

### **Accessibility Computing for the Blind and Low Vision**

**Topic Talk CTHCI'24: Sarah Sahabi** 







## What is Accessibility Research?

on both the adaptation of existing systems and designing and developing technology that is usable to all, regardless of their physical, cognitive, or communication, and interaction.

Accessibility research in HCI is a multidisciplinary research field that focuses situational limitations. It involves understanding and addressing the **unique** needs of users with disabilities to ensure equitable access to information,



00 000 00 00 000 0 0 0.0 0 0 • • · · · · 00 00 0 0 0 0 00 00 0 . . ( • 0.0 0 00 0 00 000 000 6 6 5 11 0.00 ece 0 0 0 0.0 0 0 0 ( ( 66 00 00 00 ... ( • • • • ( . 0 C 0 0 0 \* 000 0 • 00 \*\*\* \*\*\* \* \* \* 0 00 0 6 0 6 66 0 0 00 ¢ ... 66 ... 10 0 • 6 0 000 000 00 .. .. 00 .. 00 000 ( c e e (() 666 F. ( 000 1 0 0 .. e 00 666 ( ( ( e • 11

0 00 e e €€€ € 0 00 00 • 1

000 00 000 000 0 0 00 000 000 00 0

...

6) 0

° e

•

0

0

00

66 6 6.6 0 0 6.6 1 000 00 6 00 6.6 666 ¢ 6 11 . 0

> 1 00 \* \* 0 6 .. ..

6.6

EE

666

00

... \* .. eee e e .. ••• 6.0 . 6.0 8) B) · · · · . € € .... 10 • 000 5 600 . • . \* 00 000 . \* .. ... 6

( (

0

0 0 0

.

6 6

. . 0 0 0 0 0 0 0 93 8.0 000 ...

. 6.6 • \$10 100 • 0 0 0 6.5 0 . " 6 11 • 1 1 00 . ... 0 6 6 e • .. 0 0 ... 0 . 00 6.0 ( ) ( \* = 666 666 6 6 . 1 6 ... 00 C 6 • . . . € € 0 0 . ( 6 0 . . 11 • 00 • ... 0 . 666 G ( .. 0 0 . • 6.6.6 . . 1 T • 000 1 E . ... \* \* 8 6 • • • • 6 6 6 6 6 e e • <

111

...

0

00







### Problems

- small device size
- text that is difficult to read and understand
- complicated device menus
- missing meta-data
- lack of closed captioning

[Kane et al., Freedom to Roam, ASSETS'09], [Zhang et al., Screen Recognition, CHI'21], [May, Enhancing Non-Speech Information, ASSETS'23]





### Within the Last Years...



CTHCI'24 Topic Talk: Accessibility Computing for BLV (Sarah Sahabi) 7



[Mack et al., Accessibility Research, CHI'21]











### **Issue Addressed**

### Papers w/ Code

Digital Access	186
	(36.8%)
Understanding Users	139
	(27.5%)
Physical Access	105
	(20.8%)
Independence	93 (18.4%)
Communication	81 (16.0%)
Behavior Change	39 (7.7%)
Other	59 (11.7%)

[Mack et al., Accessibility Research, CHI'21]

Community of Focus	Papers w/ Code
BLV	220
	(43.5%)
Motor/Physical	72 (14.2%)
DHH	57 (11.3%)
Cognitive	46 (9.1%)
General Disability	46 (9.1%)
Older Adult	45 (8.9%)
Autism	31 (6.1%)
IDD	14 (2.8%)
Other	46 (9.1%)



## Why aren't we there, yet?

- Diverse user needs [Stephanidis et al., Uls for All, 2001]
- User representation in accessibility research [Sears et al., Representing Users, CHI'11]
- Lack of awareness from designers and developers  $\bullet$









## **BLV Research in HCI**

- funding mechanisms
- popularity of BLV people in public disability discourse
- concreteness of visual accessibility problems to HCI researchers

[Mack et al., Accessibility Research, CHI'21]

Community of Focus	Papers w/ Code
BLV	220
	(43.5%)
Motor/Physical	72 (14.2%)
DHH	57 (11.3%)
Cognitive	46 (9.1%)
General Disability	46 (9.1%)
Older Adult	45 (8.9%)
Autism	31 (6.1%)
IDD	14 (2.8%)
Other	46 (9.1%)



## **BLV Research in HCI**

- Two main sub-problems:
  - Digital Access
  - Physical access
- (48.2% of 220 BLV papers)

### • -> increasing digital access is the most common issue addressed for BLVs

[Mack et al., Accessibility Research, CHI'21]





## **Digital Accessibility**

# **Digital accessibility** means that **websites, tools, and technologies** are designed and developed so that people with **disabilities** can use them.

World Wide Web Consortium (W3C)

















# **Persisting Problems of Digital Accessibility**

- Despite existing solutions, some problems persist:
  - Hard to learn to use screen readers
  - Too slow because too fine-grained or too broad
  - Inaccessible content (missing meta-data, erroneous labels, not representable)
  - Privacy and security concerns
  - Awkwardness when used in public

[Ashok et al., W4A'15, Capti-Speak], [Lazar et al., Screen Reader Frustrations, IJHCI'07], [Williams et al., Supporting quality alt-text, W4A'22]





### **Problem: Using screen readers is hard to learn and takes** too much time





## **Capti-Speak**

- Approach: conversational interactions
  - dialog model that enables speech input for browsing actions and navigating through website to augment the usage of screen readers
  - Faster, easier, significantly more usable and efficient

e.g. 'move to the box' search box'

**Capti-speak:** a speechenabled web screen reader

Vikas Ashok, Yevgen Borodin, Yury Puzis, and I. V. Ramakrishnan, W4A'15









- Identified in a study that both screen readers and virtual assistants come with advantages and disadvantages
- Built a prototype that extends a voice-based virtual assistant with screen reader-inspired features
- Enables to switch between granularities

**VERSE:** Bridging **Screen Readers** and Voice **Assistants for Enhanced Eyes-Free Web Search** 

Vtyurina, Alexandra & Fourney, Adam & Morris, Meredith & Findlater, Leah & White, Ryen. ASSETS'19











### and would not be part of a smart speaker implementation.

~

x ^ - & & ESE AM

ĸ

日白白足





### Personalised Conversations

- Conversational interactions = anthropomorphization?
- Voice assistants in different roles: friend, butler, expert, and caregiver
- Finding: Conversational Agents should be adaptive like AI and customizable like a screen reader

Speaking with My Screen **Reader:** Using **Audio Fictions to** Explore Conversational Access to Interfaces

Mahika Phutane, Crescentia Jung, Niu Chen, and Shiri Azenkot. ASSETS'23











### **Problem: Digital content is inaccessible due to missing** meta-data or erroneous labels





### **Alt-text Generation**

- Solutions:
  - based on image type [Mack et al., Alt Text Authoring, ASSETS'21]

-> higher quality alt-texts

# Tool assisting in writing alt-text through empirically acquired suggestions

### • Al approaches for automated meta-data generation from Apple and Meta:

• Pixel-based approach for UI meta-data [Zhang et al., Screen Recognition, CHI'21]

• Computer vision-based approach for alt-text [Wu et al., Automatic Alt-text, CSCW'17]



# Problem: Digital content is inaccessible because it cannot be described in (conventional) alt-text



## mageAssist

- Solutions:
  - exploring images via touch by providing short descriptions to individual image parts
  - Hierarchical structure allows for even deeper exploration

ImageAssist: **Tools for** Enhancing **Touchscreen-Based Image Exploration Systems for Blind** and Low Vision Users

Vishnu Nair, Hanxiu 'Hazel' Zhu, and Brian A. Smith. CHI '23















### ImageAssist



### menu & beacon







hints

Image: Second Story Sunlight by Edward Hopper (1960)



# **Shape Changing Tactile Uls**

- Solution:
  - refreshable tactile displays to communicate animations or graphs





[Holloway et al., Refreshable Tactile Displays, ASSETS'22]



oscilloscopes, and video cameras to provide a tactile depiction of



## Physical Accessibility

Physical accessibility is the design and implementation of physical with their environment.



### interfaces and assistive technologies that facilitate interaction, navigation, and spatial awareness, enabling all users to effectively perceive and interact



### Navigation & Wayfinding

### **Object Recognition**







![](_page_30_Picture_0.jpeg)

![](_page_31_Picture_0.jpeg)

![](_page_31_Picture_2.jpeg)

![](_page_31_Picture_3.jpeg)

![](_page_31_Picture_4.jpeg)

![](_page_32_Picture_0.jpeg)

### Conclusion

- Wide range of challenges in accessibility research for BLV individuals
- Trends towards automation, personalisation, and providing support for developers
- Al and, specifically, computer vision play an increasingly important role • -> What opportunities arise from this?
- - Although rising in relevance, many problems remain unsolved...

![](_page_33_Picture_7.jpeg)