Advances in computing and ALS*

Reflections on directions for enhancing the quality of life

Eric Horvitz

Invited Talk
International Symposium on ALS/MND
Birmingham, UK
November 2008

Opportunity

Creative application of computing…
to enhance the quality of life of people with ALS.
Opportunity

Creative application of computing…

- Human-computer interaction
- Machine learning & intelligence
- Connectivity & content
- Robotics

… to enhance the quality of life of people with ALS.
Trends

Content, community, connectivity
Sensing & interaction
Machine learning & reasoning prowess
Computation & memory
Promise of Adaptive Interfaces

- Observe motor skills, channels & affordances
- Optimize layout to minimize effort & frustration
- Track progression and adapt
Example: *Supple Project*

Assessing performance

Gajos, Wobbrock and Weld, 2007
# Understanding Costs & Efficiencies

<table>
<thead>
<tr>
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<th>Device Used</th>
<th>Controlled with</th>
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Gajos, 2008
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Optimizing for Efficiency

Optimization to identify cost-minimizing design

Gajos, 2008
Sizing, Spacing, Layout

Gajos, 2008
Sizing, Spacing, Layout

min widget size \( \frac{1}{2} \) \( \frac{1}{4} \) = \( \frac{1}{8} \)

Gajos, 2008
Search for a Cost-Minimizing Design

Gajos, 2008
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Gaze Tracking

Gajos, 2008

Default UI

Gaze tracking
Gaze Tracking

Default UI

Gaze-tracking

Gajos, 2008
Supple Study

11 motor-impaired participants
- Consistently faster (by 26%)
- Closing significant portion of gap (63%) with healthy subjects.
- 73% fewer errors
- Strongly preferred

Gajos, 2008
ALS: Tracking & Dynamic Optimization

- Observe current motor skills
- Optimize layout & sizing to minimize effort & frustration
- Consider likely clinical trajectories and minimize costs of transition

Gajos, 2008
Models of Progression (courtesy J. Ravits)

- e.g., Focal onset (e.g. right hand): UMN & LMN share same body region
- Independent severities
e.g., Focal onset (e.g. right hand):
UMN & LMN share same body region
Independent severities
Challenges of Gaze-Centric Interfaces
Gaze-Based Interfaces: Opportunities

- Innovate beyond point & dwell
- Toward new UI designs, metaphors
- Adaptive techniques, inference about intent

(video)
New Interaction Metaphors

- Beyond point and dwell
- Rich new languages for input
  - Crossing versus pointing
  - Stereotypical patterns
Example: EyeWrite (Wobbrock, et al.)

(video)
Example: EyeWrite (Wobbrock, et al.)

Perceived Speed

Subjective response

Session number

Perceived Ease of Use

Subjective response

Session number

Perceived Fatigue

Subjective response

Session number
Potential to move a gaze-controlled cursor into the world

- e.g., Directions suggested by *WorldCursor* (A. Wilson)
Longer-term: Beyond the Display

WorldCursor Device

(video)
Machine Learning & Reasoning

Learning & reasoning about goals and needs

- Learns by watching, sensing
- Learns from corpora, patterns by time of day, time since last event / intervention
Machine Learning & Reasoning

Learning & reasoning about goals and needs

- Learns by watching, sensing
- Learns from corpora, patterns by time of day, time since last event / intervention
Learning to predict next words and phrases from rich corpora

- Context, time since last intervention, etc.
- Email store → predictive language model
  (Acero, etc al.)

Predictive language model with correction
Learning to predict next words and phrases from rich corpora

- Context, time since last intervention, etc.
- Email store → predictive language model (Acero, etc al.)

[ I want to ... [vote] [tell] [have] ]

Predictive language model with correction
Learning to predict next words and phrases from rich corpora
- Context, time since last intervention, etc.
- Email store → predictive language model (Acero, etc al.)

I want to vote
Learning to predict next words and phrases from rich corpora

- Context, time since last intervention, etc.
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Predictive language model with correction
Learning to predict next words and phrases from rich corpora

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Predictive language model with correction

[I want to vote for Barak Obama]
[you]
[science]
[going]
[seeing]
Learning to predict next words and phrases from rich corpora

- Context, time since last intervention, etc.
- Email store $\rightarrow$ predictive language model
  (Acero, etc al.)

```
[ I want to vote for Barak Obama
```

Predictive language model with correction
Learning to predict next words and phrases from rich corpora

Dasher: Combining visual flow, with predictive modeling (D. MacKay, et al.)
Machine Learning & Reasoning

Dasher: Combining visual flow, with predictive modeling (D. MacKay, et al.)

(video)
Content, Retrieval, and Experiences

- Web as rich portal
- Conferencing, collaborations, gaming with friends, family, colleagues
- Personalized search
- Simulations, virtual travel
- Presence and interaction virtual worlds
Content, Retrieval, and Experiences

- Access to places and experiences
- Sharing joint trips with friends, family
Content, Retrieval, and Experiences

- Access to places and experiences
- Sharing joint trips with friends, family
Engagement in Virtual Worlds
Research on gaze-directed interactions
(Vickers, Bates, Istance - De Montfort Univ., Leicester)
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Engagement in Virtual Worlds

Research on gaze-directed interactions
(Vickers, Bates, Istance - De Montfort Univ., Leicester)
## Engagement in Virtual Worlds

Research on gaze-directed interactions  
*(Vickers, Bates, Istance - De Montfort Univ., Leicester)*

<table>
<thead>
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<th>Task domain</th>
<th>Control source; task time (s); error count</th>
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<td>Camera movement</td>
<td>50s</td>
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<td>Object manipulation</td>
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<td>Application control</td>
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<td>Communication</td>
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Engagement in Virtual Worlds
Research on gaze-directed interactions
(Vickers, Bates, Istance - De Montfort Univ., Leicester)
Participating in Multiplayer Games

Research on gaze-directed interactions

(video)
Reaching into Other Worlds

(video)
Access to Expressive Media

Plan for rich communication of emotion

Social discourse library of videos and stills for sharing emotions, moods, gestures.

Memories library from video and image photolibrary
Inferring Memory Landmarks: LifeBrowser

Images & videos

Desktop & search activity

Appts & events

Locations

Whiteboard capture

Time

[Diagram showing a timeline with various events and activities, such as presentations, meetings, and notes, represented in a table format with dates and results by time.]
<table>
<thead>
<tr>
<th>Date</th>
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Enabling Creative Expression

Enabling guidance of painting, CAD, sculpting machinery, lathes, other artistry and crafts.

“These days, with only her eye movement unaffected by the disease, Peggy continues to live a full and creative life, enjoying time and laughter with her beloved friends, family, and caregivers.”
Longer-Term: Assistive Robotics

- Assistance and action at a distance
- Exoskeletal components
  - Wearable exoskeletons
    - e.g., Dynamic neck brace
Assistance and action at a distance

Exoskeletal components

Wearable exoskeletons

*e.g.*, Dynamic neck brace guided by gaze

(Goal: enable support, natural turning, nodding, etc.)
Longer-Term: Assistive Robotics

- Advances in multiple arenas
- Could enable assistance for patients and caretakers
Progress on "Integrative Intelligence"

- Richer dreams of fluid interaction
- Leveraging a tapestry of components

- NLP
- Motion control
- Localization
- Speech generation
- Speech recognition
- Planning
- Vision
- Learning
- Inference
Advances: Gentle Robots in "Open Worlds"

- Ongoing learning to generalize and adapt

(video)

Klingbeil, Saxena, Ng, et al
Advances: Gentle Robots in "Open Worlds"

Situated Intelligence: Bohus, Horvitz, et al.
Advances: Gentle Robots in "Open Worlds"

Situated Intelligence: Bohus, Horvitz, et al.
Toward creative application of interaction, intelligence, robotics, content to enhance the quality of life at all phases of progression.