A Better User Interface for the Visually Impaired

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Abstract. As a Visually Impaired (VI) person, I find challenges in many tasks that a fully sighted person may not. Therefore, there is a large problem-space for task selection for my context. However, although the problem-space is extensive, it's not necessarily rich. That is, some of the tasks are simply out of scope for my condition, e.g., multi-tasking two or more visually intensive tasks. In selecting a task for this research, consideration was given to audiences that have a visual disability as well as those that do not. My research will involve evaluating an interface that offers users more than just pure visual interaction. This will include the interplay of haptic [1] and audible technologies for interface design.

1 PROBLEM SPACE

Performing everyday tasks for a VI person present unique challenges that are, in many cases are occluded form a fully sighted persons context. User Interfaces (UI) with a heavy reliance visual user interaction are dominant in the marketplace. At times, this ubiquity excludes participants that cannot fully discern the Input/Output (IO) of the UI to perform a task. At best, there is a large gulf of execution VI users must overcome. Thus, the efficiency of performing the task is unduly compromised. At worst, the gulf is too large to complete a task. For this discussion, I selected a common task that presents a wide gulf of execution. I'd like to explore, through needfinding:

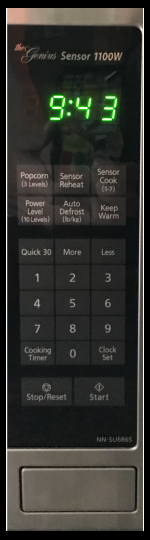
- Potential options that can bridge the gulf of execution for this task.
- Does the context of this task vis-à-vis the large gulf of execution applicable to users outside the VI domain.

1.1 Task Context

Imagine, as a visually impaired person, attempting to use an interface with a completely smooth finish that has a rather small form-factor with many options

[1] Haptic Technology

for selection. A users finger attempts to navigate this environment, listening for any clues, searching for some tactile information on the polished surface. This could be any of the ubiquitous smartphones user interfaces. However, the Human Computer Interface (HCI) for these applications has improved to the point where they enhance the user experience for the VI community. The low hanging fruit is with technologies that have not demanded better user interface design. The evolution of such products is slower and correlated with product commoditization. Though overlooked by HCI, these devices are still pervasive within the context of everyday life, thus should be considered by HCI for improvements. My proposal will apply HCI to improve UI, such as those commonly found on a microwave oven. To enhance the user experience for the visually impaired audience, other stimuli from sound or haptic can be integrated at a level at least equal to the visual channel. Ironically, many interfaces that are visually dominant for user interaction do employ touchscreen and audio IO technologies. However, using the haptic and audio features require and are dominated by the need for visual acuity.



(a) Microwave Interface

(b) Analog Microwave Interface

Figure 1: Analog Microwave Interface

2 USER TYPES

The visually impaired audience is a rather small subset of users. In 2015, there were an estimated 253 million people with visual impairment worldwide. Of

these, 36 million were blind and a further 217 million had moderate to severe visual impairment (MSVI)[2]. Although the VI user group is small, the impact of designing interfaces that best support their needs can have a profound impact.

In addition to the VI community, I plan to evaluate the redesign of a microwave UI with the broader non-VI audience. Since I am part of the VI coterie, this will minimize any potential biases that I may have during the needfinding process.

2.1 Demographics

The demographics of the VI community are not evenly dispersed across ethnicity and age. Income is lower and unemployment is higher for the VI cohort.

Although over half of all blind people are over the age of 64, there remains a large and significant group of people who are blind before the age of 20[3].

The number of non-institutionalized, male or female, all ages, with all education levels in the United States reported to have a visual disability in 2016[4].

- White: 5,546,000 (2.4%).
- Black/African American: 1,215,600 (3.0%)
- Hispanic: 1,253,400 (2.2%).
- Asian: 250,500 (1.4%).
- American Indian or Alaska Native: 100,400 (3.8%).
- Other race(s): 563,100 (2.1%).

Prevalence of Visual Disability (2016) The number of non-institutionalized, male or female, ages sixteen through 75+, all races, regardless of ethnicity, with all education levels in the United States reported to have a visual disability in 2016[5].

- Total (all ages): 7,675,600 (2.4%).

[2]World Blindness and Visual Impairment: Despite Many Successes, the Problem is Growing: Peter Ackland, Serge Resnikoff, and Rupert Bourne

[3]Chapter 2THE DEMOGRAPHY OF BLIND AND VISUALLY IMPAIRED PEDESTRIANS

[4]National Federation for the Blind

[5]National Federation for the Blind

- Total (16 to 75+): 7,208,700 (2.83%).
  - Women: 3,946,300 (3.01%).
  - Men: 3,262,300 (2.65%).
- Age 16 to 64: 4,037,600 (2.0%).
- Age 65 and older: 3,171,100 (6.6%).

Individuals who are legally blind or visually impaired in the United States have long suffered high rates of unemployment. Results from a study by Bell, et. al.[6], showed that the employment rate for individuals who are legally blind/visually impaired is 37%.

Income and Poverty Status (2016) The annual earnings and poverty status of non-institutionalized persons aged twenty-one to sixty-four years with a visual disability in the United States in 2016[7].

- Annual Earnings: (Median $38,500).
- Annual Household Income: (Median $41,300).
- Number living below the poverty line: 1,048,600 (27.7%).

Educational Attainment (2016) The number of non-institutionalized, male or female, ages twenty-one to sixty-four, all races, regardless of ethnicity, in the United States reported to have a visual disability in 2016. These numbers refer to the highest level of education attained by a given individual[8].

- Less than high school graduation: 847,000 (22.3%).
- High school diploma or a GED: 1,201,600 (31.6%).
- Some college education/associates degree: 1,151,500 (30.3%).
- Bachelor's degree or higher: 598,000 (15.7%).

[6]Employment Outcomes for Blind and Visually Impaired Adults: Edward C. Bell, Ph.D., Natalia M. Mino

[7]National Federation for the Blind

[8]National Federation for the Blind

2.2 Motivation for User Engagement

The VI community has unique needs when it comes to performing everyday tasks. Visual impairment can limit a person's ability to perform everyday tasks and can affect their quality of life and ability to interact with the surrounding world[9]. Given a chance to improve their quality of life, the VI community are motivated to participate in needfinding activities.

3 NEEDFINDING PLAN 1: SURVEY

The focus of needfinding will be survey based. I plan to distribute surveys to both VI and non-VI communities. To access the VI community, requests to participate in the survey will be circulated among various VI social media platforms. There are influencers within the VI community that have a large number of subscribers, most of whom have a visual disability. I also plan to distribute the survey to students in this class. From experience as a VI person, I'm motivated to by the need to improve everyday tasks, even something so simple as heating food in a microwave. Since I'm an active participant, perhaps an apprentice, care must be taken to avoid any contextual bias when development and interpretation of survey needfinding.

Survey questions will be created to [re/de]fine the data inventory for needfinding.

- Given a community of VI users:
  - What is the context of the task?
  - What are the user goals?
  - What are the user needs?
  - What are the user task and subtasks?

As a VI person, I believe that existing microwave interfaces present a large gulf of execution for the VI community, see figure 1a on page 2.

To bridge this gap, I plan to evaluate microwave interface designs that have more audio and haptic IO features, see figure 1b on page 2. This can include physical interfaces on the microwave, or a microwave connected to a smartphone application.

[9] World Health Organization: 10 facts about blindness and visual impairment

4 NEEDFINDING PLAN 2: EVALUATION OF EXISTING USER INTERFACES

To evaluate interfaces for microwave oven, see figure 1 on page 2, I plan to employ both personal and participant assessment. Participant evaluation will be conducted through naturalistic observation, with a goal of minimizing personal biases in my evaluation. The observational data will be used to develop survey questions for the survey needfinding task.

5 NEEDFINDING PLAN 3: ANALYSIS OF PRODUCT REVIEWS

Product reviews, customer blogs and comments can provide insight for user tasks and temper bias in my evaluation of microwave interfaces. They can also serve to refine questions for survey needfinding.

6 NEEDFINDING: SUMMARY

Needfinding tasks will be an iterative process. Needfinding Plans [1, 2] will be used as input to develop survey questions for needfinding Plan 1.

6.1 Needfinding and Prototyping

This design process will focus on user centered design. The results from needfinding will be used to prototype UI designs with the goal to improve the gulf of execution for the VI community. These protypes will serve as input into further needfinding.