A Large-Scale Mixed-Methods Analysis of Blind and Low-vision Research in ACM and IEEE

Yong-Joon Thoo¹, Maximiliano Jeanneret Medina¹, ², Jon E. Froehlich³, Nicolas Ruffieux¹ and Denis Lalanne¹

¹Human-IST Institute, University of Fribourg
²HEG Arc, HES-SO // University of Applied Sciences Western Switzerland
³University of Washington

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<table>
<thead>
<tr>
<th>Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field-, technology-, method-agnostic review</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General</th>
<th>Focused</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All abilities</strong> (e.g., visual, hearing, motor, cognitive)</td>
<td><strong>Blind and/or Low-vision (BLV) People</strong></td>
</tr>
<tr>
<td>Concept¹ (e.g., accessibility)</td>
<td>Na, technology or device³</td>
</tr>
<tr>
<td><strong>Goal/Task</strong></td>
<td><strong>Methods²</strong></td>
</tr>
</tbody>
</table>

1Mack et al. CHI'21; Sarsenbayeva et al. *International Journal of Human-Computer Studies* 2023
2Brulé et al. CHI'20
3Bhowmick and Hazarika *Journal on Multimodal User Interfaces* 2017
Context
Field-, technology-, method-agnostic review

RQ1
Research areas

RQ2
Communities of focus

RQ3
Technological trends*

RQ4
Interaction modalities

*Not part of the presentation
Methodology
Bibliometric Workflow

1. Research design
2. Compilation of bibliographic data
3. Analysis
4. Visualization
5. Interpretation

Science map:

Zupic and Čater Organizational Research Methods 2015
Methodology
Research design (1)

Bibliometric
Documents Bibliographic Coupling Analysis (DBCA)

Quantitative
Frequency counting of terms

Programmatic

BLV:

Conceptual framework
Deductive and inductive

Facet | Category
---|---
Research Context | Issue addressed Contribution type
Delineating the Field of Research (RQ1) | Research area
Communities of Focus (RQ2) | Community of focus Age category
Technological Trends (RQ3) | Interactable computer system Technology Device
Interaction Modalities (RQ4) | Vision use strategy Input modality / Output modality
## Methodology

Compilation of bibliographic data (2)

<table>
<thead>
<tr>
<th>Search Terms*</th>
<th>Venue / Document Type</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>blind</td>
<td>low-vision</td>
<td>deaf-blind</td>
</tr>
</tbody>
</table>

3,378 papers with bibliographic references and # citations (incoming) → N=3,193 (after screening)

*Adapted primarily from Brulé et al. CHI’20; Mack et al. CHI’21; and inspired by Sharif et al. ASSETS’22. Simplified for clarity. Retrieved the 7th of April 2023.
Methodology
Analysis (3) & Visualization (4)

Input

N=3,193
with bibliographic references and # citations (incoming)

N=880
with Title, Abstract and Author Keywords (TAK)

Processing*

Bibliometric processing:
1. Filtering (norm. citation)
2. DBCA
3. Clustering

Programmatic processing:
1. Counting terms in TAK
2. Consolidation (manual)
3. Counting terms in TAK

Visualization

Science map (VOS)
N=880

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cluster</th>
<th>Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Antol et al. ICCV 2015</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>Bigham et al. UIST 2010</td>
</tr>
</tbody>
</table>

UpSet plot
N=880

*Data cleaning details and tools are described in the paper
Methodology
Interpretation (5) - a two-level iterative analysis

1) First-level Analysis (N=880)
   a) **Five clusters** obtained after DBCA

   ![Science map (VOS)](image)

<table>
<thead>
<tr>
<th>Cluster</th>
<th>N=880 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_A</td>
<td>95 (10.8)</td>
</tr>
<tr>
<td>C_B</td>
<td>166 (22.4)</td>
</tr>
<tr>
<td>C_C</td>
<td>176 (20)</td>
</tr>
<tr>
<td>C_D</td>
<td>403 (45.6)</td>
</tr>
<tr>
<td>C_E</td>
<td>40 (4.5)</td>
</tr>
</tbody>
</table>

   ![Science map (VOS)](image)

   b) **Four research areas** obtained after tagging paper’s TAK

<table>
<thead>
<tr>
<th>Research Area</th>
<th>N=880 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA_1</td>
<td>280 (31.8)</td>
</tr>
<tr>
<td>RA_2</td>
<td>195 (22.2)</td>
</tr>
<tr>
<td>RA_3</td>
<td>54 (6.1)</td>
</tr>
<tr>
<td>RA_4</td>
<td>331 (37.6)</td>
</tr>
<tr>
<td>RA_Other</td>
<td>20 (2.3)</td>
</tr>
</tbody>
</table>

2) Second-level Analysis (N=100)

   **In-depth qualitative analysis** based on our conceptual framework

<table>
<thead>
<tr>
<th>Facet Category</th>
<th>Facet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Context</td>
<td>Issue addressed Contribution type</td>
</tr>
<tr>
<td>Delineating the Field of Research (RQ1)</td>
<td>Research area</td>
</tr>
<tr>
<td>Communities of Focus (RQ2)</td>
<td>Community of focus Age category</td>
</tr>
<tr>
<td>Technological Trends (RQ3)</td>
<td>Interactable computer system Technology Device</td>
</tr>
<tr>
<td>Interaction Modalities (RQ4)</td>
<td>Vision use strategy Input modality / Output modality</td>
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</tbody>
</table>

N=100

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td>RA_1</td>
<td>32</td>
</tr>
<tr>
<td>RA_2</td>
<td>22</td>
</tr>
<tr>
<td>RA_3</td>
<td>6</td>
</tr>
<tr>
<td>RA_4</td>
<td>38</td>
</tr>
<tr>
<td>RA_Other</td>
<td>2</td>
</tr>
</tbody>
</table>
Results and Discussion
Delineating the Field of Research

Cluster
- A (N=95, 10.8%)
- B (N=166, 18.9%)
- C (N=176, 20%)
- D (N=403, 45.8%)
- E (N=40, 4.5%)

Quantitative: Bibliometric & Programmatic

A & B: app; accessibility

C: access; interact; tactile

E: model; app; deep learning

D: system; navigation; environment

Antol et al. (2015)
Bingham et al. (2010)
Jala et al. (2021)
Masud et al. (2022)
Cardillo et al. (2022)
Results and Discussion
Delineating the Field of Research

BLV Research (N=880)

Research Area

Accessibility at Home & on the Go (N=280, 31.8%)
Non-Visual Interaction (N=195, 22.2%)
Education (N=54, 6.1%)
Orientation & Mobility (N=331, 37.6%)

Major Topics

Visual Question Answering
Visual media description
Assistive wearable and mobile technologies

Qualitative

1Antol et al. ICCV’15; Bigham et al. UIST’10; Brady et al. CSCW’13; Gurari et al. CPVR’18
2Gleason et al. CHI’20; Morris et al. CHI’16; Wu et al. CSCW’17; Stangl et al. CHI’20
3Ahmetovic et al. CHI’20; Neto et al. IEEE THMS 2017
Results and Discussion
Delineating the Field of Research

BLV Research
(N=880)

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Major Topics</th>
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</thead>
<tbody>
<tr>
<td>Accessibility at Home &amp; on the Go (N=280, 31.8%)</td>
<td>Speech¹</td>
</tr>
<tr>
<td>Non-Visual Interaction (N=195, 22.2%)</td>
<td>Touch²</td>
</tr>
<tr>
<td>Education (N=54, 6.1%)</td>
<td></td>
</tr>
<tr>
<td>Orientation &amp; Mobility (N=331, 37.6%)</td>
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¹Azenkot and Lee ASSETS’13; Branham and Roy ASSETS’19; Leporini et al. OzCHI’12; Pradhan et al. CHI’18
²Holloway et al. CHI’18; Kane et al. CHI’11; Oliveira et al. ASSETS’11; Ozioko et al. IEEE TNSRE 2020
Results and Discussion
Delineating the Field of Research

BLV Research (N=880)

Research Area

Accessibility at Home & on the Go (N=280, 31.8%)  Non-Visual Interaction (N=195, 22.2%)  Education (N=54, 6.1%)  Orientation & Mobility (N=331, 37.6%)

Major Topics

1. Brulé et al. CHI’16; Metatla et al. CHI’19 & 20; Thieme et al. DIS’17
2. Kane and Bigham SIGCSE’14; Koushik et al. CHI’19
Results and Discussion
Delineating the Field of Research

BLV Research (N=880)

Research Area
- Accessibility at Home & on the Go (N=280, 31.8%)
- Non-Visual Interaction (N=195, 22.2%)
- Education (N=54, 6.1%)
- Orientation & Mobility (N=331, 37.6%)

Major Topics
- Accessibility at Home & on the Go
  - Qualitative
    - Localization, detection, pathfinding
    - Outdoor/indoor environments
    - Navigation behaviors and preferences

1, 2 Ahmetovic et al. MobileHCI’16; Au et al. IEEE TMC 2013; Bai et al. IEEE TMC 2017; Sato et al. ASSETS’17
3 Azenkot et al. CHI’11; Colley et al. CHI’20; Williams et al., ASSETS’13 & 14
Results and Discussion
Communities of Focus

Qualitative

Quantitative: Programmatic

UpSet plot
N=880

→ Reporting participants’ visual abilities
Results and Discussion
Interaction Modalities

Qualitative

- Use of residual vision
- Provide more control to users
Conclusion

- Delineation of the most prominent research areas related to BLV across ACM and IEEE
- An evidence-based discussion of current gaps and opportunities for future work
- Open-source programmatic analysis to support our two-level analysis
Thank you

https://github.com/human-ist/BLV-research-analysis

Yong-Joon Thoo
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