Accessible Computing Research for Users who are Deaf and Hard of Hearing (DHH)

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DHH Auditory Issues

• Links
  – Accents/Intonation
  – Listening Quality
  – Listening Fatigue
DHH Access
Sensory Enhancement

• Assistive Listening Devices
  – Hearing Aids
  – Bone Implants
  – Cochlear Implants
  – FM/Bluetooth Systems
  – Noise cancelling Systems
Assistive Listening Devices

**Hearing Aids**
- Amplify specific frequencies

**Cochlear Implants**
- Stimulate nerves on the cochlea

**Research Directions:** Signal processing to boost specific frequencies, identify speech sounds, and filter background noise. Social science research on acceptance, abandonment, and outcomes.
DHH Visual Access Issues

• Visual Access Demonstrations
  – Visual Noise
  – Divided Gaze
  – View of lecture and captions
  – View of lecture and interpreters

• Visual Access
  – Direct instruction (signing)
DHH Access
Sensory Transformation

• Transform: Audio to Visual/Tactile Info
  – Non-Speech Information
    • Personal notification - Audio to Visual/Tactile
      – Watches, Pagers, Enhanced captions, ….
    • Mass notification – Audio to Visual
      – Fire alarms, Emergency sirens, ….
  – Speech
    • Transcript/Captions: Speech to Text
      – Off-line, Real-Time, Enhanced
    • Sign Language Interpreters: Speech to Sign
      – Off-line, Real-Time
Audio Notification

- Identify ambient sounds
  - Baby crying, emergency siren
  - Conveying musical information

Research Directions:
- Audio-detection and classification algorithms
- Conveying sound information through other channels (visual, tactile)
- Methods for conveying location of sounds
- Design of displays or wearable devices

http://dx.doi.org/10.1145/2661334.2661410
Off-Line Captioning/Subtitles

For videos posted online, movies, television, and other media produced after-the-fact by a variety of sources:

- Professional caption/subtitle services
- Non-Expert Volunteers
- Automatic Speech Recognition (ASR)

Research Directions:

- ASR research on improving accuracy
- Providing access to recordings of classroom lectures
- Tools to support volunteer captioning of video content
- Automatic time-alignment and positioning of captions based on transcripts without timing information
Real-Time Captioning/Subtitles

For live events, performed by:
- Professional Real-Time Captionist
- Crowdsourced Non-Experts
- Automatic Speech Recognition
  - With humans correcting errors
  - With professional re-speaking

Research Directions:
- Word prediction or abbreviation expansion
- Interfaces for efficiently correcting errors
- Merging transcriptions from multiple sources
- Incentives or task-simplification for non-experts
- Usability or educational-outcomes of classroom use
Caption Display & Placement

• Example Research Directions:
  – Placement and format for captions/subtitles, based on user studies or eye-tracking
  – Methods for conveying speaker identity for on-screen captions
  – Projection and placement of captions for live events, e.g. following the speaker
  – Methods for conveying sound effects or emotional information via formatting or multi-modal channels
Gaze and Attention Management

- **Class Act (Teachers)**

- **Example Research Directions:**
  - Encourage lecturers to pause when presenting new visual materials during ASL interpreting.
  - Helping students in a classroom know “where to look” when viewing speaker, visual aids, and captions or ASL interpreting.
  - Bringing these channels of information into closer proximity on a computer display.
  - Providing indicators of where a student stopped reading when they look away from captions.

http://dx.doi.org/10.1145/2596695.2596701
Why Sign Language Technologies?

• ASL: primary communication means for 500,000 people
• American Sign Language ≠ Signs in English word order
• Many members of the Deaf Community prefer to receive information in the form of American Sign Language (ASL)
• Standardized testing has revealed that many deaf adults in the U.S. have lower levels of English literacy
• Much English text on the Internet is too complex
• ASL has no written form; so, must use videos or animations
  – Video is time-consuming to update and edit
  – We need software: Script → ASL Animation
Automatic Creation of Sign Animation

- **Scripted** by a someone who knows ASL: put signs and facial expressions on a timeline to make sentences.
- **Generated automatically** (e.g., machine translation), although the state-of-the-art for this technology is limited.
- For both, an animation must be *synthesized* with many detailed movement and timing parameters set correctly.

**Research Directions:**
- Automating the selection of specific motion-details so that the script writer or generation system does not need to specify this
- Using motion-capture data to build machine learning models of human movements for specific linguistic properties
- Conducting user-studies to evaluate understandability of animations
Sign Language Recognition

• Converting a video or motion data (e.g., gloves or kinect) into a symbolic sequence of the ASL words.
  – The accuracy of these systems is currently modest, and it depends on the vocabulary detection size and whether you must recognize isolated words or continuous signing in sentences.

Research Directions:
• Fundamental computer vision or machine learning work
• Applications in educational tools, ASL dictionary look-up systems, input to machine translation systems, as a control method for games or computers, or automatic processing and labeling of ASL videos for research.

Educational Applications

Learning Sign Language
- Games for children or adults to support learning ASL
- Tools to identify online videos containing ASL
- Tools for ASL dictionary search
- Tools for providing automatic feedback to ASL students

Learning Supported by Sign
- Math, science, and English educational software with video or animation of ASL.
- Community-based collection and curation of a STEM terminology in ASL.

Speaking and Writing Skills
- English-writing tutoring software for DHH students
- Speech training software that provides visualizations of mouth/tongue movements

http://dx.doi.org/10.1145/2700648.2809859
http://cats.gatech.edu/content/copycat
Communication Technologies

- Video Communication
  - ASL: Signer to Signer
    - Research: Compression of ASL video for use on mobile devices and wireless networks
  - ASL: Signer to Non-Signer
    - Research: Relay providers, interoperable platforms
  - English: Speech Reading during Video Chat
    - Research: Effect of audio delay on speech reading, benefits of onscreen indicators of phonemic information

- Communication in Specific Contexts:
  - Research: Emergency services or healthcare providers
DHH Participation in Research

• Methodological Research
  – Usability study protocols
  – Online surveys with signing
  – Conducting focus groups
  – Measuring information comprehension in ASL
  – Collecting subjective preferences in ASL
  – Demographic factors influencing responses
  – Best practices to encourage participation of DHH students in research