Robotics and Assistive Technology

SoNIC Summer Research Workshop*

Guest Lecturer: Lucy Jiang
Instructor: Tapomayukh "Tapo" Bhattacharjee
TAs: Ruolin Ye, Chenxi Ji, Shubhangi Sinha, Marcus Lee, Nayoung (Sarah) Ha, Lucy Jiang

EmPRISE Lab
EMpowering People with Robots and Intelligent Shared Experiences

Cornell Bowers CIS
Computer Science

*SoNIC is funded in part by the Hopper-Dean Foundation and the National Science Foundation

Guest Lecture on Accessibility Research

Background Information

- What is disability?
- Language etiquette
- Models of disability
- Intro to accessible technology
  - Captions
  - Audio description

Accessibility Research

- Working with, not just for, disabled users
- Highlighting some research projects
  - Image accessibility
  - 360° video accessibility
- Accessibility in robotics
- How can you get involved?

What is disability?

1.3 billion people have a disability –
that's 16% of the world's population

https://www.who.int/news-room/fact-sheets/detail/disability-and-health

Types of Disabilities

- **Vision disabilities**
  - Blindness, low vision, etc.
- **Hearing disabilities**
  - d/Deafness, hearing loss, etc.
- **Intellectual disabilities**
  - ADHD, autism, etc.
- **Mental health conditions**
  - Depression, anxiety, etc.
- **Chronic conditions**
  - Cancer, diabetes, rare diseases, etc.
- **Mobility disabilities**
  - More on the next slide

This image was used with permission from the DO-IT Center and is available to others at uw.edu/doit/resources/line-drawings.

https://www.cdc.gov/ncbddd/disabilityandhealth/disability.html

Mobility Disabilities

- Can be due to different causes
  - Neurodevelopmental conditions (e.g., cerebral palsy - CP)
  - Acquired injuries in adulthood (e.g., spinal cord injury - SCI)
  - Degenerative diseases (e.g., multiple sclerosis - MS)
  - Chronic musculoskeletal problems
  - Aging
- Can be temporary or permanent
  - Experiences and symptoms can vary from day to day
- Impacts
  - Access to places, buildings, rooms, activities, etc.
  - Activities of daily living

https://www.washington.edu/doit/mobility-impairments

Language Etiquette

Dos

Identity-first

✅ Disabled people
✅ The disabled community

Person-first

✅ People with disabilities
✅ Person who is…

Don’ts

❌ Confined to a wheelchair
❌ Handicapped
❌ People who “suffer” from…

How can we think about disability?

- **Medical model:** disabled people are viewed as having something "wrong" with them or that they can be "fixed"
- **Social model:** disability comes from a mismatch between people and the environments and interfaces that they interact with

https://www.123rf.com/photo_182735572_inaccessible-environments- abstract-concept-vector-illustration.html

https://www.disabilitynottinghamshire.org.uk/index.php/about/social-model-vs-medical-model-of-disability/

What is accessibility and accessible technology?

Accessibility (often shortened to a11y) is the practice of making information, activities, and / or environments sensible, meaningful, and usable for as many people as possible

Accessible technologies are products, equipment, and systems that enhance learning, working, and daily living for persons with disabilities

https://www.seewritehear.com/learn/what-is-accessibility/
https://www.atia.org/home/at-resources/what-is-at/

How can technology both **enable** and **disable** people?

https://cdn.mos.cms.futurecdn.net/7eSMkuACmGVfyPHX8RftGL.jpg

Screen Readers

- **Screen reader**: a software that allows blind or low vision users to read the text on a screen with a speech synthesizer or braille display
- Apple users have **VoiceOver** built in to iPhones and Macs
- Android users have **TalkBack** built in to Android phones
- Windows users often use **Nonvisual Desktop Access** (NVDA)

https://www.afb.org/blindness-and-low-vision/using-technology/assistive-technology- products/screen-readers

Automatic Captions

- YouTube
  - Average accuracy rate is around 60-70%
- Zoom (Otter.ai)
  - Average accuracy rate is around 83%
  - Major variability across different conditions
- Education
  - Schools are legally required to provide captioning as an accommodation
  - 80% of students who use captions are not DHH

https://itss.d.umn.edu/centers-locations/media-hub/media-accessibility-services/captioning-and-captioning-services/correct
https://www.airgram.io/blog/otter-ai-review
https://www.3playmedia.com/blog/problem-using-auto-captions-education/

Auto vs. Manual Captions on YouTube

https://www.youtube.com/watch?v=mhNcztyXySM

https://www.youtube.com/watch?v=FU9J6mrKE28

The Power of High Quality Captions

A screenshot of Tom Scott making a pun, where the captions have the words “much room” in superscript above the word “mushroom” and the thumbnail shows that this is the most replayed section of the video

Audio Descriptions

- **Audio description (AD)**: the descriptive narration of key elements of live theater, television, movies, and other media
- Who benefits?
  - Blind and low vision people
  - People who cannot watch action scenes due to motion sickness
  - People who are washing the dishes
  - People who are driving

https://adp.acb.org/ad.html

https://www.youtube.com/watch?v=7-XOHN2BWG4

Working with Disabled Users

- Strengths-based approach: presume competence
  - Everyone has the potential to learn, think, and understand
- Ensure that your study is as accessible as possible
  - **Procedure**: screen-reader accessible forms, sign language interpreters, etc.
  - **Facility**: accessible room, captions enabled on Zoom, etc.
  - **Logistics**: accounting for barriers to transportation or inflexibility in scheduling
- **Not all disabled people are the same!**
  - Just because something works for someone doesn't mean it works for someone else

Content adapted from slides by Dr. Elaine Short and a book chapter by Lazar et al.
https://drive.google.com/file/d/1vxgyVOmcwNHV51ZysW-AgDXNpXRdrS0K/view
https://www.sciencedirect.com/science/article/abs/pii/B9780128053904000169

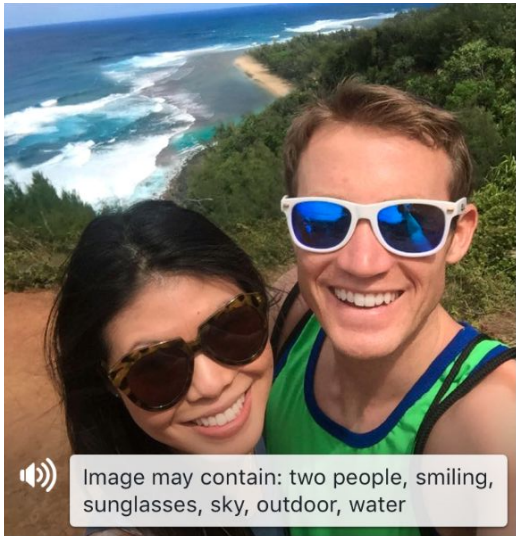
Applications of Artificial Intelligence

- Artificial intelligence can be used to provide access for lots of things
  - Image descriptions
  - Closed captions
  - Even plain old information!
- But, we need to think about the quality of access that AI can provide
  - Consulting disabled people for their thoughts about quality is super important

AI-Generated Image Descriptions

- Automatic image descriptions: vague and broad descriptions that only give categories rather than details

2017



2022

Photo shared by Cristiano Ronaldo on November 18, 2022 tagging @portugal. May be an image of 1 person and standing.

https://www.instagram.com/p/ClGmhcqo3HE/

"Automatic Alt-text" by Wu et al.
https://dl.acm.org/doi/10.1145/2998181.2998364

360° Video Accessibility

- **How do we convey visual immersion to blind / low vision users?**
  - Similar to traditional audio description, use precise wording and include ample detail
  - Utilize **spatial audio** to both improve immersion and guide users in the 360° space
  - Integrate haptic and tactile elements
  - Indicate what **POV** the video is portrayed in (e.g., first person → "you")
- We explored this question by interviewing:
  - Blind and low vision AD consumers
  - Sighted AD creators (including some people who wrote the AD for your favorite Netflix shows!)
  - Blind and low vision AD creators / audio engineers

"Beyond Audio Descriptions" by Jiang et al.
https://lucjia.github.io/research

Beyond Audio Description: Exploring 360° Video Accessibility with Blind and Low Vision Users Through Collaborative Creation

Accessible 360° Video Prototype

Accessibility in Robotics

- Work with end users to better understand their needs
  - Consult experts before building something!
- Design for a user's **abilities** - this helps us create systems that leverage the full range of human potential
  - BLV people often already have white cane skills that could be enhanced with technology, rather than replaced
  - People may have multiple disabilities
    - If a user is deafblind, the feedback could be augmented with more tactile elements (Braille, vibrations, etc.)
    - If someone has limited hand and arm mobility, the cane could be made easier to hold / have wheels so it can be pushed

"Ability Based Design" by Wobbrock et al.
https://dl.acm.org/doi/10.1145/1952383.1952384

How can you get involved?

- Reach out to anyone on the teaching team if you're interested in learning more!
  - Tapo's lab focuses on developing robotic technologies for people with mobility limitations to assist them with activities of daily living (ADLs)
  - My advisor's lab focuses more on digital accessibility for BLV folks
- Check out the following organizations / conferences
  - CMD-IT/ACM Richard Tapia Celebration of Diversity in Computing Conference: annual conference for promoting and celebrating diversity in computing
  - AccessComputing: organization dedicated to supporting and increasing representation of disabled people in computing
  - Teach Access: holds an annual "study away" program to learn more about a11y in industry

Citations

[1] https://www.who.int/news-room/fact-sheets/detail/disability-and-health
[2] https://www.disabilitynottinghamshire.org.uk/index.php/about/social-model-vs-medical-model-of-disability/
[3] https://www.seewritehear.com/learn/what-is-accessibility/
[4] https://www.atia.org/home/at-resources/what-is-at/
[5] https://www.afb.org/blindness-and-low-vision/using-technology/assistive-technology-products/screen-readers
[6] https://itss.d.umn.edu/centers-locations/media-hub/media-accessibility-services/captioning-and-captioning-services/correct
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[8] https://www.3playmedia.com/blog/problem-using-auto-captions-education/
[9] https://adp.acb.org/ad.html
[10] https://drive.google.com/file/d/1vxgyVQmcwNHV51ZysW-AgDXNpXRdrS0K/view
[11] https://www.sciencedirect.com/science/article/abs/pii/B9780128053904000169
[12] https://dl.acm.org/doi/10.1145/2998181.2998364
[13] https://lucjia.github.io/research
[14] https://dl.acm.org/doi/10.1145/1952383.1952384

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