Making Technology Accessible and Inclusive for All: Designing UIs for Individuals with Visual Impairments

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Introduction

Since we are currently living in a digital era, it is crucial that technology is inclusive for everyone, including those with visual impairments. Technology benefits those with visual impairments because it makes difficult tasks easier for them, such as navigation and communication. Given the recent advances in technology, many researchers proposed user interfaces (UIs) to assist these individuals. Wearable devices, haptic graphs, navigation systems, and accessible touch screens are examples of some of the UIs that have been researched. After enough research has been done, these technologies were eventually made available for use. However, there is still room for further research in this area. I will discuss a few examples of these user interfaces from key papers. I will then propose two research ideas with explanations.

Enhanced Text User Interface

A website's accessibility does not imply its usability. Websites use a Graphical User Interface (GUI), but GUIs are intended for sighted users. Leuthold, Bargas-Avila, and Opwis [6] propose a new kind of interface for websites, known as an Enhanced Text User Interface (ETI). This interface makes it easier for visually impaired users to navigate websites because it relies solely on text rather than graphics [6]. When Leuthold et al. [6] tested the ETI with 39 blind users by providing them with a search task on the University of Basel's website (Figure 1), they discovered that they were able to execute the task a lot faster than they would with a GUI. In conclusion, the ETI shows improvement from the GUI, making it more usable for blind users.


Seitentitel

Universität Basel

Suchhilfen (enthält 2 Links)

1. Suche
2. Sitemap

Hauptnavigation (enthält 6 Links)

1. AKTUELL
2. UNIVERSITÄT
3. STUDIUM
4. FORSCHUNG
5. WEITERBILDUNG
6. UNI-LEBEN

News (enthält 3 Links)

1. 03.02.2005
Regenz billigt Verfahren zur Wahl des neuen Rektors

2. 03.02.2005
Antonio Loprieno zum Präsidenten der Planungskommission gewählt

3. 03.02.2005
Gesamterneuerung der Regenz im Sommersemester 2005

Veranstaltungen (enthält 3 Links)

1. 21.02.2005 18.15
'si chiama fagotto' - Zu einer Zeichnung mit Musikinstrumenten von Giovanni Ricamatori, genannt Giovanni da Udine

2. 22.02.2005 18.15
Baustellen im Parlament - eine wirtschaftspolitische Betrachtung

3. 22.02.2005 19.30
Die frühmittelalterlichen Kirchenruinen von Tomils/Sogn Murezi im Domleschg-Kloster, Wallfahrtsort oder Hospitz?

Weitere Links (enthält 5 Links)

Figure 1. The University of Basel's website using an ETI (from Leuthold et al., 2008, p. 265)

Figure 2: A user interacting with a tactile-audio map (from Wang, Li, Hedgpeth, and Haven, 2009, p. 43).

Drishti

Navigation can be quite challenging for the visually impaired. However, recent advances in technology can help make it easier. As a result, Helal, Moore, and Ramachandran [2] created Drishti, a wireless, integrated navigation system. Drishti means "vision" in Sanskrit [2]. It integrates wearable computers, voice recognition and synthesis, wireless networks, geographic information systems (GIS), and global positioning system (GPS) technology [2]. It is based on augmented reality (AR) and user interfaces. The virtual world supplements the real world in the case of AR [2]. Much of Drishti's interaction comes from a voice interface designed for the visually impaired [2]. Information about current environmental conditions are queried from a spatial database and are provided on the fly via thorough explanatory voice cues [2]. Static and dynamic data within the system helps guide the blind user with navigation [2]. Drishti also calculates optimized routes based on user preference [2].

Access to Digital Maps

In addition to Drishti, tactile-audio maps assist those with visual impairments in local navigation. The first step in this approach is to detect and segment text from a map image [7]. Next, the remaining graphics from the map image are recreated in a tactile form, which can be easily reproduced through a tactile printer [7]. The printer then generates a Scalable Vector Graphics (SVG) file that provides users with interactive access to the image via a touchpad [7]. The result is a tactile-audio representation of the original map image [7]. The goal of tactile-audio maps is to make digital maps of local directions accessible in real-time [7]. Figure 2 shows a user interacting with the system by freely exploring the tactile map with her hands.

Haptic Interfaces: Graphs and Data Visualization

The purpose of haptic graphs is to make graphs accessible for visually impaired computer users [9]. Typically, graphs and diagrams are presented in Braille, but only a small proportion of visually impaired users know and use Braille [9]. The resolution of these graphs are very poor, only giving visually impaired users a rough idea about the graphs [9]. Haptic graphs use force feedback devices as well as 3D sound and computer assistance to help make it easier for the visually impaired to access graphs and diagrams; integrating surface property and auditory cues also helps these users explore haptic graphs [9]. Engraving and texture usage were used to model curved lines on these graphs, and these techniques were based on experiment results conducted on both blind and sighted people [9]. Force feedback devices, such as PHANToM (Figure 3), allow information to be exchanged between humans and computers through a haptic channel, i.e. pertaining to the sense of touch [9]. PHANToM combines the sense of touch and representative soundscapes to assist users with visualization [9]. As well, Fritz and Barner [1] discussed the lack of available computer interfaces to display higher dimensional data for the visually impaired and designed a data visualization system to display data in 1D, 2D, or 3D. Haptic rendering and haptic enhancement techniques are incorporated into the data visualization system [1]. Data visualization helps people understand data better by representing real or simulated data in a comprehensible form [1]. Overall, though, haptic interfaces can provide new visualization paradigms and improve human-computer interaction methods [1].

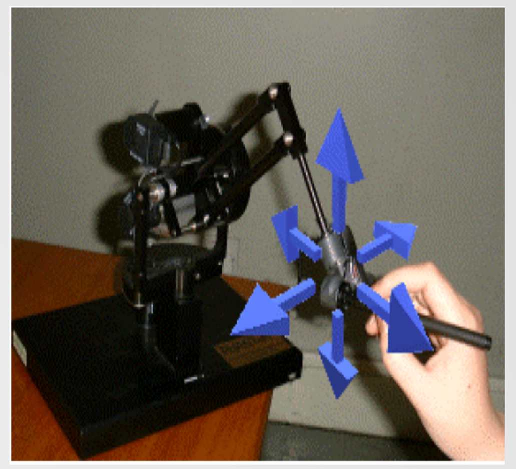

Figure 3: The PHANToM device (from Yu, Ramloll, and Brewster, 2001, p. 102).

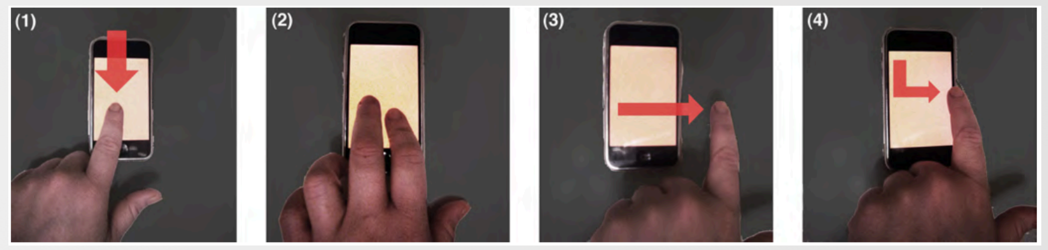

Figure 4: The Slide Rule and its multi-touch gestures (from Kane, Bigham, and Wobbrock, 2008, p. 4).

Touchscreens

Touchscreen devices, such as the iPhone, are incredibly common. Despite this, touchscreens are inaccessible to the visually impaired. Luckily, researchers have developed techniques to help make touchscreen devices more accessible and easier to use. Kane, Bigham, and Wobbrock [3] created the Slide Rule, which is a set of audio-based, multi-touch interaction techniques that let visually impaired users to access touch screen applications. It has a non-visual interface where the touch screen becomes a touch-sensitive surface that "speaks" [3]. Figure 4 shows all the gestures that make up the Slide Rule. In addition, researchers have explored ways to make touchscreens more accessible. Kane, Wobbrock, and Ladner [4] have suggested design guidelines to make touch screens more accessible, including avoiding symbols used in print writing and favouring edges, corners, and other landmarks. McGookin, Brewster, and Jiang [5] have also suggested guidelines for designers, including using different button shapes, avoiding short impact-related gestures, and providing feedback for all actions. Ye, Malu, Oh, and Findlater [8] explored the idea of wearable technology to assist with touchscreen navigation. Wearable technology has the potential to improve access to information and social interactions, according to a study involving wearable devices on visually impaired individuals [8].

Open Areas of Research

Psychophysical studies to evaluate the effectiveness of various haptic enhancements

More research in haptic data visualization system needs to be done. For a visualization system to be truly accessible, multimodal systems need to be adapted to meet the different needs of each user [1]. Fritz and Barner [1] placed a high priority on this area of research to realize the full potential of multimodal and non-graphical visualization systems. These studies can help determine optimal formulations of data modulated textures [1].

Adding text entry methods for the Slide Rule

This is one way of extending the current implementation of the Slide Rule to handle additional tasks and scenarios [3]. Since the current Slide Rule prototype includes the QWERTY keyboard for text entry, gesture-based or Braille chording techniques may help improve text entry [3].

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