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ACCESSIBILITY DESIGN PRINCIPLES OF MOBILE APPLICATION FOR VISUALLY IMPAIRED PEOPLE

HAMMAD HASSAN QURESHI*, DORIS HOOI-TEN WONG

Razak Faculty of Technology and Informatics,
Universiti Teknologi Malaysia Kuala Lumpur, Malaysia
*Corresponding Author: hammadqureshi79@gmail.com

Abstract

In order to communicate and associate with the daily information, many Visually Impaired People (VIP) use the screen reader and mobile devices. In order to improve the accessibility of mobile applications for Visually Impaired People (VIP), there are several exceeding guidelines, recommendations, and standards. There are still accessibility issues in mobile applications for VIPs despite all these. In order to build up the universal design of mobile applications for VIPs, instructions are given to the developers with these standards, recommendations, and guidelines. There are many difficulties in the development process of mobile applications for VIPs that demoralize the mobile application developers for imposing accessible applications. This is required to get control of the difficulties and challenges of accessibilities while VIPs interact with these mobile applications. Many mobile applications are accessible for people with the visually disabled. However, the style and design guidelines are going through patterns with the promotion of principles of the first mobile. The foundation of comprehensive, universal, and user-centred accessibility design guidelines for mobile applications is a tangible step. The aim of this paper is a comprehensive list of guidelines that have been classified this issue for the accessibility of mobile applications for Visually Impaired People (VIP). There is a low rate of lack of compliance for mobile applications design guidelines at the system level and this rate of lack of compliance is at its peak on the content and design levels, which is specified by the result. The degree of technological growth and also specifying when to use those tools in process of development.

Keywords: Mobile design guidelines, Mobile applications, Visually impaired people, User-centred design.

1. Introduction

There are a great number of functionalities in mobile applications and smart devices because these mobile phones have become a power full communication tool. In different domains, there is a lack of ability to utilize these mobile device applications by VIPs such as shopping, transportation, entertainment, and health [1]. World Health Organization (WHO) published on 26 February 2021that there are about 2.2 billion people are suffering from any type of visual impairment, half of that 2.2 billion are blind they have no perception of light in their eyes. There are about 72% of visually impaired people use mobile phone applications to communicates daily information according to a questionnaire performed by WebAIM2. This ratio of using mobile applications by VIPs indicates the importance of producing and developing accessible mobile phone applications. In different smartphones operating systems have some built-in applications for screen reading, like Talkback4 in android, VoiceOver for iOS, and large font settings. In order to make the mobile applications accessible for VIPs, it is the responsibility of developers to make accessible mobile applications for VIPs [2].

A large number of recommendations, instructions, and guidelines are available that give assistant to the mobile application developers in developing accessible mobile phone applications. The Web Content Accessibility Guidelines -WCAG [3] and instructions are described by smartphone companies like WorldWeb Consortium, Apple, Samsung, and Google. Despite the existence of these accessibility instructions, there are still many accessibility issues in mobile applications that are not completely accessible for VIPs. There were many accessibility problems found in mobile phone applications by [4, 5] In another study Kim et al. explored many mobile applications, they found a lack of proposed guidelines for mobile application developers to make accessible mobile applications. There is a large gap between the actual use of accessibility recommendations in mobile application development and guidance. In Information and Communication Technology the accessibility of mobile applications plays an important role. Many mobile application development companies have not implemented these accessibility measures in their development process or do not aware of these accessibility guidelines [6, 7]. The difficulty, expansiveness, and complexity to use properly these guidelines can the one reason. In the implementation of accessible mobile application modules for VIPs, an automatic mechanism assists the developer. It can encourage comprehensive mobile development circumstances and help to fill this gap.

There are many methods to build up mobile phone applications, like the use of domestic programming languages for example swift, C++, or the use of hybrid coverage between the web and native languages. The javascript and HTML5 web languages are also used to enhancing the richness of web interfaces of mobile applications [5-7]. Therefore, keep in mind these points this paper aims to explore the previous literature that communicates the generation and use of tools that can encourage the developers to develop accessible mobile applications for VIPs. The second aim is to make the prototype to develop the mobile applications for VIPs, which demonstrated the strength to develop mobile applications that are useful for VIPs.

The remaining part of this paper is organized as follows: Section 2 describes the background. Section 3 describes the methodology of the experiment. The results and discussion of the experiments are discussed in Section 4. The conclusion and feature direction are described in Section 5.

2. Background

It is necessary to produce factor applicability with information about work in Web and mobile accessibility that happened before this establishment. The first version of the Web Content Accessibility Guidelines (WCAG) is published by the World Wide Web Consortium (W3C) in 1999 [7], but there were lots of violations of guidelines leaving behind it. There are a set of checkpoints in WCAG 1.0 that proposed guidelines for web application developers because they try to involve accessibility in their applications. With the help of this list, application developers were capable to test their formations that they attained the required accessibility standards. However, there were many flaws in the WCAG 1.0. An approved inquiry was held by the Disability Rights Commission in which they faced approximately 45% of difficulties and problems experienced by the users [8]. The guidelines of WCAG 1.0 did not point out that the application would be able to use when you apply these guidelines. An application or site remained inaccessible to the user due to user traps in its operations on the other hand site claims that it followed all the requirements of accessibility [7]. The WCAG 2.0 is another released in December 2008 which is a more technological, flexible, and accurate version [3]. More universal standards of guidelines were developed in the second iteration, which provides extra support for describing each guideline. There are three levels of design guidelines compliance in WACG 2.0, being the standard that is divided into the different categories'AAA', 'AA', and 'A'. The basic standard is needed for the accessibility of application is 'A'. The success standards are further divided into the four main principles, including these three levels. The four principles are the following: Perceivable, Operable, Understandable, and Robust. These principles are considered to be the main code of belief for accessibility. Here is a quick overview of these principles.

2.1. Perceivable:

In this principle, it makes sure that all the data is observable by all the users, inclusive of all those who have some natural impairments like visual impairment, blindness, and deafness. All the guidelines are classified as recognizable tests whether the content (like audio, video, and image) has substitutive perceivable with a disability.

2.2. Operability

The second principle that relates to the conception of all characteristics should be fully implementable by everyone, regardless of the restrictions of users. The replacement of input control (such as a keyboard alternative voice command) does not authorize by a mobile application, it causes the failure of the operable principle. Another cause of failure is no specified time limit for action. An individual with a disability has problems or slows down the operability, with both of the above-mentioned examples.

2.3. Understandable

Mutual understanding is related to the perceptual ability of the user to understand the meaning of the information presented. The guidelines in this category include ordering elements to ensure order prediction and consistency, as well as providing contextual support to guide customers through actions.

2.4. Robust

The last of the four principles, robustness, defines the flexibility of content in interpreting it through user agents, such as web browsers or auxiliary technologies. Despite the flow of technology and the pace of its development, a robust application would ideally contain content that is always accessible regardless of any changes. Understanding these principles and accessing the web for relevant instructions was a step forward.

In terms of physical and automated diagnostics, researchers are evaluating the WCAG 2.0 website's tactics and determining current issues. In a study of Indian web portals, Petra et al. Commercial websites have a higher rate of infringement than official websites selected for evaluation [9]. These results alert developers to common concerns in their industry. Encourages web designers to focus on improving accessible adaptations to their sites. However the WCAG 2.0 is used by web developers, but there are no official guidelines for mobile application developers. A task force Web Accessibility Initiative (WAI) related to the World Wide Consortium(W3C) is generated, which is struggling to regulate how the WCAG 2.0 guidelines could be appropriate for mobile phone applications. A mobile accessibility document is drafted as the result of WAI [10]. The preliminary version defines and focuses on the areas of accessibility concerns that relate to a mobile context, for each of the four core principles. After that, the principles of those associated mobile applications with web guidelines are translated. Nevertheless, it was found that the key mobile access issues identified by case studies were generally kept out of line with the high priority guidelines in WCAG 2.0, and the numerous issues facing users. Matters were not covered at all [11]. Power et al. found that the guidelines were also inadequate in a web context. Only 50% of VIPs have problems with WCAG 2.0 [12]. Therefore, in order to fully evaluate mobile applications, it was deemed necessary to comply with WCAG 2.0 guidelines derived from the contents of other research studies. The articles reviewed included mobile accessibility requirements that were more verifiable and detailed than those created by the WAI working group. Other articles broadcasted observational analyses of smartphone use by people with visual Impairments, identified accessibility issues unique to mobile applications, and describe a set of requirements based on these results [13]. In order to the produced list of guidelines, many of these requirements are used with the combination of W3C suggestions. The advancement of assistive technologies and how they interact with devices and mobile applications also have a significant influence on accessibility.

A mobile voice user interface originated by Corbett et al.. In order to achieve actions on a user's mobile phone applications, a voice interface is used to support interaction [14]. The voice commands are not usually available to perform complicated tasks in mobile phone applications, Gmail inbox is an example of this. There is a great need for accessibility in the market of mobile application development for mobile interfaces [13]. There is great strength in these assistive technologies, that they have abilities to provide a protocol for different users. This only happens when the mobile applications fulfil the definite guidelines during the development process. The use of established protocols and standards has become mandatory for mobile application developers to developed mobile applications of assistive technologies. [15] Let's assume that mobile applications do not exist in isolation; rather, adding a new "organism" to an existing when developing a new application is simply population. They formulated that accessibility issues are not

only due to intrinsic aspects of the application (such as graphic design and source code) but also to extrinsic factors (such as context area and cultural norms).

A procedure developed by [16], to producing the accessibility guidelines that assist a mobile user with cognitive disabilities. In their experiments, realizing the needs of a person having cognitive disabilities and new guidelines are compiling with W3C guidelines. Only one type of disability was focused on by [16] while, developing accessibility guidelines for a particular mobile device were manufactured by Hyun et al. The user tests and literature overview were involved in the procedure of creating mobile application guidelines by [17]. In an analysis of the validity of these documents, it was discovered that there was no reliable reference to an exhaustive reference to the potential accuracy of evaluations to evaluate the accuracy of an application. There are also suggestions for mobile accessibility in these applications, especially in the areas of interaction problems and components and there is a lot of contingencies in the application.

3. Methodology

There are three steps of go along to the methodology or experimental process: i) Set up a set of testable accessibility guidelines. ii) Application selections those are come in for testing. iii) Based on well-known accessibility guidelines a heuristic evaluation of selected Application.

3.1. Set up a set of testable accessibility guidelines

Put these guidelines together and then brought back them to normal by eliminating redundancy. Instructions for their application to mobile applications. Tested instructions apply to self-contained mobile applications. Aggregates or guidelines or applications based on other functions of the device outside the application. While this has certainly had a significant effect, the use of cell phones during the test, however, may be accompanied by an application that relies on changes to the operating system, for example, how the Android screen reader the talkback [7] was performed, then how did the application perform. The results list contained 92 unique guidelines that were later used for evaluation. They were placed on a table and organized in two stages. The first was to label each policy based on the policy definition. Second, similar tags are categorized. For example, coders first labelled guidelines with codes such as form, volume control, and buttons. In the second phase of the coding process, these tags were added to the" User Interface Controller" category. Two coders with experience and access to HCI worked on labelling and classifying guidelines. They shared a codebook to keep track of the tags and codes they used. The coding process resulted in 11 different categories covering the initial guidelines. These 11 types, like the W3C policy framework, serve as verifiable standards and organizational frameworks for their purpose (as applied in the mobile context) Guidelines can manage into three levels by coders including these levels:

a) Design: The design of a user interface instructs that how to interact with the mechanics, information, and commands displayed to mobile users. However, this is critical for mobile accessibility applications. Example of the direct connection: The interaction does not lead to a large power amplitude. 66% of the guidelines recognized in the literature are based on Design-level guidelines.

b) System: At this level, access policies specify how applications are to be implemented for assistive technologies to be implemented and how assistive technologies are to be implemented. Guidelines: The screen reader can detect orientation changes. The 17% of the guidelines that the system has identified in the literature are system-level directives.

c) Content: The content contained within the mobile applications consider as text, images, audio, and videos to be contained within apps. Many applications allow users to create content. User-generated content is an essential part of the usefulness of these apps. Social media applications have several guidelines that define sample guidelines for mobile applications, for example, images alternate with text. The guidelines that have been identified from the literature, that contain 16% content guidelines. By identifying these innovations and using diagnostics in these mobile applications, can better considerations of the strengths and characteristics of the logical development process in terms of access as a measure of quality.

3.2. Application selections those are come in for testing

In the second phase of the experimental process, an application test kit was created. Popular apps are chosen from a variety of tasks to represent the different tasks users perform daily. Popularity is determined by the number of times an app is downloaded as shown on Google Play. The following five categories were defined and selected: Social Media and Communication, Productivity and Education, Lifestyle and Entertainment, Shopping and Finance, and more. The five main categories were chosen to ensure that the selected applications cover the full range of use. An application was only considered if it had more than 10,000 downloads. For each category, the applications were ranked in descending order of popularity. For scientific evaluation, a list of a total of 15 social applications that focus on social media and communication applications was created. The study focuses on social media and communication applications because of their widespread access to all user data and the unique challenges of accessing user-generated content.

3.3. Heuristics evaluation process

Heuristic assessment can be described as the process of expert review of a system based on well-established rules or guidelines. On the recommendation of Nelson´s 3-5 reviewers [18], it was decided that 4 reviewers should perform 5 tasks independently for each of the 25 requests for their verification following the newly established rules. However, after finding out that the work count was reduced to 2 but it turns out that the access breach within one application is often consistent. An application task inevitably involves the app's main screen, as the user was considered the first user on the main screen. It was then chosen by observers based on a task that they considered to be the second most important task. For example, Amazon's test assumes that one of the user's primary roles in the app is to purchase a product, so the screens involved in the process are selected for evaluation. The latest developments are based on Android devices including the Samsung Galaxy with Android Marshmallow 6.0.1. and a Nexus with Android Nougat 7.1.1. In order to evaluate the mobile applications, all evaluators educate to evaluate the mobile applications using the available list of accessibility guidelines. In using mobile applications by visually impaired people, many guidelines apply to users and

developers. The basic requirement of this paper is to understand those guidelines. An open-ended interview is taking place in the presence of both developers and VIPs.

There were around nine people with vision disabilities and four mobile application developers participate in this interview. In the interview, there were some basic questions and some questions related to the accessibility of mobile phone applications like "the flow and navigation of mobile applications easily understandable or not. Do you imagine that there is a need for a special mobile application for VIPs or they can use a normal one?" The assessment of these questions was open-ended rather than close-ended [19]. The SPSS software was used in order to analyse all the answers, comments, and requirements from interview questions. In order to present the accessibility requirements, all requirements are placed in their respective nodes, the nodes were based on the background knowledge of accessibility guidelines of VIPs.

4. Result and Discussion

The quantitative approach is used in this study. In the result of this study, there are many accessibility guidelines were found from mobile phone applications. That has normally been violated in mobile phone applications in the case of visually impaired people. There was about a 90% violation rate found on the screens of mobile phone applications. Most violations are on design and content level in different categories like UI Element, Video, Audio, Text, and Flexibility or efficiency. In UI Element the VIPs and developers found the violation that there is no control was available on the active screen for text size changing. At the design level in a category of flexibility or efficiency, there is no control for selecting from the forefront and VIPs have no presentation options are offered. At the content level, there are seen many violations in the video category like there is no full-text and audio description of videos. The guideline was not completely followed, it was identified by a mobile application developer when a VIP trying to understand an image from a Google screen reader. From the developer's point of view that they could describe the pictures, but that description is not sufficient for VIPs. There were many pictures, text fields, and buttons that appear on the screen, some UI elements that holdfast the guidelines while the other elements did not hold fast. Another VIP mentioned this problem during performing the task that labelling of buttons was not proper. There are many violations that have minimal effects related to video content. During observation of live video streaming, there were 93% of violation rates in these videos, that the title of the video was not provided. The guidelines that were minimum violated, those evaluated by both VIP and mobile application developers. Understandable and clear fonts were not used in mobile phone applications. Same performing applications were not combined in a similar category. Most mobile phone application has no text justifications. Evaluation of the overall performance of mobile applications was 75%. The lowest compliance rate is 49.25% by Snapchat while the best compliance rate is 92.60% by WhatsApp.

In the video category, there were mostly violations of accessibility guidelines. The user-developed content has a higher rate of violation due to lack of accessibility. It was also observed that many mobile applications based on user-uploaded content especially social media applications, in these mobile applications pictures and videos, were fewer textual explanations. The textual description varied of the application content that was created by the application themselves. Twitter-type applications do not grant the user that they upload the textual description for the video. It was also

observed during the analysis of mobile applications, that many of them complied with a major part of guidelines. The mobile application is out of reach to the use of VIP, due to a violation of the primary task. For example, the compliance rate is 97% of Food Panda's application but during the evaluation, it was observed that it is very difficult for VIP to take place the order. The reason behind this, text components representation on the order screen was unstable. This leads to the user's task of ordering the food was inaccessible when a mobile screen reader is in use. It was also observed that the tasks were performed by the screen reader, but the interactivity was a big problem due to its speed and without the use of assistive technologies, it was more disappointing. For example, sometimes in mobile applications, there was no text shown in the textbox even that a signal comes from the screen reader that the text had been entered. In this case, there was a chance of error due to the number of times a user gives the information. The independent mobile application developer cannot be achieved all-around accessibility of mobile applications. The most common issues must be acquired by their origin. The issue that is available in most mobile applications, indicated that a very ordinary paradigm and development operations used to develop inaccessible mobile applications. The development process of mobile applications must be changed and there is a need for enhancement in education and perception of the source code. There is also a need that people with disabilities to also be considered as a part of the development culture.

5. Conclusion and Future Work

The main goal of this study is the understandability of accessibility design guidelines for creating user-centric mobile applications for Visually Impaired People. Mobile phone applications at the system level could be accessible on a large scale, but the inaccessibility of design and content is a big issue of that inaccessibility at the usage level. In order to accommodate the accessibility guidelines, we need to educate the mobile application developers and VIPs. Everyone is a content designer in the world of social media, different platforms should be built up that should motivate in manufacturing the accessible content, that content will be accessible on that platform for all.

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