

장애인 웹 접근성 향상방안 연구☆

A Study on Improvement Plan of Web Accessibility for the Disabled

전 우 천¹
Woochun Jun

홍 석 기^{2*}
Suk-Ki Hong

요 약

최신 정보통신기술의 발달에 힘입어 우리의 삶은 매우 빠르게 변하고 있으며 삶 자체의 스타일도 크게 영향을 받고 있다. 현대 지식정보화 사회에서 장애인들도 진보한 정보통신기술의 혜택을 누릴 수 있는 권리가 있다. 하지만, 정보격차라는 장벽이 존재하여 장애인들이 정보통신기술로 세상과 소통하는 데 어려움이 있다. 이러한 관점에서, 정보격차를 줄여서 장애인들로 하여금 정보통신기술의 혜택을 누릴 수 있도록 해야 한다.

최근에 장애인과 비장애인 사이에 정보격차를 줄이기 위한 다양한 연구가 진행되고 있다. 정보격차를 줄이기 위한 다양한 시도들 중에서, 웹 접근성의 향상이 가장 큰 관심사이다. 이것은 웹이 다양한 정보통신기술 도구들 중에서 아직까지 가장 널리 쓰이는 대표적인 도구이기 때문이다.

본 논문의 목적은 장애인들을 위한 웹 접근성 향상을 위한 실제적인 가이드라인을 제안하는 것이다. 본 논문에서 제안하는 개선방안은 기존의 웹 접근성 향상 방안에 기초를 두고 있으며 장애인들에 더 적합하게 수정하고 개선한 방안들이다. 본 논문에서 제안하는 웹 접근성 향상방안은 다음과 같은 원리를 가지고 있다. 첫째, 입력을 확인한 후 전송하게 한다. 둘째, 즉각적인 응답요구를 금지한다. 셋째, 필요하면 내용을 저장하거나 기록할 수 있어야 한다. 넷째, 물리적인 움직임을 최소화한다. 다섯째, 다양한 상호작용 기능을 제공한다.

☞ 주제어 : 웹 접근성, 장애인, 정보격차

ABSTRACT

Owing to recent advanced techniques in information and communication technology(ICT), our daily life has been changing very quickly and our life style has also been affected greatly. In the current knowledge and information society, the disabled can have a right to enjoy benefits of advanced ICT technologies. However, there is a barrier called digital divide so that the disabled have some difficulties to communicate to the world with ICT technologies. In this sense, our job is to close digital divide and let the disabled enjoy benefits of ICT technologies.

Recently there have been some research works to close digital divide between the disabled and the non-disabled. Among various attempts to close digital divide, improving web accessibility for the disabled is the biggest concern since web is a still representative tool among ICT tools.

The purpose of this paper is to propose some practical guidelines for improving web accessibility for the disabled. The proposed improvement guidelines are developed based on the existing web accessibility guidelines and are upgraded for more adaptable to the disabled. Our principles are based on the following philosophy. First, any input transmission must be more confirmed. Second, prevent any instant request. Third, allow the disabled to record or store the contents if necessary. Fourth, reduce physical movement for the disabled. Fifth, provide more interaction tools for the disabled.

☞ keyword : Web Accessibility, the Disabled, Digital Divide

1. Introduction

With aid of advanced ICT technologies, our daily life has

been changing very quickly. The advanced ICT techniques make our life very abundant and fast in every aspect of our life. In the current knowledge and information society, everyone is eligible for enjoying the benefits of advanced ICT technologies. Especially those techniques would be very helpful and essential for the physically or mentally disabled who can hardly enjoy normal life. Among various barriers to the disabled in daily life, so called digital divide is a big barrier nowadays.

A digital divide is formally defined as follows [1,2]. A

¹ Dept. of Computer Education, Seoul National University of Education, Seoul,137-742, Korea.

² Dept. of Management, Dankook University, Jukjeon, Gyeonggi-do, 448-702, Korea

* Corresponding author (skhong017@dankook.ac.kr)

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digital divide is an economic inequality between groups, broadly constructed, in term of access to, use of, or knowledge of information and communication technologies. Also, the divide inside countries can refer to inequalities between individuals, households, business, and geographic areas at different socioeconomic and other demographic levels, while the global digital divide designates countries as the units of analysis and examines the divide between developing and developed countries on an international scale.

In order to close the digital divide between the disabled and the non-disabled, we need to support various efforts including technical issues. Among those technical issues and solutions, improving web accessibility is the biggest concern for all. This is because web is still representative ICT tool and widely used for both the disabled and the non-disabled. Web accessibility means that people with disabilities can use the Web[3]. Web accessibility is that people with some kinds of disabilities can perceive, understand, navigate, and interact with the web, and that they can contribute to the web. Web accessibility encompasses all kinds of disabilities that affect access to the web, including visual, auditory, physical, speech, cognitive, and mental disabilities.

The purpose of this paper is to propose new guidelines for improving web accessibility. For this purpose, formal definition and issues about digital divide and web accessibility are introduced. The current status of web accessibility is followed. Based on the current status analysis and new guidelines are proposed.

The paper is organized as follows. In Section 2, the current status of digital divide, necessity of web accessibility, and the current status of web accessibility are introduced. Also, the existing web content accessibility guidelines are introduced. Then new guidelines are developed and proposed in Section 3. Finally, in Section 4, conclusions and further research issues are discussed.

2. Related Works

2.1. The Current Status of Digital Divide

In [4], the extensive survey works for digital divide have been published. The purpose of the research is to investigate digital divide for the neglected class of our society, The

neglected class includes the disabled, low-income group, farmers and fishermen, and the aged.

Our concern in the work is digital divide for the disabled. The digital divide is classified into 2 categories in [4]. Two categories are PC-based digital divide and mobile digital divide, respectively.

PC-based digital divide consists of three further categories: access divide(access to PCs and internet), competence divide(capability to use ICT hardware devices and software), and application divide(capability to apply ICT techniques into daily life like problem-solving). Assuming that the general public have 100 of informatization level, the disabled have 83.4 in the year of 2012. It means that PC-based digital divide for the disabled is 16.6. Especially access divide is 6.1, competence divide is 21.0, application divide is 25.9.

As an optimistic point of view, digital divide has been closed year by year: 42.5(2004), 26.1(2006), 21.2(2008), 19.7(2009), 18.7(2010), 17.8(2011), 16.6(2012). From above survey results, we can conclude that, for PC-based divide, the divide has been closed gradually. Also, the ratio of PC distribution is high, however, technical capability to use ICT tools and application capability to use those tools in their daily life are still low. In the meanwhile, PC-based digital divide for other neglected class in the year of 2012 is as follows: the low-income group: 17.8, farmers and fishermen: 35.2, the aged: 28.8.

Mobile digital divide consists of three further categories: mobile digital access divide, mobile digital competence divide, and mobile digital application divide. Mobile digital access divide means ratio of possession of mobile internet access devices. Mobile digital competence divide means capability to use various mobile services such as shopping, banking, e-government, SNS use, etc. Finally, mobile digital application divide is ratio of utilization and diversity of mobile internet.

Mobile digital divide for the disabled is much bigger than PC-based digital divide. In [4], in the year of 2012, mobile digital divide is 30.2(mobile digital access divide: 34.1, mobile digital competence divide: 27.6, mobile digital application divide: 31.1). We can conclude that, in every aspect of mobile digital divide, mobile digital divide is low. Also, we can see that ratio of possession of mobile internet devices are low so that competence and application capability are also low. In the meanwhile, mobile digital divide for other neglected class

is as follows: the low-income group: 46.1, farmers and fishermen: 25.3, the aged: 22.2.

The overall conclusion is that the disabled can enjoy the benefits of PC-based environments while they are suffering from mobile environments. The immediate issue is that the disabled need to have mobile devices with various laws and regulations, and also technical issues like providing good user interface of mobile devices for the disabled and providing various teaching-learning methods for use of ICT and mobile technologies.

2.2. Web Accessibility

In the literature, it is known that the main cause of digital divide is web accessibility [5]. Web is a representative technique among various ICT techniques [6]. In our daily life, most activities of using internet, like visiting web sites and enjoying online shopping are based on the web. Digital divide may be resulted from internet environments such as lack of PCs and wired/wireless internet communication lines. However, regardless of internet environments, there are some class who cannot access to and use of internet technologies and services. The typical type of the class is the disabled including the visually handicapped, the hearing-impaired, and mentally handicapped, etc.

For the initial web browsers, the disabled might have not big problems to access and use to web since most web contents were text-based. But, recently, with an aid of fast internet access lines, web contents have more non-text contents including graphic contents, animation contents, video contents, and sound contents. The disabled such as the visually-impaired, the hearing-impaired, the physically-impaired persons may have some problems to use web. For example, the visually-impaired may not see monitor screen. The hearing-impaired may not hear sound from PCs or notebooks. The physically-impaired persons may not move a mouse easily.

The purpose of the web is to let everyone access and use the web contents easily and conveniently. The disabled have a right to access and use the web like the non-disabled. That is the reason that we need to improve web accessibility. Surely web accessibility is not only for the disabled. However, the biggest beneficial of web accessibility is the disabled. In other

words, if the disabled can use the web conveniently, everyone also can use the web conveniently.

2.3. The Existing Web Accessibility Guideline

The World Wide Web Consortium(W3C) is an international community that develops open standards to ensure the long-term growth of the Web. W3C has announced Web Content Accessibility Guidelines(WCAG 2.0) in December 2008 [7]. The guidelines are the latest world class version so far. Now the guidelines are the global standards to be followed by every nation and every organization, etc.

The guidelines have the following four principles, which lay the foundation necessary for anyone to access and use web contents. The principles are explained in Table 1.

(Table 1) Four principles for web accessibility[7]

| Principle | Description |
|----------------|--|
| Perceivable | Information and user interface components must be presentable to users in ways they can perceive |
| Operable | User interface components and navigation must be operable |
| Understandable | Information and the operation of user interface must be understandable |
| Robust | Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies |

Perceivable means that users must be able to perceive the information being presented. That is, it can't be invisible to all of their senses. *Operable* means that users must be able to operate the interface(the interface cannot require interaction that a user cannot perform). *Understandable* means that users must be able to understand the information as well as the operation of the user interface(the content or operation cannot be beyond their understanding). *Robust* means that users must be able to access the content as technologies advance(as technologies and user agents evolve, the content should remain accessible).

According to WACG 2.0, if any of four principles is not true, users with some kinds of disabilities will not be able

to use the Web. Each principle has its own guidelines to implement and specify the principle further. The followings are guidelines for each principle.

Principle 1. Perceivable

Guideline 1.1: Text Alternatives

Provide text alternatives for any non-text contents so that it can be into other forms people need, such as large print, Braille, speech, symbols or simpler language.

The purpose of this guideline is to ensure that all non-text contents are also available in text form.

Guidance 1.2: Time-based Media

Provide alternatives for time-based media.

The purpose of this guideline is to provide access to time-based and synchronized media.

Guideline 1.3: Adaptable

Create contents that can be presented in different ways(for example simpler layout) without losing information or structure.

The purpose of this guideline is to ensure that all information is available in a form that can be perceived by every user, for example, spoken aloud, or presented in a simpler visual layout. If all of the information is available in a form that can be determined by software, then it can be presented to users in differently (such as visually, audibly, tactilely, etc.).

Guideline 1.4: Distinguishable

Make it easier for users to see and hear content including separating foreground from background.

While some guidelines are focused on making information available in a form that can be presented in alternative formats, this guideline is concerned with making the default presentation as easy to perceive as possible to the disabled. The main focus of this guideline is on making it easier for users to separate foreground information from the background. For visual presentations, it is to ensure that information

presented on top of a background contrasts sufficiently with the background. On the other hand, for audio presentations, it is to ensure that foreground sounds are sufficiently louder than the background sounds.

Principle 2. Operable

Guideline 2.1 Keyboard Accessible

Make all functionality available from a keyboard

If all functionality can be implemented by using only keyboard, it can be achieved by keyboard users, by speech input (that creates keyboard input subsequently), by mouse(including on-screen keyboards), and by any other kinds of assistive technologies that can create simulated keystrokes as their output. Also, note that providing universal keyboard input does not mean that other types of input should not be supported.

Guideline 2.2: Enough Time

Provide users enough time to read and use contents

The disabled may need more time to finish their jobs than the non-disabled users. This is because they may need longer time to respond physically or mentally and read things, etc. This guideline is to ensure that users are able to complete their jobs required by the content with their own speed. The primary way is to eliminate time constraints or provide enough extra time to allow them to finish their works.

Guideline 2.3: Seizures

Do not design content in a way that is known to cause seizures.

Some people with seizure disorders may have a seizure triggered by flashing visual content while most people are unaware that they have this disorder until it strokes. The purpose of this guideline is to ensure that content satisfying WCAG 2.0 avoids the types of flash that are likely to cause any seizure when viewed even for a second or two.

Guideline 2.4: Navigable

Provide ways to help users navigate, find content, and determine where they are.

The purpose of this guideline is to help users find the content they need to access and allow them to keep track of their location. Usually these tasks are more difficult for the disabled. For finding and navigation, it is important to let users find out where they are. Also, for navigation, information about the possible destinations needs to be available.

Principle 3: Understandable

Guideline 3.1: Readable

Make text content readable and understandable.

The purpose of this guideline is to allow text content to be read by any users, and to ensure that information necessary to understand is available. The disabled may experience text in different ways. The text content can be read visually, audibly, tactilely, etc.

Guideline 3.2: Predictable

Make web pages appear and operate in predictable ways.

The purpose of this guideline is to help the disabled by presenting content in a predictable order from web page to web page. Also, it is to make the behavior of functional and interactive components predictable. For some users, it is difficult to form an overview of the web page. Users with cognitive disorders may be confused if web components appear in different places on different pages. Placing repeated components in the same relative order within a set of web pages allow users with reading disabilities to focus on an area of the screen. Also, users with limited use of their hands can finish their works using the fewest keystrokes.

Guideline 3.3: Input Assistance

Help users avoid and correct mistakes.

Usually the disabled may have more difficulty creating error-free input than the non-disabled. Furthermore, for the disabled, it is hard to detect that they have made an error. The usual error indication methods may not be obvious to them because of a limited field of view, limited color perception, or use of assistive technologies. The purpose of this guideline is to reduce the number of serious or irreversible errors that

are made. So it is important to increase chances that all errors will be noticed by the user, and help users understand what to do for correcting an error.

Principle 4: Robust

Guideline 4.1: Compatible

Maximize compatibility with current and future user agents, including assistive techniques.

The purpose of this guideline is to support compatibility with current and future agents, especially assistive technologies. This can be achieved by 1) ensuring that web authors do not do things that could break assistive technologies (for example, poorly formed markup) or circumvent assistive technologies (for example, by using unconventional markup or code) and 2) exposing information in the content in standard manners that assistive technologies can recognize and interact with. Information and communication technologies change very quickly. Thus assistive technology developers have difficulty to keep up with new technologies. It is important that content should follow conventions and be compatible with API (Application Programming Interface) so that assistive technology can go along with new technologies as they evolve.

2.4. Literature Reviews

In [8], some guidelines to improve web accessibility for the disabled are developed based on WCAG 2.0 guidelines. The proposed guidelines are as follows.

Principle 2: Operable

Guideline 2.5: Help Menu

Provide help menu for all web contents.

The purpose of this principle is to help the disabled navigate easily and conveniently. The help menu includes the summary of the web usage, copyright protection policy, view download, and personal information protection guidance, and any other useful menu.

Guideline 2.6: Sitemap menu

Provide help sitemap for all web contents.

The purpose of this guideline is to provide overall menu structures of the web content for the disabled. With aid of sitemap, the overall menu can be identified easily at a glance.

Guideline 2.7: Mobile

Provide mobile content and usage to download it.

The purpose of this guideline is to provide mobile contents and information on how to download or link to the mobile content. Usually the mobile contents can be downloaded to smart devices via Twitter or Facebook services.

Principle 3: Understandable

Guideline 3.5: Input Minimization

Minimize input and provide alternatives for text input.

The purpose of this guideline is to help the disabled type input as little as they can. The more input may cause the possible errors and the physical fatigue to the disabled. Also, instead of writing long sentence, provide alternatives such as voice recording and Webcam recording, etc.

Guideline 3.6: Single-page Content

Do not let the disabled use scroll bar.

Single-page document means that all contents are just fitted in a normal page frame in web browser so that users need not to use scroll bar using mouse or page down key[9]. If contents are longer than a single page frame, provide extra contents to a new page. In this case, the new page is connected to the old page via link. The link is usually located in the bottom of the previous page. If there are still contents that cannot be fitted in the new page, make another web page likewise.

The single-page content is very useful for the disabled because it can minimize the physical movement and provide the consistent content structures all the time.

Guideline 3.7: Instant Guidance to Input

Provide an instant feedback to input

The purpose of this guideline is to provide the instant guidance to any kind of input. Usually, users may cause some errors when they first encounter input menus. This can be

implemented as various manners. The easiest way is to use mouse-over property. The mouse-over property can be implemented easily by way of JavaScript Form.

In [10], the current status of web content accessibility on general hospital websites is presented. Their research results show that the rate of compliance with web accessibility was generally insufficient. They insist that, for improvement of the realization of web accessibility, more efforts need to be put for constant education and promotion, and there can be an institutional supplementation, etc.

In [11], a web accessibility compliance framework is proposed. The proposed web accessibility framework is developed primarily for banking. The framework is developed for the general public so that the disabled can easily access to bank with aid of the framework.

In [12], the design guidelines for improving web accessibility of disabled people are proposed. The study, first, analyzed various web accessibility requirements based on web standards, web accessibility guidelines, and the related researches and proposed a web accessibility checklist with 42 requirements. Next, the study evaluated 15 websites of public institutions such as government departments, association of disabled people, and public libraries using the checklist. Finally, the study revealed non-adherence requirements and suggested website design guidelines in terms of contents configuration, sound, color, keyboard handling, mouse handling, access, image processing, text processing, and code processing.

In [13], CMS(Content Management System) is developed for everyone to be able to access to information easily in the mobile/web environments that are changing rapidly. The CMS is designed and manufactured based on KWACG, W3C XHTML-1.0-Strict DTD, W3C CSS2 web accessibility and web standards. CMS builder is a WYSIWYG manner making it easy to use and manage, as well as a variety of the web was to operate in a mobile environment.

3. Improvement Plan of Web Accessibility

3.1. The Basic Principles

In this section, principles for improving web accessibility are introduced. The basic principles are as follows.

First, any input transmission must be confirmed. For example, if a user is trying to save the web form and is ready to send the form, the request should be confirmed before transmission. By doing this, the user can check their input again and prevent any unintended mistakes.

Second, prevent any instant request. Those instance requests include instant popup menu and instant request with time limit. The disabled can hardly give respond to the request.

Third, allow the disable to record or store the contents if necessary. This enables the disabled to use the contents later. For example, the disabled may need to record sound message and store some portion of web contents later use. In this case, those record or store command function must be activated.

Fourth, reduce physical movement for the disabled. The disabled can have longer time to take an action on the web.

Fifth, provide more interaction tools. For the disabled, they may need more interaction tools to communicate each other. For example, for the visually-impaired disabled, sending voice email instead of email should be available for send a message.

3.2. Improvement Guidelines

In this section, new guidelines for improving web accessibility to the disabled are developed. The practical guidelines are developed based on the existing WCAG 2.0 guidelines and the existing work in [8].

Principle 1. Perceivable

Guideline: Interaction

Provide alternative communication tools for more interaction

The purpose of this guideline is to provide alternative communication tools for the disabled in order to communicate each other. For example, for the visually-impaired persons, voice email should be available instead of the typical email.

Principle 2: Operable

Guideline : Instant Request

Prevent any kind of instant request to the disabled.

The purpose of this principle is to prevent any instant request to the disabled. The typical instant request is request

through the popup menu or sound message without repeat function. Those instant requests are usually hard to catch up for the disabled. So, in order to improve web accessibility, prevent or reduce the instant request.

Guideline : Record

Let the disabled record or store web contents

The purpose of this guideline is to allow the disabled to record or store web contents for later use. For time-based contents such as sound messages, those contents must be recored so that the disabled can re-read or re-listen later.

Principle 3: Understandable

Guideline: Icon Maximization

Maximize icons to reduce physical movement

The purpose of this guideline is to allow the disabled to choose icons with less physical efforts. According to the Fitts's law[14], any menu size must be reasonable. The Fitts's law is explained using the following mathematical formula.

$$T = a + b \log_2 \left(1 + \frac{D}{W} \right)$$

Where

-T is the average time taken to complete the movement.

-a represents the start/stop time of the device.

-b represents the inherent speed of the device(a and b are determined experimentally by fitting a straight line to measured data).

-D is the distance from the starting point to the center of the target.

-W is the width of the target measured along the axis of motion.

This guideline means that any menu or icon should be reasonable size. That is, the menu or icon should not be too small. The reason is that, for the disabled, it is hard to find and move to the small menu or icon. With the reasonable size menu or icon, the average movement time can be minimized.

Principle 4: Robust

Guideline: Confirmable

Any input must be confirmed before transmission

Any input request and transmission must be checked and confirmed before store and transmission. This enables the disabled to think twice before taking an action. This also enables the disabled to prevent unintended mistakes. If possible, any mistake or unintended input must be undone.

4. Conclusions and Further Works

With aid of recent advanced ICT technologies, our life style has been changing very quickly. Everyone can now enjoy the benefits of those advanced technologies every day. However, the disabled usually cannot enjoy the same life as the non-disabled due to the physical or mental handicap.

In the current knowledge and information-based society, the disabled can communicate to the world via diverse ICT techniques. However, there is a barrier called digital divide. In the literature, the main cause of digital divide is web accessibility. This is because the web is still a representative tool for the current PC-based society and even mobile environment.

The purpose of this paper is to investigate the current status of web accessibility and develop new guidelines for improving web accessibility. For this purpose, the current status of digital divide and issues in web accessibility are introduced.

The basic principles for the new guidelines are as follows. First, any input transmission must be more confirmed. Thus, users can check their input again and prevent any unintended mistakes. Second, prevent any instant request. The disabled can have hard time to give respond to the request quickly. Third, allow the disabled to record or store the contents if necessary. This enables the disabled to use the contents later. Fourth, reduce physical movement for the disabled. The disabled can have longer time to take an action on the web. Fifth, provide more interaction tools for the disabled. For the disabled, they may need more interaction tools to communicate each other.

In this paper, five practical guidelines are developed based on the existing web accessibility guidelines for different categories: perceivable, operable, understandable, robust, respectively.

Further research issues are as follows.

First, we need to develop the specific guidelines and techniques to implement the proposed guidelines. Every techniques should be implemented on web browser or related environment.

Second, we can extend our work to the smart environments. Although ratio of possession of smart devices for the disabled is low, the ratio is getting higher. Thus we will develop new guidelines to improve web accessibility in smart environment.

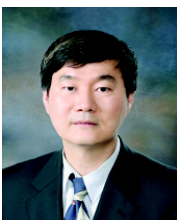
Third, more teaching-learning methods should be developed and distributed to let the disabled learn ICT technique use. As we can see from the digital divide survey report, especially for PC-based environment, the disabled have some difficulties to use ICT techniques. This is due to that their chances to learn and apply new techniques have not been enough.

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● 저 자 소 개 ●



전 우 천 (Woochun Jun)

1985년 서강대학교 전산학과 졸업(학사)
1987년 서강대학교 대학원 전산학과 졸업(석사)
1997년 School of Computer Science, University of Oklahoma 졸업(박사)
1998~현재 서울교육대학교 컴퓨터교육과 교수
관심분야 : 장애인정보화교육, 정보영재, 정보통신윤리, etc.
E-mail : wocjun@snue.ac.kr



홍 석 기 (Suk-Ki Hong)

1986년 서강대학교 경제학과 졸업(학사)
1996년 University of Nebraska-Lincoln, Management 졸업(박사)
2003~현재 단국대학 경영학과 교수
관심분야 : e-Business, e-Service, SCM.
E-mail: skhong017@dankook.ac.kr