

Rapid Prototyping of Accessible Interfaces With Gaze-Contingent Tunnel Vision Simulation

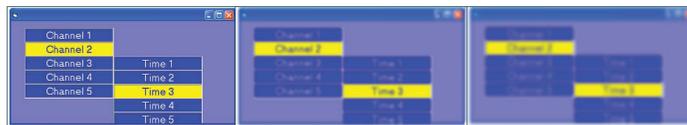
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Challenges in Including Users with Disabilities in UCD

- In theory, incorporating the perspective of users with disabilities throughout the user-centered design (UCD) process should address **accessibility** criteria in the development of technologies [Preece+, '15].
- Problem: Inclusion in UCD is difficult to practice.**
 - Arranging user trials to test the design comes with high costs and effort.
 - Diverse range of abilities complicates the practice of evaluation – hard to find a sample of participants and identify representative needs.
 - E.g. Levels of visual acuity or field loss vary among low vision (LV) individuals [Openshaw+, '07].

Simulation-Based Approach

- How to approach the problem in including representative users for user trials and evaluation?
- Simulation techniques** are available for developers to see or experience possible interaction patterns caused by particular disabilities.



Interface visualized to match predicted perception of different levels of visual acuity loss [Biswas+, '12]

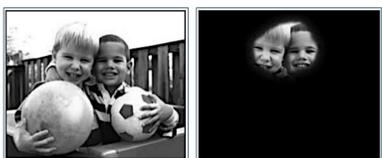


Simulation glasses to experience the effects of vision loss [Goodman+, '13]

- BUT how can the simulation be incorporated as part of the design process?** Need to assess its role in **Identify – Design – Evaluate Cycle**

Goal: Exploring the Use of Simulation in the Design Cycle

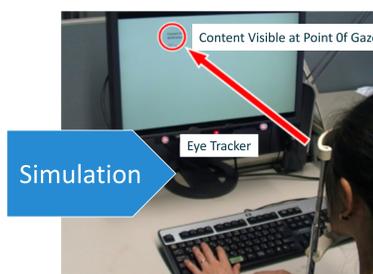
- Motivation:** Assess the role of disability simulation for developers to take into account when running the design cycle of accessible interfaces
- Feature:** Propose a gaze-contingent interface to simulate the effect of “**tunnel vision**” on **(1) interface prototyping** and **(2) testing** of Navigation Aid for LV users with limited peripheral vision



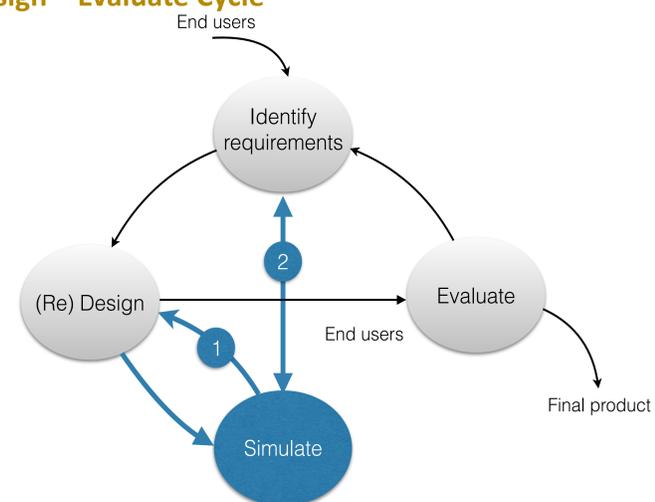
Perception of Target Users: **Retinitis Pigmentosa (RP)** [Mandal, '13]

How the users would react to the proposed design?

ID	Navigation Aid
RA	
RL	
RI	
AL	
AA	



Sighted individuals react to the design under 5-Degree Simulated Field of View



Incorporation of Simulation: **paths (1) & (2)** added in the common UCD process [Preece+, '15]

- Methodology:** Investigate how our tunnel vision simulation reflected on the interface can be used to affect the behaviors and design and evaluation input of sighted individuals
 - Results of validation studies were compared between participants under simulation and those with RP symptoms (= limited peripheral vision)

Studies Compared Between Simulated Tunnel Vision and RP

1. Gaze Movement Study

Purpose: Whether our simulator elicited similar gaze patterns as those observed under RP
Method: Collect gaze positions in visual search tasks of identifying target regions on the screen – analyzing characteristics of saccadic eye movements that exceed outside of tunnel visual fields [Luo+, '06]

2. Empirical Study 1: Interface Testing

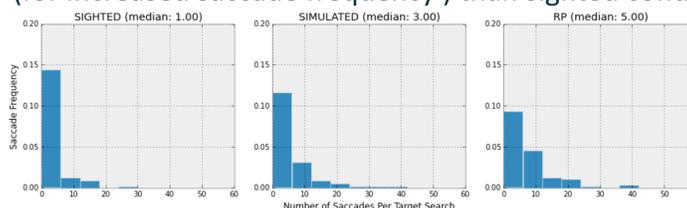
Purpose: How simulated users would react to the “look and feel” of five prototypes in comparison to that of RP
Method: Survey ratings of each prototype based on attributes such as ease of task completion and preference

3. Empirical Study 2: User Testing

Purpose: Grasp simulated user feedback, in comparison to that of RP, via evaluation of the experience in performing online shopping with the proposed navigation aid
Method: Qualitative/quantitative research against performance criteria

Findings: For Rapid Prototyping – Testing Phases

RP behaviors of gaze patterns appeared **more consistent with simulated tunnel-vision** (for increased saccade frequency) than sighted condition.



Chi-Squared Distance Values:
 Between sighted & RP histograms (d = 18.26) - p = 001
 Between simulated & RP histograms (d = 5.76) - p = .218

Enabled **representative user trials with lower cost** to observe the effect of interfaces - similar basic interface problems were mentioned by sighted under simulation and RP individuals (PrototypeID RL favored for ease of task and ease of perceiving navi. info.)

- Potential for quick and cheap prototypes to be generated while factoring in the effect of visual practices, as in the path for **(1)**.

Enabled controlled **test conditions to address objective/subjective feedback** of representative users, as in the path for **(2)**

- For both simulated and RP groups, reviewed to limit cognitive load for layout understanding when using the aid to effectively navigate the web page.

Future Work

- Investigate the effects of different simulation-based techniques from the developer viewpoints.
- Need to support configuration for multiple visual conditions.

[Preece+, '15] Preece, Sharp, Rogers: “Interaction design – beyond human computer interaction”
 [Openshaw+, '07] Openshaw, Branham, Heckenlively: “Understanding cone dystrophy”
 [Biswas+, '12] Biswas, Robinson, Langdon: “Designing inclusive interfaces through user modeling and simulation”
 [Mandal, '13] Mandal: “What is Retinitis Pigmentosa?”
 [Goodman+, '13] Goodman-Deane, Waller, Collins, Clarkson: “Simulating vision loss: what levels of impairment are actually represented?”
 [Luo+, '06] Luo, Peli: “Patients with tunnel vision frequently saccade to outside their visual fields in visual search”