Computing Interfaces for Everyone

Abdullah Almurayh, *Member, IAENG,* and Sudhanshu Semwal, *Member, IAENG*

***Abstract*—Companies, businesses and agencies rely on computing technology, taking advantage of its trends and benefits. Some categories of users – people with disabilities – have faced considerable challenges accessing the cloud to the point that they have become excluded. Many of the existing systems and companies still rely on assistive tools that are expensive, incompatible with some applications, and challenging to use by people with disabilities. The goal of this paper is to encourage the inclusion of a person with a disability in computing technologies and the opportunities that these technologies afford. Our research finds that the lack of usability limits the use of these tools and restricts achievement of users with disabilities. Usually, there is a reasonable and realistic effort of research to include accessibility or usability, or both. In this paper, we provide our insight for creating inclusive computing opportunities for all.**

***Index Terms*—User interface, Accessibility, Assistive Technology, Integrated Tools, Multimedia, Computing, Human Computer Interaction**

I. Introduction

DISABILITY confines a person to minor life activities and limits available options. Technology can provide a significant increase in employment options for everyone. The recent growth of technology has seen the emergence of cloud computing. Businesses and governments both rely on cloud computing to perform several tasks. Our goal is to make cloud computing accessible to people with disabilities. We also want accessibility for all. Here by accessibility we mean that disabled users can have access to resources. For example, an accessible web is the web that is not only used by the disabled, but also easy to use by all [1].

In 1998, the U.S. Congress amended the Rehabilitation Act of 1973 by adding Section 508 Laws that require accessible electronic information technologies and services for the disabled. Section 508 sets accessibility standards for all information technology including software, applications, operating systems, web, multimedia, telecommunications, closed products, and computers [2]. Assistive technology is developed to improve functional capability and accommodations for functional limitations [3] [4]. Assistive technology comprises tools, products, facilities, systems, and mechanisms used by people with impairments such as the physically disabled, blind, visually impaired, deaf, and other conditions [5]. However, assistive technology solutions are many times not affordable due to high cost [6]. Additionally, assistive computer applications may not be compatible and they can add privacy and security concerns [7]. Furthermore, a large degree of impairment may limit the person to perform a major life activities [8].

A disability could affect a person's employment status, which can cause job loss [9]. Most employers have shifted to computer-based services and the Internet cloud; therefore, requiring knowledge of cloud computing skills [10]. This may require physical skills[1] and soft skills such as personal skills, relationships, and communications [10]. Employees with disabilities, on the other hand, may not be able to achieve these requirements because of health reasons. Section 508 considerations, as discussed earlier, will definitely increase the opportunities for employees with disabilities to work productively, when complied along with the requirements of the Americans with Disabilities Act [11]. The question arises: what is the best means by which that can be accomplished to make people or employees with disabilities more productive?

We believe that people with disabilities should have the same opportunity as everyone else. We also believe that an information technology (IT) job is an excellent rewarding career, as it exists almost in all companies, schools, and businesses, and therefore it is important for a disabled user to be skilled in such tasks. Hence, this paper investigates the user's accessibility beyond just accessing information technology and systems management. We believe that cloud computing skills can be learned by new enhanced interfaces and tools that are applicable for everyone – including users with disabilities – with the same level of effectiveness, ability, and productivity.

II. Background

A. Disability

Disability literally refers to limitation, restriction, constraint, restraint, and obstacle. Disability can occur due to a health problem, a genetic problem, or an incidental disaster[2]. Disability leads to an impairment including visual, cognitive and learning, hearing, and physical [12]. These impairments cause activity limitation, for example, restriction of movement, a restriction in participation, and difficulties at work [13]. It is estimated that 1000 million people live with disabilities around the world[13]. This requires interventions to remove environmental and social barriers [13].An important fact is that being disabled does not mean unskilled, many disabled people have extreme motivation and are a skill-rich workforce.

B. Accessibility

Accessibility could mean that disabled users can have access to resources. The same definition can be utilized for other applications: Mueller emphasizes that some people

Manuscript received July 11, 2014; revised August 11, 2014. This work was supported in part by the Media Convergence, Games and Media Integration Consortium (GMI) and Research Lab, awarded by the College of Engineering and Applied Science at University of Colorado at Colorado Springs, and sponsored by the Saudi Arabian Cultural Mission(SACM).

A. Almurayh and S. Semwal are with the The Department of Computer Science at the University of Colorado at Colorado Springs,CO, 80918 USA. E-mail: (aalmuray@uccs.edu, ssemwal@uccs.edu).

[1]Familiarity with physical equipment and the technical knowledge to perform a task

[2]As defined by www.dol.gov and www.who.int

associate the term *accessibility* with physical accommodation such as handicapped parking [14]. However, accessibility is the principle of making applications suitable and beneficial for everyone [14]. Accessibility is affected by many design problems when the user is unable to see, hear, move, process information, read specific text, use a keyboard, hold the mouse, speak or to comfortably understand the language of the area, and other similar issues. Other design problems are technical, related to, for example, having a text-only screen, a small size screen, slow Internet connection, various web-browsers for exploring applications, different operating systems, and the like [15]. Based on a variety of users' requirements, needs, and impairments, the difficulty of making interfaces accessible for everyone is explained in this paper [16].

C. Section 508

Each federal department or agency is required to provide access to programs, activities, electronic and information technology [17]. Moreover, companies could comply with the government requirements by offering accessible IT for everybody. IBM, for example, decided to build accessibility into the entire development process company-wide [17]. ADA states, "*No single worldwide standard has been developed, and to date there is no plan to develop a single standard. However, it is important that the accessibility standards produced by the various groups working worldwide are harmonized*" [18]. Federal websites are required to provide accessibility and accommodate the existing regulations; yet, many federal websites continue to be inaccessible [19].

D. Assistive Technology

Cowan describes assistive technology as "*any item, piece of equipment or product system whether acquired commercially off the shelf, modified or customized that is used to increase, maintain or improve functional capabilities of children with disabilities*" [20]. Mann also defines assistive technology as a general term that comprises technologies, tools, products, facilities, systems, and mechanisms used by people who have impairments such as the motor disabled, blind, visually impaired, deaf, and the like [5]. Moreover, Michael defines assistive technology as tools to accommodate for functional limitations [3]. IDEA describes assistive technology as an item that is used to increase, maintain, or improve functional capabilities of a disabled person [4]. Assistive technology can be categorized into access and spatial controls, localization, moving, listening, communication, computer-based instruction, computer applications, vision, recreation, and special care [7]. In addition, assistive technology may be stand-alone (e.g., Mobility Smart Better-Grip Reacher) or embedded hardware such as a haptic feedback glove for the blind. Assistive technology also could be embedded as a computer mechanism (e.g. Speech recognition) or can be a stand-alone tool like a Braille display [7] [21].

Unfortunately, there are different concerns and issues when using assistive technology in the real world. Users face social, cultural, design, privacy, security, compatibility, and other limitations. Incorporating *social acceptance* into the design of assistive technology is necessary; otherwise, assistive technology may not have appealing design for that social situation[22]. Similarly, the proliferation and wide usage of assistive technology can be affected by cultural differences including life style, language, economy, and diversity [7]. Some assistive applications – screen readers and Braille translators – are very high priced [7].

Poor design does not accommodate changes easily. Screen readers, for example, do not read by looking at web pages; however, they indicate text phrases through the HTML code and announce whatever is found. If the screen readers misinterpret the HTML code, a meaningless sound will be played. Another similar issue is privacy of any accessed data. This can affect the privacy during information exchange [23], for example, voice recognition being used to interact in a crowded room. In terms of security, there are two opposite perspectives of security challenges against assistive technologies: vulnerability and those related to settings. Vulnerability affects the underlying system if the assistive tool does not comply with high security levels. Setting related issues (i.e. rules, restrictions, permissions, privileges, policies, or firewalls) are set to the underlying system or resource. Such settings can restrict assistive tools in performing efficiently or prevent them from accessing the resources permanently. Adobe Acrobat software, for example, allows the user to forbid some parts of a PDF file from being copied, printed, extracted, commented on, or edited. Screen readers, on the other hand, will not be able to extract the document's text in order to transform it into a spoken format [24]. Compatibility challenges are demonstrated by whether content works well with different assistive tools on different platforms. Google Chrome web browser, for instance, supports some assistive technology [25].

E. Statistics

Recently, the employment rate for the disabled community has dropped rapidly as shown in Figure 1. Further, during the decline in the rate of employment for people with disabilities, there has been a marked rise in the number of Internet users. Businesses depend on the Internet and cloud computing, which adds additional challenges to the disabled community. Because of lack of good user tools, and skill set acquisition is difficult.

The Bureau of Labor Statistics (www.bls.gov) is a Federal government agency, which provides Data Retrieval tools including Labor Force Statistics. As BLS promotes using their tools, we were able to collect data of employment statistics for employees with and without disabilities for the period from 2008 to November 2013. A person with a disability includes deaf, blind, difficulty concentrating or remembering, physical disability, mental disability, and emotional condition. In addition, the data includes both genders 16 years old and over. Table 1 highlights that the annual number of employees from 2008 to 2013 is considered equivalent in both cases: employees with and without disabilities. The employment-population ratios indicated in Table 2 shows the massive annual gap between the employment ratios of people with disabilities (18.5%) versus non-disabled people (64.5%).

ISBN: 978-988-19252-0-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

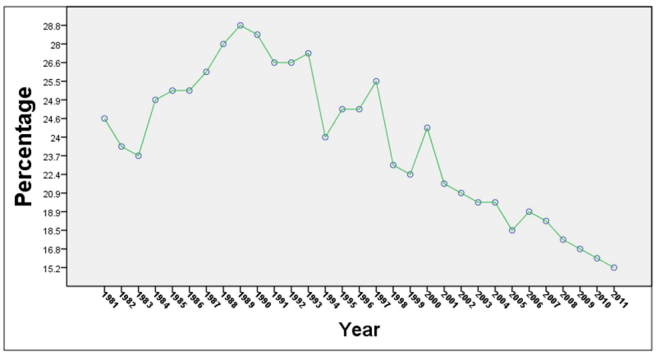

Fig. 1: Employment rate including men and women, aged 18-64 with a work limitation employed in the United States from 1981 to 2011. *Source: http://www.disabilitystatistics.org*

TABLE I: Averages numbers of employment ratio for the period 2008 to 2013, *extracted from Labor Force Statistics* – www.bls.gov

	Annual Averages of Employment over Population	
Year	With a disability	With no disability
2008	20.44 %	67.59 %
2009	19.17 %	64.51 %
2010	18.58 %	63.49 %
2011	17.77 %	63.61 %
2012	17.83 %	63.90 %
2013	17.74 %	63.98 %

III. Literature Review

A. The law

In 1987, the Rehabilitation Act of 1973 was amended, by adding Section 508, because Federal agencies had significantly increased their reliance on electronic office technologies. Section 508 is aimed to ensure that such information technology would be accessible to individuals with disabilities. In 1998, Section 508 was amended and legislated to eliminate barriers in information technology including web contents to allow new opportunities for people with disabilities and to inspire development of new technologies that will help them achieve their goals. This law applies to all Federal agencies when they develop, acquire, maintain, or use electronic and information technology and web content. However, there is some debate as to what legally defines an agency. Federal agencies are required, upon request, to provide information and data to individuals with disabilities through an alternative means of access that can be used by the individuals (www.ahrq.gov). Federal regulations and guidelines (e.g., Section 501 and Section 504 of the Rehabilitation Act) require equal access for individuals with disabilities.

The Americans with Disabilities Act (ADA) requires that state and local governments to provide qualified individuals with disabilities equal access to their programs, services, or activities. There is nothing in section 508 that requires private web sites to comply unless they are receiving federal funds or under contract with a federal agency. Similarly, ADA requires providing qualified individuals with disabilities equal access. All electronic information must be accessible for the disabled in a variety of ways, which are specific to each disability. By looking at Section 508 technical standards, it is important to realize that all users must have the same opportunity to access everything regardless of their conditions. In 2001, Section 508 became effective for individuals with disabilities (i.e. employees, applicants, or members of the public seeking information or services from the agency) have to be provided with the appropriate accessibility to IT resources (gsa.gov).

The Web Content Accessibility Guidelines (WCAG) provides an international set of guidelines, published in December 2008, based on four principles (www.w3.org). These guidelines include perceivable, sensible content using the browser or assistive technologies; operable, users can interact with all controls using the mouse, keyboard, or an assistive device; understandable, content is clear and limits confusion and ambiguity; and be robust, compatible with old and new user agents and assistive technologies. Moreover, ADA's Voting Accessibility Act of 2012 indicates that online-voting technologies must provide blind voters with the ability to cast their votes privately and independently and to verify without sighted assistance that their ballots accurately reflect their voting choices. Section 508 standard was formulated to include the availability of a transcript of audio content (www.access-board.gov). Captioning allows the audio content of web multimedia to be primarily accessible to the people with hearing impairments (www.ncdae.org).

Buy Accessible Wizard (BAW) evaluates acquisition deliverables against applicable provisions as determined by the Wizard. The guide includes important provisions that has the emphasis of equivalent alternatives for non-text elements, multimedia, colors, geometric shapes, plug-ins, applets, electronic forms, and the like (www.buyaccessible.gov).

Section 1 "Commission for the Blind Act" establishes and authorizes a coordinated program of services, which will be available to individuals who are blind. The program is designed to maximize employment opportunities for such individuals and to increase their independence and self-sufficiency (www.nfb.org). To meet this law, agencies have to provide and maintain an orientation and adjustment center to afford appropriate training to prepare blind and visually impaired persons for eventual vocational training, job engagement, and independence or individuality. *Section 701* was amended in 2011, under the Workforce Investment Act of 1998, indicating that increased employment of individuals with disabilities can be achieved through implementation of statewide workforce investment systems. This provides meaningful and effective roles for individuals with disabilities and through the provision of independent living services, support services, and meaningful opportunities for employment in integrated work settings through the provision of reasonable accommodations. This Act empowers individuals with disabilities to maximize employment, economic self-sufficiency, independence, and inclusion and integration into society (www.gpo.gov).

Lazar and Hochheiser stated that "*Accessible information technology is not just good design and a clever way to win new users, it is the law*" [26]. They emphasize how computing specialists and scientists have contributed in achieving the goal of accessible information systems that benefits all users. However, in order to help designers avoid compliance difficulties, there must be a clear consideration of the implicating four major U.S. disability rights laws, which are Section 504 of the Rehabilitation Act (1973), Section 508 of the Rehabilitation Act (1998), the Americans With Disabilities

ISBN: 978-988-19252-0-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

Act (1990), and the 21st Century Communications and Video Accessibility Act (2010) [26]. In fact, sometimes people mistakenly assume that disabled individuals require non-disabled people to help them in their jobs. The National Federation of the Blind, for instance, confirms that B/VI community is working in nearly all vocations (www.nfb.org).

B. HCI Research

Human-computer interaction plays a substantial role in complying with both accessibility and usability for everyone. In the Web, merging accessibility and usability can be accomplished though patterns to enhance usability of web forms [27]. This approach involves a collection of patterns for human-computer interaction to cooperate with both usability and accessibility. It states that the aged and disabled are usually discounted by software developers (e.g. web designers) as well as computer service providers such as the Internet providers. Most websites use attractive technologies (e.g. flash, multimedia elements, objects... etc.) to invite as many users or customers as possible [28]. Although this does not comply with the accessibility law, web designers also have the right to create attractive websites using attractive technologies such as multimedia flash, objects, and the like.

Varona and Manresa-Yee state that people with disabilities (specifically physically disabled and mentally impaired users) have not received the same opportunities as others in their in inclusive computing research [29]. They developed a project – called SINA – that promotes a vision-based user interface to enhance computing accessibility for users with motor disabilities. The interface tracks the user's face to recognize gestures within the face region in real time as an alternative way of using a mouse device [29]. Hands-free interfaces such as SINA create a form of Human Computer Interaction (HCI) for people with physical disabilities, who are unable to use a mouse as an input device [30].

Spoken interface provides new interaction techniques [31]. This approach has potentials including decreasing the usage of mouse and keyboard as well as performing tasks promptly. Such work increases the benefit of speech technologies and makes them more practical. Although this approach is not directly intended to be for users with impairments (i.e. vision, blindness, mobility...etc.), speech interaction is suitable for universal usage.

Speech and touch interaction can be beneficial with communication applications for individuals with mobility impairments [32]. Participants performed tasks with multiple interaction prototypes including speech, touch, gesture, keyboard and mouse, and two types of computing platforms – desktop and smartphone. This prototype was intended to meet needs of mobility-impaired users by including email and social media. Taking advantage of the newer HCI devices, with speech recognition and understanding technology, will improve communication further for individuals with mobility impairments as well as other impairments. However, touchscreen computing devices may not always be the right choice for the B/VI community [33].McGookin et al. [33] presented a study that illustrates the problems with touchscreen accessibility. They proposed and tested ways to overcome touchscreen accessibility problems through evaluating a solid paper overlay touchscreen-based MP3 player, and a touchscreen gesture-based player [33].

Crossover applications are technology developed with a focus on users with disability and a goal of being useful for all [34][35]. A great example of a crossover application is static or dynamic captioning that is useful for people with hearing impairment; we can use captioning for many other reasons (e.g., quiet place or time, public area, hospital, airport, and where it is hard to hear or disallows loudness, etc.). Crossover applications create a self-contained coherent environment for disabled and non-disabled users. All users can interact in different ways with each other using the same tool with the same result.

As part of software engineering, accessibility can be included into its software development phases [36]. The disability-aware software engineering process model was proposed for incorporating development phases related to enhanced accessibility and usability of software, applications, and systems. However, this research could consider multiple disabilities in software development and the role of human computer interaction in enhancing accessibility and usability. The integration of accessibility provides the requirements of all users, including the disabled, during earlier development phases of software [37]. Three key points that prompt the idea are: (a) accessibility requirements, (b) integration of accessibility requirements in phases of software development, and (c) incorporation of accessibility awareness in designing and modeling the user interface. Although this paper focuses on web accessibility, it describes a conceptual model that can be applicable to other applications. Meeting requirements of real users in design is what ultimately recognizes the usability of interfaces. Therefore, the evaluation of the earlier mentioned work of Manresa-Yee and The "hands-free interface" project [37] was carried on for nine months. The evaluation of their vision-based user interface to enhance computer accessibility was associated with assessing usability together with validating its human computer interaction issues [30].

An idea called "Design-for-all" was proposed recommending that it becomes a practice rather than just an idea [38]. Design-for-all can be referred to as universal design including accessibility since it promotes diversity and more specifically people with disabilities and of advanced age. User participation is the focus and user requirements need to be elaborated on constantly in the design process. Design-for-all is not only for assistive technologies, but also for education, universities, networking, information platforms, engineering centers, award schemes, research, public procurement guidelines, etc. While the research on graphical user interfaces and in interaction techniques has been developed, there is no sufficient connection that exists between them [39]. Another approach that covers accessibility and usability is to provide a custom interface into an existing kiosk interface [12]. This research proposes a configurable user interface in order to customize it for a person with a disability. These approaches can be added to the ready-built user interface without the need of altering or rebuilding the interface or its software, making it cost effective. AEGIS is a project that includes accessibility support in existing user interfaces, assistive tools, and software through using embeddable technologies and techniques [40]. This tremendous project is an open effort and so would be widely available to all.

The disabled person is more likely to abandon academic studies or higher education, especially in science, mathemat-

ISBN: 978-988-19252-0-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

ics, engineering, technology, and the like [41]. This means that a disabled person has less of an opportunity for career success compared to non-disabled [41]. As mentioned previously, businesses have shifted their work toward computer-based infrastructure such as cloud computing. As a result, people with disabilities have an obvious quantitative absence in the computer field and qualitative anxieties too. Ladner and Comden [42] presented a research session – related to AccessComputing – that is aimed at making computing classes and departments accessible. The session was exhibited under the theme of "Diversity through Accessibility" [42]. They presented resources to improve teaching students with disabilities. Clearly, we need to provide the universal design that promotes effective accommodations and expands the range of users' abilities.

IV. Findings

Usability is a key issue since it considers what and how an individual – regardless of his conditions – can benefit from information technology. Universality is a fundamental requirement where information technology is available, accessible and usable, for everybody. Accessibility must be fundamentally contained by the usability and both must support universality for all users as shown in Figure 2. We believe that system accessibility can be accomplished by providing different interactions using existing technology. In addition, integrating interactions into a user interface, would eliminate dependence on assistive tools. This would help to avoid further issues (e.g. compatibility, upgrades, updates...etc.).

Rather than changing the underlying system, more interactive methods could be embedded to make the design more accessible and usable for everyone. Providing a universal application-programming interface (API) that allows adding a variety of user interactive interfaces can effectively help to create inclusive systems and allows developers to create crossover user interfaces. Section 508 will be met as everyone could be included with a reasonable accommodation. In summary, two important focuses of our paper are worth mentioning. First, the acquisition of cloud computing administration skills by the users with disabilities can open more job opportunities for them. Second, independent user interfaces though different mechanisms (input/output devices) should be available and integrated into existing computing systems (e.g. cloud computing).

V. Conclusion

This research has explored the inclusion of everyone – including the disabled – in computing. Users with disabilities face challenges since private companies need not comply with Section 508. Furthermore, the existence of the marginalization of disabled people in computing affects employment opportunities, especially with the business shift to the Internet and cloud computing. We believe that Section 508 and other supportive Acts would be complied with more if low cost solutions, suitable to wide range of users, are available.

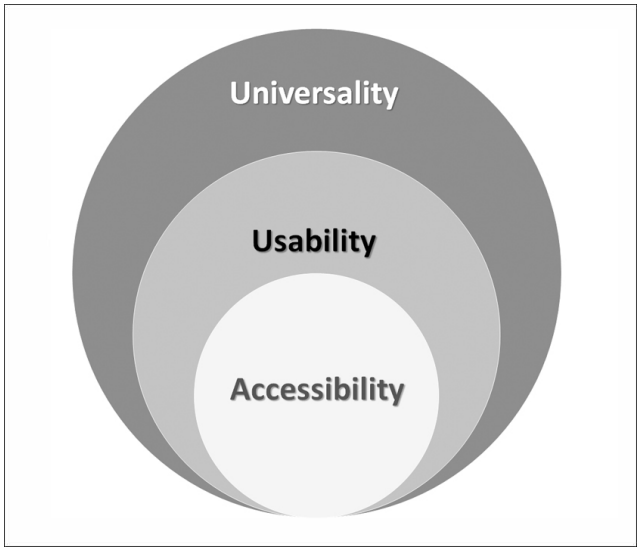

Fig. 2: Stacked Venn diagram shows overlapping relationships between accessibility, usability, and universality in a system.

References

[1] M. Zajicek, "Web 2.0: Hype or happiness?" in *Proceedings of the 2007 International Cross-disciplinary Conference on Web Accessibility*. New York, NY, USA: ACM, 2007, pp. 35–39.
[2] Section508.Gov. Section508 compliance. [Online]. Available: http://www.section508.gov
[3] M. W. Boyce, D. K. Fekety, and J. A. Smither, "Resource consumption and simulator driving performance using adaptive controls," *Assistive technology*, vol. 25, no. 3, pp. 158–165, 2013.
[4] D.E. (2004) Individuals with disabilities education improvement act of 2004. [Online]. Available: http://idea.ed.gov/download/statute.html
[5] *Assistive technology for persons with disabilities*. American Occupational Therapy Association, 1995.
[6] J. Pal, M. Pradhan, M. Shah, and R. Babu, "Assistive technology for vision-impairments: Anagenda for the ictd community," in *Proceedings of the 20th International Conference Companion on World Wide Web*. New York, NY, USA: ACM, 2011, pp. 513–522.
[7] A. Almurayh and S. Semwal, "Cultural considerations for designing crossover applications for the visually impaired," in *Information Reuse and Integration (IRI), 2013 IEEE 14th International Conference on*. IEEE, 2013, pp. 668–675.
[8] DOL. (2014) Disability, health benefits advisor. [Online]. Available: http://www.dol.gov/elaws/ebsa/health/67.asp
[9] D.O.L. (2008) What are "mitigating measures"? [Online]. Available: http://www.dol.gov/ofccp/regs/compliance/faqs/ADAfaqs.htm
[10] C. E. Kelly and J. J. Fader, "Computer-based employment applications: Implications for offenders and supervising officers," *Fed. Probation*, vol. 76, p. 24, 2012.
[11] EEOC. (2001) Eeoc adopts new internal procedures on reasonable accommodation for individuals with disabilities. [Online]. Available: http://www.dol.gov/elaws/ebsa/health/67.asp
[12] A. D. Edwards, "Assistive technologies," in *Web Accessibility*. Springer, 2008, pp. 142–162.
[13] WHO. Disabilities. [Online]. Available: http://www.who.int/topics/disabilities/en
[14] J. Mueller, *Accessibility for Everybody: Understanding the Section 508 Accessibility Requirements*. Apress, 2003.
[15] F. Puhretmair and K. Miesenberger, "Making sense of accessibility in it design - usable accessibility vs. accessible usability," in *Database and Expert Systems Applications, 2005. Proceedings. Sixteenth International Workshop on*. IEEE, 2005, pp. 861–865.
[16] R. Rutter, P. H. Lauke, C. Waddell, J. Thatcher, S. L. Henry, B. Lawson, A. Kirkpatrick, C. Heilmann, M. R. Burks, B. Regan *et al.*, *Web accessibility: Web standards and regulatory compliance*. Apress, 2006.
[17] J. Thatcher. (2011) Web accessibility for section 508. [Online]. Available: http://jimthatcher.com/webcourse1.htm
[18] ADA. (2012) Section 508 report to the president and congress: Accessibility of federal electronic and information technology. [Online]. Available: http://www.ada.gov/508/508˙Report.htm

ISBN: 978-988-19252-0-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

[19] A. Olalere and J. Lazar, "Accessibility of us federal government home pages: Section 508 compliance and site accessibility statements," *Government Information Quarterly*, vol. 28, no. 3, pp. 303–309, 2011.

[20] D. M. Cowan and Y. Khan, "Assistive technology for children with complex disabilities," *Current Paediatrics*, vol. 15, no. 3, pp. 207–212, 2005.

[21] Z. Hua and W. L. Ng, "Speech recognition interface design for in-vehicle system," in *Proceedings of the 2Nd International Conference on Automotive User Interfaces and Interactive Vehicular Applications*, ser. AutomotiveUI '10. New York, NY, USA: ACM, 2010, pp. 29–33.

[22] K. Shinohara, "A new approach for the design of assistive technologies: Design for social acceptance," *SIGACCESS Access. Comput.*, no. 102, pp. 45–48, Jan. 2012.

[23] S. Martin, J. E. Bengtsson, and R.-M. Dröes, "Assistive technologies and issues relating to privacy, ethics and security," in *Supporting People with Dementia Using Pervasive Health Technologies*. Springer, 2010, pp. 63–76.

[24] Adobe. Prevent security settings from interfering with screen readers. [Online]. Available: http://help.adobe.com/en˙US/acrobat/X/pro/using

[25] Google. Accessibility: Assistive technology support. [Online]. Available: https://sites.google.com/a/chromium.org/dev/user-experience/assistive-technology-support

[26] J. Lazar and H. Hochheiser, "Legal aspects of interface accessibility in the u.s." *Commun. ACM*, vol. 56, no. 12, pp. 74–80, 2013.

[27] H. Vieritz, D. Schilberg, and S. Jeschke, "Merging web accessibility and usability by patterns," in *Computers Helping People with Special Needs*, ser. Lecture Notes in Computer Science. Springer Berlin Heidelberg, 2010, vol. 6179, pp. 336–342.

[28] Z. Wisniewski and A. Polak-Sopinska, "HCI standards for handicapped," in *Universal Access in Human-Computer Interaction. Addressing Diversity*, ser. Lecture Notes in Computer Science, C. Stephanidis, Ed. Springer Berlin Heidelberg, 2009, vol. 5614, pp. 672–676.

[29] J. Varona, C. Manresa-Yee, and F. J. Perales, "Hands-free vision-based interface for computer accessibility," *Journal of Network and Computer Applications*, vol. 31, no. 4, pp. 357–374, 2008.

[30] C. Manresa-Yee, J. Varona, F. J. Perales, F. Negre, and J. J. Muntaner, "Experiences using a hands-free interface," in *Proceedings of the 10th International ACM SIGACCESS Conference on Computers and Accessibility*, ser. Assets '08. ACM, 2008, pp. 261–262.

[31] D. F. Rodrigues and J. P. Neto, "A spoken interface for an operating system," in *Applications of Portuguese Speech and Language Technologies*, Propor 2008 Special Session. Microsoft Language Development Center, 2008.

[32] C. G. Pires, F. M. Pinto, E. M. Rodrigues, and M. S. Dias, "On the benefits of speech and touch interaction with communication services for mobility impaired users," in *AAL*, 2011, pp. 60–73.

[33] D. McGookin, S. Brewster, and W. Jiang, "Investigating touchscreen accessibility for people with visual impairments," in *Proceedings of the 5th Nordic Conference on Human-computer Interaction: Building Bridges*, ser. NordiCHI '08. New York, NY, USA: ACM, 2008, pp. 298–307.

[34] B. Wilke, J. Metzgar, K. Johnson, S. Semwal, B. Snyder, K. Yu, and D. Neafus, "Crossover applications," in *Proceedings of the 2009 IEEE Virtual Reality Conference*. Washington, DC, USA: IEEE Computer Society, 2009, pp. 305–306.

[35] S. K. Semwal, "Collaborative crossover applications," in *Collaboration Technologies and Systems (CTS), 2012 International Conference on*. IEEE, 2012, pp. 636–637.

[36] J. T. Nganji and S. H. Nggada, "Disability-aware software engineering for improved system accessibility and usability." *International Journal of Software Engineering & Its Applications*, vol. 5, no. 3, pp. 47–62, 2011.

[37] H. Vieritz, D. Schilberg, and S. Jeschke, "User interface modelling for accessible web applications with the unified modelling language," in *Automation, Communication and Cybernetics in Science and Engineering 2011/2012*. Springer Berlin Heidelberg, 2013, pp. 939–951.

[38] C. Bhler, "Design for all-from idea to practise," in *Computers Helping People with Special Needs*, ser. Lecture Notes in Computer Science. Springer Berlin Heidelberg, 2008, vol. 5105, pp. 106–113.

[39] D. Burkhardt, K. Nazemi, N. Bhatti, and C. Hornung, "Technology support for analyzing user interactions to create user-centered interactions," in *Universal Access in Human-Computer Interaction. Addressing Diversity*, ser. Lecture Notes in Computer Science. Springer Berlin Heidelberg, 2009, vol. 5614, pp. 3–12.

[40] P. Korn, E. Bekiaris, and M. Gemou, "Towards open access accessibility everywhere: The gis concept," in *Universal Access in Human-Computer Interaction. Addressing Diversity*, ser. Lecture Notes in Computer Science. Springer Berlin Heidelberg, 2009, vol. 5614, pp. 535–543.

[41] S. Burgstahler and R. Ladner, "Increasing the participation of people with disabilities in computing fields," *Computer*, vol. 40, no. 5, pp. 94–97, 2007.

[42] R. E. Ladner and D. Comden, "Computer science for everyone: Making your computing classes and departments accessible," *SIGCSE Bull.*, vol. 40, no. 1, pp. 547–548, 2008.

ISBN: 978-988-19252-0-6
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)