6.S196: Principles and Practice of Assistive Technology
Lab: Low-Vision Assistive Technologies

Objectives:
- Learn about assistive technologies used by individuals who are legally blind.
- Quantitatively assess the efficiency of common low-vision adaptations.

Activities
- Lab session with laptop computers

Deliverables
- There will be no deliverable beyond

Background

Although many—particularly the elderly—have reduced vision, here we focus only on those individuals who are legally blind.[1] In the United States, being legally blind requires that:

    a) Vision in the best eye is worse than 20/200 with best correction, and/or
    b) Field of view is no more than 20 degrees.

Estimates on the number of legally blind in the United States range between 3-10 million, but it is difficult to accurately determine because census data often collects data in such a way that those who are legally blind are inseparable from those who are either completely blind or those who have visual limitations that are uncorrected (but correctable). It is worth noting, however, that fewer than 40% of those who are blind or legally blind are employed in the US (note that this is different from being unemployed, which entails actively seeking work out).

When considering the utility of an assistive technology or accommodation, it is useful to distinguish between near- and far-sight tasks and, in particular, some of the most common tasks in each that present problems.

Problem Near-Sight Tasks include:
    i) Computer / cellphone use.
    ii) Reading books, papers and restaurant menus.
    iii) Handwriting / filling out forms.

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[1] Unfortunately, the term legally blind is a bit of a misnomer as individuals so described have vision ranging from light perception to sufficiently high-functioning as to safely ride a bicycle. Legally blind is usually reserved for formal conversations (e.g. with governments or employers); "low-vision" is otherwise more colloquial.

Problem Far-Sight Tasks include:
  iv) Navigation, sign spotting.
  v) Viewing presentations / TV
  vi) **Person interaction** (principally this is person recognition)
  vii)**<u>Many</u> social activities** (most anything that includes demonstration or distant cueing, particularly when impromptu or when there is a time component, e.g. dance, sports, theatre, board/card games)

Note: Many assistive technologies exist for i-v; far fewer, if any, for vi and vii.

The degree to which someone with low-vision is affected in these activities will of course depend on their acuity but, perhaps less obviously, will be greatly affected by whether (and if) they are near- or far-sighted. For instance, someone who's low-vision <u>and</u> near-sighted will need less (if any) magnification for reading materials.

Assistive Technologies
The most common low-vision AT includes
  • Screen Magnifiers for interacting with computers / phones
    o For desktops/laptops, Windows (with Ai Squared's ZoomText or Freedom Scientific's MAGic) have traditionally been the preferred platform though OSX (with it's built-in magnifier) is gaining traction.
    o For cellphones, Windows Mobile used to be the preferred platform but iOS has since taken over (and Windows Mobile was replaced with the less accessible Windows Phone)
  • Monoculars (handheld or head-mounted, optical or electronic) for viewing signage and for viewing presentations.
  • Board Magnifiers (camera-based systems that project to a laptop/display); typically used in classrooms and, less commonly, in the workplace.

Other products/technologies, e.g. monitor arms (which float a monitor off and over the lip of a desk for effective computer ergonomics), consumer GPS and cellphones serve double duty as AT for the low-vision (though they weren't built for that purpose and are rarely considered as such).

In addition to assistive technology, provision of certain accommodations by employers and federally-funded schools are mandated by (typically) the Vocational Rehabilitation Act of 1973 and the Americans with Disabilities Act. Highlights include:
  • Human note-takers in universities
  • Testing / materials accommodations in universities (e.g. large print, extended time).
  • "Reasonable" accommodations that do not impose an "undue hardship" on an employer for an employee to perform an essential function of a job.

Lab Activities

In this lab, we will quantitatively assess the efficiency of some common low-vision adaptations. Specifically, we will look at how use of a board magnifier affects efficiency when taking notes, and also at how different presentations of magnified font affect reading speeds.

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1. Board Magnifiers

You may do 1a, 1b in any order. In both steps, you are asked to time yourself copying equations. Please do so with the same attention to detail as though you were taking notes for a class.

a. Head over to the Note-Taker Station with a pen/pencil, a sheet of paper and a timer. Familiarize yourself with the interface by panning and zooming with the usual two-finger gestures.

> ➢ You may also need to adjust the camera's focus by sliding the lever (atop the lens and closest to you).

Now, using a stopwatch (your cellphone will do), time how long it takes to copy the equations "on the board" as seen through the board magnifier's interface. You can pan and zoom (if needed) while doing this. Record this number.

b. Head over to either adjacent station in which there are two sheets of equations. Time how long it takes to copy the equations on both sheets by looking at them with your naked eye (as you normally would).

Consider the difference in times (if any), bearing in mind that the equations' complexities were roughly equivalent. Is there a difference and, if so, how substantial was it? Do you think this stemmed more from your inexperience with the board magnifier's interface, or from the time it took to pan and zoom around the image? Consider how a low-vision student might be affected if doing this in a class that contained 10 times this number of equations.

> There is a varifocal monocular near the Note-Taker station. You needn't time yourself with it, but take a look at the small equations through it – you may notice that it gets increasingly dark and unstable as you zoom in. Camera optics are subject to the same problems but they can compensate for the former by gaining the image (at the cost of noise) – it is for this reason that I think

monocular use among the visually-impaired will fall off in favor of camera-based AT.

2. Large Print

In this exercise, we measure how large print interfaces (both physical and digital) can affect reading speed. In the exercises that follow, you will be timing yourself while reading approximately 1000 words of text in each of four separate interfaces. You should "read for comprehension," i.e. neither studying nor skimming it. Because you will be reading chapters from a book, it is recommended that you do them in order.

a. Time how long it takes to read the Chapter 01 (paper, normal font) handout. Divide this number by 853 to get your normal words-per-minute (WPM)

b. Time how long it takes to read the Chapter 02 (paper, large print) handout. Divide this number by 798 to get your large-print WPM.

c. Using your laptop, download the first half of Chapter 03 at the below link and, using your favorite PDF reader, magnify it so that a maximum of 4-5 words fit on the screen at any one time (thus, to read this you will need to pan left and right across each line). Now, time how long it takes you to read this and divide by 855.

http://people.csail.mit.edu/dshayden/ppat/chapter_3a.pdf

d. Lastly, also using your laptop, download and install the Amazon Kindle application and, within it, download Pride and Prejudice. Again, set the font so that a maximum of 4-5 words span the screen. Using the left and right arrows to page, find your place in Chapter 3 and then time yourself finishing the chapter. Divide this number by 842.

Do you notice a difference between the physical and digital interfaces? Reading speeds were commonly observed to be 10-15% slower on screens in older generations but the divide is apparently lessening with the current generation.

Notice also that there are, in general, two methods for applying magnification – those in which the user pans and zooms around an otherwise unmodified interface (c.), and those in which the formatting is reflowed (d.). Is one method categorically better than the other or are there situations in which one would be better suited (with respect to efficiency and learnability)?