The Accessibility of Mobile Health Sensors for Blind Users

Lauren R. Milne, Cynthia L. Bennett, Richard E. Ladner

University of Washington, Computer Science & Engineering

milnel2@cs.washington.edu, bennec3@cs.washington.edu, ladner@cs.washington.edu

Abstract

Mobile health (mHealth) applications are becoming popular and could be useful for people who are blind as they allow the data from mainstream health sensors to be accessed on the smartphone. However, in order for the health sensors to be accessible, the smartphone applications must be accessible. In early 2014, we conducted a survey of the accessibility of nine mHealth applications for the iPhone and found that none of them met our criteria (based on the guidelines provided by Apple and Section 508) for being accessible. We found that the majority of the accessibility problems encountered were relatively simple and believe that it would only take a small amount of effort on the part of developers to fulfill the potential for mHealth applications to make mainstream health sensors fully accessible to blind users of smartphones.

Keywords

Accessibility; blind; smartphones; mHealth.

Introduction

A number of research studies suggest that blind people have worse health than those without disabilities (Capella-McDonnall; Thylefors). Because people who are blind are more likely to report poor or worsening health (Capella-McDonnall) and more likely to have serious health issues such as diabetes (Thylefors), they may benefit from health sensors, such as blood pressure monitors or scales, and it is important to ensure these devices are accessible.

Versions of these health sensors can now connect to smartphone applications (part of a larger group of applications called mHealth or mobile Health applications) to log health information. As the mainstream versions of many of these health sensors are not accessible on their own, connecting them to a smartphone equipped with a screen reader such as VoiceOver (iOS) or TalkBack (Android) could be a way to make these mainstream devices accessible out of the box for people who are blind. Because many of the applications and devices in the mHealth industry are targeted for the sighted community, they reach a larger consumer base and are likely to become widespread and less expensive than narrowly targeted assistive technology. However, because developers are not thinking about the broader market that includes blind customers, they may not be following the recommended accessibility guidelines provided for smartphones.

To determine the current state of the accessibility of mobile health sensors that connect to smartphones, we conducted a survey in March 2014 of commercial iPhone health applications and determined how accessible they were with VoiceOver. We did not examine other accessibility features such as the ability to zoom, the use of high contrast or large print. We looked at mHealth applications that connected to different types of external sensors including blood glucose monitors and blood pressure monitors, as we were interested in whether the smartphone applications succeeded in making a previously non-accessible device accessible. We found that none of the

applications surveyed met all of the accessibility standards that we established based on iOS and Section 508 accessibility guidelines.

Related Work

mHealth Applications

There are a number of reviews of smartphone medical applications (Mosa, Terry), but these reviews focus on healthcare practitioners' use of smartphones and do not consider accessibility. We have found no academic reviews of mobile healthcare applications from an accessibility lens. However, within the blind community, people often generate lists of the most accessible applications, which can include health applications, such as those listed in "Apps for the Blind" (see citation).

Accessibility Guidelines for Smartphones

To the best of our knowledge, there is no universal set of guidelines for smartphone accessibility. Instead, some smartphone companies have developed a set of specific guidelines for their own products: Apple provides "Accessibility Guidelines for iOS", and Android has an "Accessibility Developer Checklist." These guidelines vary based on the screen readers and the other features available on the smartphones. In general, these guidelines recommend that all elements of the screen report themselves to the screen reader (or other accessible device) and that the applications be navigable by switching the focus from one element to another. In the best case, this means that elements are accessible to screen readers, Braille displays, and other assistive technology.

More broadly, the US Federal government has standards set out in the Section 508 amendment to the Rehabilitation Act (Rehabilitation Act. *Section 508 Standards Guide)* that apply to all information technology provided by Federal agencies. Section 508 has standards for software

applications, portable computers and telecommunication devices. These standards are broad, but include elements applicable to smartphone applications.

Accessibility Guidelines for Webpages

Although there is no universal accessibility standard for smartphones, there are standards governing webpages, and we can derive some necessary accessibility features for smartphones from these standards. The Web Content Accessibility Guidelines (WCAG 2.0) provides a list of 65 standards to make webpages accessible, and there have been surveys to determine how well websites meet those standards (Kane).

Methods

Data Sources

We conducted a survey to evaluate smartphone applications that work with an external sensor to replace two types of devices: glucose monitors and blood pressure monitors. To find the smartphone applications, we searched internet technology blogs and articles related to mHealth and reviews of medical smartphone applications. We also searched through the Apple App Store using the following keywords: “glucose,” “glucose meter,” “blood pressure,” and “blood pressure monitor.” As we were mainly interested in whether people would be able to access the information received from the external sensing devices once it synced with the phone, we did not evaluate the external devices (glucose meter or blood pressure cuff). Instead, we manually input the data and then evaluated accessibility of the entire application, with the exception of iHealth’s iGluco application, for which we used the external device as we were unable to manually input data. All applications were evaluated on an iPhone 4s and an iPhone 5 running iOS 7 with VoiceOver. We evaluated the applications with the latest updates in March 2014 (Appendix 1).

Inclusion and Exclusion Criteria

We chose to only evaluate iOS applications that were primarily for helping with medical problems rather than general fitness applications. We evaluated medical applications designed for use at home by patients rather than in clinical settings by healthcare practitioners and focused on applications that received information from an external device (glucose monitors and blood pressure monitors). All applications evaluated are listed in Appendix 1.

Accessibility Rubric

While there is no set of accessibility standards specific to smartphones, there are recommendations provided by each smartphone platform ("Accessibility Guidelines for iOS", "Accessibility Developer Checklist"). The Federal Government also provides a standard for software applications created or funded by the government through the Section 508 amendment to the Rehabilitation act (Rehabilitation Act. *Section 508 Standards*). We drew from both the Apple accessibility guidelines and those set forth in Section 508 to create the Accessibility Rubric to evaluate each of the applications. We evaluated our applications according to the following seven guidelines:

1) Labels Correct: All elements have labels that correspond to what they do (e.g. an "Add" button is labeled "Add").
2) Traits Correct: All elements have traits that correspond to what they are (e.g. an "Add" button has the trait "button").
3) Values Accessible: The values of each element are accessible (e.g. a blood pressure measurement text field might have the value 120/80).

4) Hints Provided: Hints are provided to help users navigate application (e.g. “double tap to enter information”).
5) Table Data Coherent: All the information in a table is accessible and read in a coherent manner (measurement values and units are read together).
6) Traits and Labels Read Together: All of the labels and their corresponding traits are read together (e.g. a label for a button such as “add readings” is read either right before or right after the corresponding button is focused on).
7) Non-textual Data Accessible: Graphs, charts and other images are explained or information on them is accessible.

The first four criteria (Labels Correct, Traits Correct, Values Accessible, and Hints Provided) are based on Apple’s recommendations that all elements must “provide accurate and helpful information about its screen position, name, behavior, value and type.” The next two criteria (Table Data Coherent and Traits and Labels Read Together) were not explicitly mentioned in the Apple guidelines, but were developed by us when we encountered usability problems. The final criterion (Non-Textual Data Accessible) was based on Section 508’s guideline that “when an image represents a program element the information contained by the image must also be available in the text.” All the traits were evaluated in a binary manner: if all the elements in the application conformed to the standard for each guideline, the application passed (received a Y in Table 1); if only some of the elements conformed, it did not (the box in Table 1 is left blank).

Table 1. Accessibility of mHealth application across seven features. If all the elements in the application met the accessibility guideline, it received a Y. If the application did not have a certain element it received a N/A.

Application	Labels Correct	Traits Correct	Values Accessible	Hints Provided	Table Data Coherent	Labels with Traits	Non-textual Data Accessible
iBGstar*	Y						
Glooko Logbook*	Y	Y	Y	Y	N/A	Y	
Telcare*			Y				
iGluco*		Y	Y		Y		
iHealth BP Monitor*			Y		Y		
Withings**		Y	Y		Y		
iBP**	Y		Y		Y	Y	
myVitali**		Y	Y				
DigiFit**	Y		Y			Y	

***Glucose Monitors, **Blood Pressure Monitors**

Discussion

The results of our study are summarized in Table 1. We evaluated glucose monitoring applications from four companies: iBGstar, Telcare, Glooko, and iHealth (Appendix 1). Both the iBGstar and Telcare applications allowed one to manually input blood glucose data without the external device. For the Glooko application, we were unable to evaluate one of the guidelines (whether the table data was coherent) without the external device, and that is labeled N/A in Table 1. We used the external device to add measurements for the iHealth iGluco app, as we

were unable to manually add data. We evaluated blood pressure monitors from iHealth, Withings, iBP, myVitali and DigiFit (Appendix 1).

Although the majority of the features in all the applications were somewhat accessible, we found that none of the applications met all the guidelines. On average, applications met 2.6 out of 7 accessibility guidelines, with two applications (iBGstar and Telcare) meeting only one guideline, and one application (Glooko) meeting 5 of the 6 guidelines it was graded on (one of its features was not evaluated). In general, elements that were standard iOS elements, such as tabs for multiple pages in an application or add buttons for adding data, were accessible, as they had the correct labels, traits, values, and often had hints. However, when the developers added their own elements, they rarely included the information that would make them accessible and often did not provide the correct labels, traits or values for the elements.

One problem with many of the applications was that the visual design of the elements often did not correspond to an understandable audio layout. For example, in many applications, the labels for buttons would be above the buttons, and if there were multiple buttons in a row, the labels would receive the focus first then the buttons themselves, making it difficult to determine which buttons corresponded to which labels. Additionally, the measurements in many tables were difficult to read as values and their units were separated (e.g. a blood pressure reading of 120 mmHg/70 mmHg and 80 beats/min taken on Sept. 28th, might be read as “120, 70, 80, Sept. 28, 2013, mmHg, mmHg, beats/min”). Finally, two of the applications (iHealth and Withings) did not switch pages correctly; the application would switch pages, but VoiceOver would continue relaying information from the previous page.

Conclusion

None of the mobile health applications that we evaluated met all of the accessibility criteria recommended by Apple and Section 508. Additionally, many of them had problems that were outside of the scope of the Apple guidelines (which generally are concerned with making individual elements accessible as opposed to making sure the flow of the application is accessible). In the future, we would like to extend this study to other smartphone platforms such as Android and Windows, and we believe a universal set of smartphone accessibility guidelines needs to be developed. Although there is exciting potential for mHealth applications to make both inaccessible devices and health records usable by people who are blind, there is a great need to ensure that the developers include accessibility considerations when designing applications.

Appendix 1: mHealth Applications Evaluated

1) iBGstar Diabetes Manager Application, sanofi-aventis, Version 2.2
2) Telcare, Telcare Inc., Version 2.0.1
3) Glooko, Glooko, Inc., Version 2.5.0
4) iGluco, iHealth Lab, Inc., Version 3.0.1 (used with Wireless Smart Glucose Meter, Model BG5)
5) iHealth MyVitals App, iHealth Lab, Inc., Version 2.3.4 (BP)
6) Health Mate, Withings, S.A.S. Version 1.32.2
7) iBP, Leading Edge Apps LLC, Version 6.1
8) myVitali, myVitali AG, Version 1.5.1
9) DigiFit, DigiFit, Inc., Version 7.51

Works Cited

"Accessibility Developer Checklist." *Android Developers.* Android. Web. 28 Sept. 2013. <http://developer.android.com/guide/topics/ui/accessibility/checklist.html>.

"Accessibility Programming Guide for iOS." *iOS Developer Library.* Apple, Inc. 16 Feb. 2012. Web. 28 Sept. 2013. <https://developer.apple.com/library/ios/documentation/UserExperience/Conceptual/iPhoneAccessibility/Accessibility_on_iPhone/Accessibility_on_iPhone.html>.

"Apps For The Blind And Visually Impaired." AppAdvice, LLC. 2014. Web. 6 May 2014. <http://appadvice.com/applists/show/apps-for-the-visually-impaired>.

Capella-McDonnall, M. "The need for health promotion for adults who are visually impaired." *Journal of Visual Impairment and Blindness*, 101.3 (2007): 133-145.

Kane, Shaun K., et al. "A web accessibility report card for top international university web sites." *Proceedings of the 2007 international cross-disciplinary conference on Web accessibility (W4A).* ACM, 2007.

Mosa, A., I., Yoo, and L. Sheets. "A Systematic Review of Healthcare Applications for Smartphones." *BMC Medical Informatics and Decision Making.*12.67 (2012) Web. 26 Sept. 2013. < http://www.biomedcentral.com/1472-6947/12/67>.

Rehabilitation Act of 1973. *Section 508 Standards Guide*. <http://www.section508.gov/>

Terry, M. "Medical apps for smartphones." *Telemed J E Health* 16.1 (2010): 17-22.

Thylefors, B., et al. "Global data on blindness." *Bulletin of the World Health Organization* 73.1 (1995): 115.

Web Content Accessibility Guidelines (WCAG) 2.0, *W3C World Wide Web Consortium 2012.* Web. 7 May 2014. <http://www.w3.org/TR/200X/REC-WCAG20-20081211>