장애인을 위한 스마트 애플리케이션 접근성 향상 가이드라인 개발 연구

전우천

서울교육대학교 컴퓨터교육과

요 약

현대 정보 사회에서 정보격차라는 장벽이 존재한다. 이러한 장벽 때문에 장애인들은 세상과 소통하는 데 어려움이 있다. 최근 스마트 기술의 발달에 따라 스마트 기기는 장애인들에게 필수품이 되어가고 있다. 현재 장애인들의 스마트 애플리케이션 접근성 향상은 큰 관심을 받고 있다. 본 논문의 목적은 장애인의 스마트접근성 향상을 위한 가이드라인을 개발하는 것이다. 이 가이드라인은 기존의 모마일 접근성 가이드라인에 기초를 두고 개발하였다. 가이드라인은 다음과 같다. 즉, 스마트기기에서 청색 최소화, 입력창에 자동 포커스 제공, 행위 추적, 폰트 칼라 변경 가능, 모션에 의한 응급상황 공지, 제스처 인식, 컨트롤 위치, 스크롤링 금지, 시각경고메시지의 음성화 서비스, 아이콘에 대한 텍스트레벨 부착 등을 포함한다.

키워드 : 정보격차, 장애인, 스마트 애플리케이션 접근성, 모바일 접근성, 정보통신기술

A Study on Development of Enhancement Guidelines of Smart Application Accessibility for the Disabled

Woochun Jun

Dept. of Computer Education, Seoul National University of Education

ABSTRACT

In current information society, there is a barrier called digital divide. Due to this barrier, the disabled have difficulties to communicate with the world. Recently, with advanced smart techniques, smart devices become necessity for the disabled. Currently improvements of smart application accessibility become a great concern for the disabled. The purpose of this paper is to present some guidelines for enhancing smart application accessibility for the disabled. The enhancement guidelines are developed based on the existing mobile accessibility guidelines and modified for better adaptability for the disabled. Our principles are as follows: minimizing blue light emission from smart devices, automatic focus on input window, action trace, font color change, emergency notification by motion, gesture recognition, control location, scrolling avoidance, auditory service for visual warning, and icon literation.

Keywords : Digital Divide, The Disabled, Smart Application Accessibility, Mobile Accessibility, ICT

1. Introduction

With aid of advanced ICT and smart technologies, our life style has been changing very conveniently. The advanced techniques have our life very enjoyable in every aspect of our life. In the current information and knowledge society, everyone has a right to enjoy the benefits from those advanced technologies for abundant life. Those techniques can also be very useful for the physically or mentally disabled who have some difficulties to enjoy normal life. Among various kinds of barriers to the disabled, *digital divide* becomes a serious barrier in the current information and knowledge society.

A digital divide is formally defined as follows [8][18]. A digital divide is an economic inequality between groups, broadly constructed, in term of access to, use of, or knowledge of ICT. 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, various efforts have been made as follows [5][9]. First, new smart devices are developed and distributed for the disabled. The typical devices include tablet PCs and smart phones with advanced assistive technologies. Second, ICT education has been provided for the disabled. ICT education can be classified into two categories: ICT literacy education and application education. ICT literacy education means education about the basic knowledge of ICT. The knowledge includes how to use ICT and smart techniques and devices. However, ICT application education is education dealing with how to apply ICT techniques to problem-solving in daily life. Both of ICT literacy education and applica-

tion education are mutually supporting each other. It means that one cannot exist without the other.

With advances in smart technologies, smart devices become necessity for all including the disabled. For the disabled as well as the non-disabled, active use of smart application can improve the quality of life. Smart application accessibility means accessibility for smart application software[9]. Our concern is to increase smart application accessibility so that more disabled can enjoy the benefits from smart software.

The purpose of this paper is to propose new practical guidelines for enhancing smart application accessibility. For this purpose, the existing research works of smart application accessibility are introduced. Based on current analysis of the existing research, new enhancement guidelines are proposed.

The rest of this paper is organized as follows. In Section 2, the current status of smart digital divide is introduced. Also, the existing smart application 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 Smart Digital Divide

National Information Society Agency announced digital divide status for the disabled [13]. In [13], the digital divide for the smart environment is measured using a standard called the *smart digital divide*. The smart digital divide is the digital divide in the smart environment. Smart digital divide consists of three categories: smart digital access divide, smart digital competence divide, and smart digital application divide. The smart digital access divide means the ratio of citizens who use smart devices and of those

who don't. Smart digital competence divide is one's capability to use various smart application services. Finally, smart digital application divide is the ratio of utilization and diversity of wireless internet. Also, the overall smart digital divide is composed of smart digital access divide (20%), smart digital competence divide (40%), and smart digital application divide (40%), respectively.

In [13], it is assumed that the informatization level of all citizens is 100. First, PC-based digital divide for the disabled is as follows; overall digital divide is 83.8 (digital access divide: 94.7, digital competence divide: 79.8, digital application divide: 74.6). Second, smart digital divide for the disabled is as follows; overall digital divide is 49.2 (digital access divide: 64.3, digital competence divide: 37.3, digital application divide: 49.2). As indicated in the above statistics, the smart digital divide is much bigger than the existing PC-based digital divide. It means that the disabled have less smart devices and less application knowledge on how to use and apply smart technologies in their daily life. For the three smart digital divide indexes, smart digital competence divide has the lowest score. It is necessary to provide various education opportunities for the disabled on how to use smart application services.

2.2 The Existing Mobile Accessibility Guidelines

In [12], mobile accessibility improvement guidelines are presented. There are seven mandatory requirements to be observed. The followings are seven requirements and their brief descriptions.
① (Alternative Text) Non-text contents must provided with alternative text.
② (Focus) Focus must be applicable to all objects, and focus must be moved sequentially.
③ (Operating System Accessibility Function Support) Accessibility functions and attributes that are provided by operating system must be supported.

④ (Press Operation Support) All controls must be controlled with touch or tap operation.
⑤ (Recognition regardless of Color) All information represented in screen must be recognized regardless of color.
⑥ (Luminosity Contrast) All information represented in screen must be recognized with minimum luminosity contrast so that one can identify foreground color from background color.
⑦ (Providing caption and sign language) Multimedia contents must be provided the equivalent caption and sign language contents.

There are eight recommended improvements for mobile accessibility.
① (Native UI Component) Use of native UI components provided by operating system must be maximized.
② (Enough Space among Controls) Controls must be placed with enough space among them.
③ (Alarm Function) If alarm function is used for users, as many audible and visual options such as vibration, light, and sound must be provided.
④ (Use of General Font) The size adjust and expansion function of fonts must be provided, and all methods to use related functions supported by operating system must be provided.
⑤ (Consistency of User Interface) The placement of user interface elements must be provided with consistency.
⑥ (Restriction of Blinking Use) Contents that may cause seizure from light sensitivity must be able to be turned off.
⑦ (Restriction of Background Sound) Background music played automatically must not be used.
⑧ (Evaluation for the Disabled User) Disabled citizens must be used during application development and testing.

On the other hand, BBC announced mobile acces-

sibility guidelines[4]. The guidelines have the following three principles.

First, use platform and web standards as intended. It means that use always web and platform specific standards as intended. When standards and guidelines are implemented using non-standard techniques, there can be a risk that users who depend on platform specific accessibility features such as accessibility settings and screen readers will be excluded from accessing the contents.

Platform specific guidelines include the iOS Accessibility Guidelines[3], the Android User Interface Guidelines[1] and the Designing for Accessibility portion of the Android guideline[2]. For the web, there are the Web Content Accessibility Guidelines[16] as well as Mobile Accessibility resources[17] from W3C.

Second, use standard user interface controls where possible. Standard user interface controls, objects, and elements should be used to ensure a greater level of accessibility. Custom controls tend to not implement accessibility as fully as standard platform controls, For instance, in iOS standard, controls will have traits assigned that are understood by VoiceOver and therefore users.

Third, support platform accessibility. It means that all content and functionality must work alongside, and not suppress, native accessibility and features and settings.

For navigation methods, all content must be accessible and navigate using the platforms navigation paradigm for assistive technology. For instance, the directional controller must be supported on Android to allow users of the TalkBack screen reader to review and navigated page document. Android requires that all elements must be keyboard accessible so they can be accessed with a d-pad or track ball. Android 4.0 has lessened this requirement by including an "Explore by Touch" method.

On iOS, it is possible to hook items into the Accessibility API by ensuring all meaningful items have accessibility enabled which in turn makes them focusable.

Also, support platform assistive technologies or features. When applications or sites block, disable, or interfere with platform specific accessibility features or technology, the disabled may not be able to use the site or app. Potential issues include suppressing zoom on web sites or disabling the ability to highlight and copy text in HTML and therefore 'Speak Text' features.

Some users with disabilities may require multiple accessibility features because they have multiple impairments. For instance, a user may be deaf and blind or may have low vision and unable to use a pointing device or touch screen. Multiple operation modes should be supported to allow users to access content according to their preferences.

On Android and iOS for example, built-in keyboard support should not prevent other standard touch events. iOS accessibility features and the API are designed to make accessibility information and input methods available to multiple impairment types. However some optimization such as the deliberate misspelling of an accessibility label or hint to ensure correct pronunciation can make the content inaccessible to other disability types – for instance, users of Braille who are deaf blind.

3. Improvement Guidelines of Smart Application Accessibility

3.1 Development of the Guidelines

In order to improve smart application accessibility for the disabled, the following principles are adopted: minimizing blue light emission from smart devices, automatic focus on input window, action trace, font color change, emergency notification by motion, gesture recognition, control location, scrolling avoidance,

auditory service for visual warning, and icon literation, respectively.

Guideline 1: Blue Light Emission
Minimize blue light from smart devices.

Recently it is reported that blue light from smart devices may impair human visual cells [14]. This is the completely opposite claim to the common knowledge that blue light is good for reducing eye strain. In the meanwhile, in [11], blue light from smart devices can delay sleep, especially in teens. Thus, use of blue light needs to be minimized for the disabled as well as teens.

Guideline 2: Automatic Focus on Input Window
Provide focus on any type of input window

The purpose of this guideline is to provide automatic focus on input window so that the disabled can input easily without navigating whole window. Also, for multiple input in the same window, focus must be moved to next input window as soon as input is finished in a window.

Guideline 3: Action Trace
Provide action trace function.

Action trace means a kind of log that records what a disabled person did in smart device. Like a recoding in voice communication, the action trace is useful when a disabled person input sensitive information or download some files. This function can be very helpful for the disabled in case of self-protection.

Guideline 4: Font Color Change
Let the disabled can change font color if necessary

For people with color blindness, sometimes it is hard to read smart device screen. As well as changing background color, it is necessary for the disabled to change font color immediately. Also, full color code should be provided for them.

Guideline 5: Emergency Notification by Motion
Provide emergency notification function by motion sensing.

The disabled may have some emergency situations like fall or heart attack. In this case, it is very difficult for the disabled to call for help using their smart devices. For emergency situation, it is better to use one quick motion for emergency notification. The typical motion is to shake twice or squeeze hard their smart devices.

Guideline 6: Gesture Recognition
Provide gesture recognition function.

For people with physical disabilities, it is sometimes better to use gesture instead of talking or typing on smart devices. The typical functions by gesture include exit, logoff, and so on.

Guideline 7: Control Location
Controls must be located on the bottom of the screen.

For web-based environment, controls usually are recommended to be located on the bottom of the interface[10]. The reason is that user can look contents first and use controls if they want. Locating controls on the top of the interface may distract user's attention. For mobile or smart environment, the same principle is applicable so that controls must be located on the bottom of the screen[6].

Guideline 8: Scrolling Avoidance
Avoid scrolling for the disabled

For web-based interface, people don't like scrolling[7]. Instead single-page document is recommended. A single-page document is a web page that does not require scrolling. It means that any web contents more than one web page are divided into several single-page documents. For smart environment, scrolling needs to be avoided so that any content or message needs to fit a single screen.

Guideline 9: Auditory Service for Visual Warning
Provide auditory message for visual warning message from system or other sources.

Usual visual warning messages are brought as form of pop-up windows or very short-term message. This many cause people with visual impairment to miss the messages. In this sense, the auditory message conversion service for visual warning message is necessary.

Guideline 10: Icon Literation
All icons must have text label in icon images.

If text labels can not be shown in icon image due to some reasons like small space on screen, the system must provide an option to show text label for all icons by choice of the disabled. The reason to provide text label is that sometimes icon itself may give ambiguous meaning. For people with mental or visual impairment must need text label on all icons.

3.2 Effects of the Proposed Guidelines

Depending on impairment types. our 10 guidelines have the various effects. Based on Tiresias checklist for software applications[15], the following <Table 1> shows effects for different impairment types.

The following abbreviations are used to represent the different impairment types.

> P: Physical impairments
> SP: Severe physical impairments
> V: Impaired Vision(for example, color blindness)
> B: Blind persons
> H: Slight to moderate hearing impairments
> D: Deaf
> C: Cognitive impairments
> O: Other (for example, left handed, different language …)

The following numbers denote different types of effects by the proposed guidelines.

①: No significant effect
②: Minor effect
③: Moderate effect
④: Significant effect

<Table 1> Effects of the proposed guidelines depending on impairment types

Guideline	P	SP	V	B	H	D	C	O
1	④	④	④	④	④	④	④	④
2	②	②	②	③	①	①	③	①
3	①	①	③	③	①	①	④	①
4	①	①	④	④	①	①	①	①
5	④	④	④	④	④	④	④	④
6	④	④	②	②	②	②	③	③
7	②	②	③	③	②	②	④	②
8	③	③	③	③	②	②	②	②
9	①	①	④	④	①	①	①	①
10	②	②	④	④	②	④	④	②

According to <Table 1>, guideline 1 and 5 can be useful for all types of impairment. Actually, both guidelines are also very helpful for all citizens. On the other hand, guideline 4 and 9 can be applied to only people with visual impairments. The main beneficiary from guidelines is a person with visual impairments. In the meanwhile, according to [15], the main beneficiaries are SP(Severe physical impairments) and B(Blind persons).

4. Conclusions and Further Works

Currently we live in knowledge-based society so that our life depends on advanced ICT and smart technique. In the current society, everyone has a right to enjoy an abundant lifestyle using those advanced techniques. Currently our society is changing quickly from PC-based environments to smart-based environments as well as from wired to wireless. As more smart devices are developed and available for the disabled, enhancing smart application accessibility

becomes an important concern.

The purpose of this paper is to propose new practical guidelines for improving smart application accessibility. For this purpose, the current status of smart application accessibility and the literature reviews for smart application accessibility are introduced. Based on the existing guidelines, new guidelines are proposed: minimizing blue light emission from smart devices, automatic focus on input window, action trace, font color change, emergency notification by motion, gesture recognition, control location, scrolling avoidance, auditory service for visual warning, and icon literation, respectively.

The immediate research work is to provide more specific guidelines for the proposed guidelines. Also, we need to develop new and overall guidelines covering both web-based environment and smart environment.

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저자소개

전 우 천

1985 서강대학교 졸업

1987 서강대학교 대학원 졸업(석사)

1997 Univ. of Oklahoma 졸업
    (박사)

1998년~현재 서울교육대학교 컴
    퓨터교육과 교수

관심분야: 장애인 정보화 교육, 정
    보 통신 윤리

e-mail: wocjun@snue.ac.kr