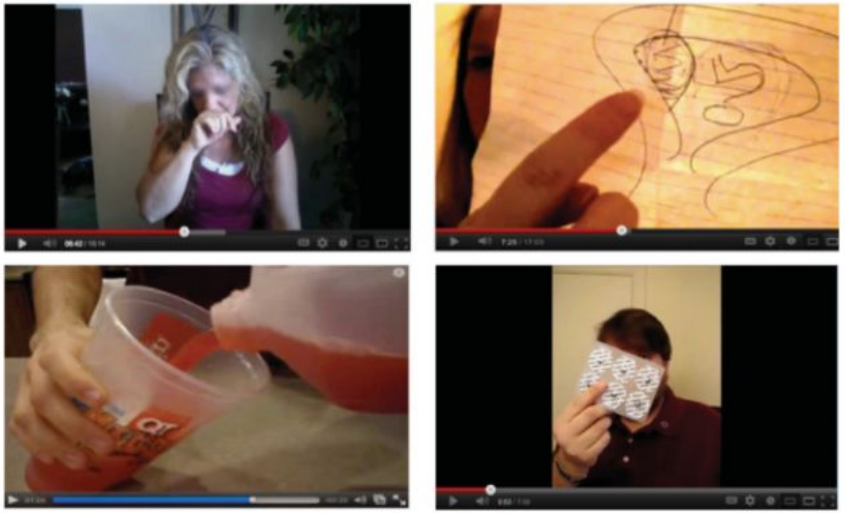
- Supports lightweight awareness between senior adult and adult children
- Provides indications of older adult's activity levels without explicit information
- Intended to encourages communication between family members without feelings of being "watched"

# Digital Family Portrait (Rowan et al.)

# Vlogging for Social Support for Chronic Illness (Huh, et al.)

Study of existing use of health vlogs on YouTube

- Cancer and HIV patients
- Looked at content, comments, development over time, relationships



# Assisted Navigation and Wayfinding Support

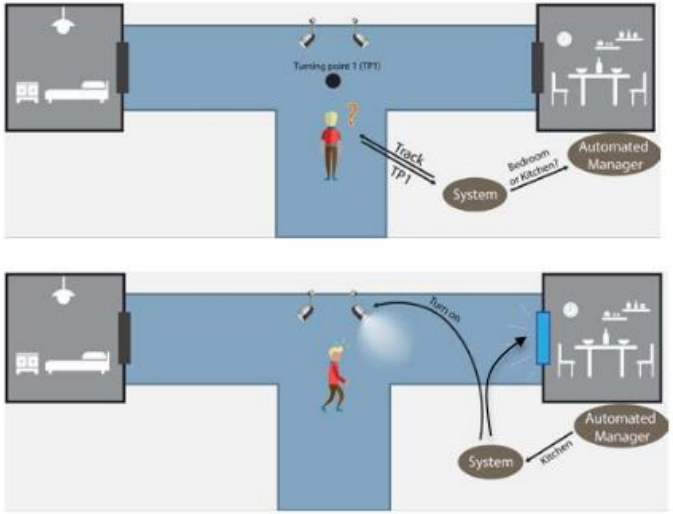
- Mobility can be a substantial challenge for people with chronic illnesses and cognitive disabilities
- Problems with working, driving, walking, or taking transit
- Problems with orientation indoors or outdoors
- Technologies can help support navigation of environments

# Robotic Walker (Thrun)

- Walking support device that includes a robot to physically guide elderly patients in assisted living facilities
- Uses artificial intelligence to help with path planning, tracking other people, and preventing collision
- Includes a touch interface for receiving commands from the individual
- Shows simple directions (e.g., arrows) on a display

# Robotic Walker (Thrun)

# Light Guiding (Ly et al.)




- Sensors track patient with dementia in care facility
- Draws inferences about goal using intelligence
- Shows animated LED tracks to guide patient

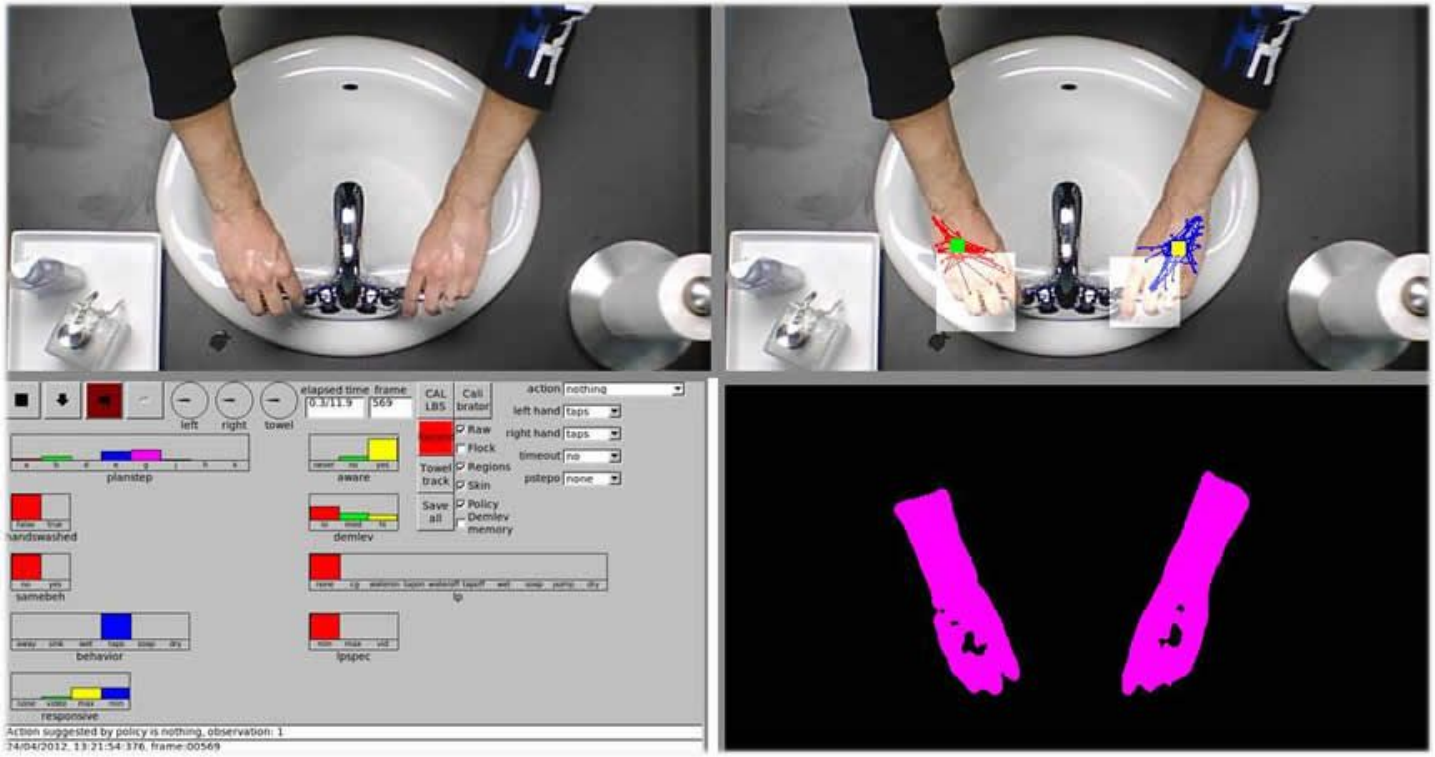
# Prompting and Reminders

- Aimed at assisting cognition for people with cognitive disabilities, memory impairment, or attention problems
- Provide guidance and management services to remind people how to execute activities
- Caregivers are often overburdened and stressed, so systems provide additional support

# COACH (Mihailidis et al.)

- Designed to assist people with severe dementia who have difficulties remembering the proper sequence of ADLs
- E.g., COACH uses video camera to observe user as she attempts to wash hands
- Video image is analyzed to identify current steps (e.g., turning on water, using soap)
- Provides recorded verbal prompt if a problem is recognized

# COACH (Mihailidis et al.)



# SUCCESS AND CHALLENGES FOR PERVASIVE HEALTHCARE

# How to Assess Success?

- Improved health metrics
- Improved quality of life
- Less time in hospital
- Fewer readmissions to hospital
- More/better information for clinicians
- Better understanding of own health
- More independence
- Low burden
- Greater efficiency
- Lowered need for treatment
- Etc.

# Ongoing Challenges for Pervasive Health

- Privacy of sensitive health information
- Reliability of sensor-based technologies
- Overhead of introducing new systems and reluctance to move from analog to digital technologies
- Difficulties of testing and evaluating the effects of technologies on health and wellness

# Development and Evalution

- Many approaches from CSCW and UbiComp are appropriate
  - Participatory Design
  - Contextual Inquiry
  - Distributed Cognition
  - Activity Theory
  - Cultural Probes
  - Etc.
- … but concrete measures of effectiveness remain a challenge

# Evaluation of Health Technologies

- Difficult to measure behavior change
- Difficult to measure effects of social factors
- Ethical challenges of deploying experimental technologies that affect health
- Long-term empirical studies with measurable results are challenging to deploy
  - Legal and safety compliance
  - Cooperation of health organizations

# Technology Approaches for Pervasive Health

Preventative Care

Hospital Care

Chronic Care

- Automated and selective capture and access of health information
- Persuasive technologies for self-monitoring
- Social health

# Technology Approaches for Pervasive Health

Preventative Care | Hospital Care | Chronic Care

- Context-Aware Services and Awareness
- Pervasive Groupware and Collaboration Support
- Record-keeping and Note Taking
- Handling Multiple Activities and Supporting Rapid Context Switching

# Technology Approaches for Pervasive Health

Preventative Care | Hospital Care | Chronic Care

- Pervasive Monitoring
- Social Connectedness and Communication Support
- Assisted Navigation and Wayfinding Support
- Prompting and Reminders

# IFI Course Evaluation 2019

Please fill out the survey - we take your feedback very seriously and use it to improve the course every year.  Thank you!

https://qmsl.uzh.ch/en/9EVTR