Universal Design of Mobile Apps: Making Weather Information Accessible

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Abstract. Mobile weather apps are just one class of products that ought to be developed under a Universal Design rubric. However, despite the large number of mobile weather apps available, most have not been developed from the ground up to be more universally accessible. This paper discusses a universally designed weather app that demonstrates how effective universal design can be for a commonly used service.

Keywords: Universal design · Accessibility · Weather app · Visually impaired · Blind · Sonification · TalkBack · VoiceOver · Assistive technology

1 Introduction

Mobile apps are just one class of products that ought to be developed under a Universal Design rubric. However, even very common apps, with truly universal utility, are often not created for as wide an audience as possible. As one example, accessing the current and forecasted weather conditions is a common part of nearly everyone's day [1]. As such, a large number of mobile weather apps are available, on all of the mobile platforms, and even on desktop platforms; most have some similar features, along with a slew of unique aspects that try to set them apart in the crowded weather app marketplaces (see Fig. 1 for a few of the many examples). Unfortunately, even though many of these apps may comply with accessibility requirements (largely by inheriting accessibility features of the mobile—or other—operating system), they have not been developed from the ground up to be more universally accessible. This position paper discusses a universally designed mobile weather app that demonstrates just how effective universal design can be. A more extensive discussion of the motivation and our methods is available in the complete description of this project, found in [2]. Here we frame the problem of universal design as a lack of research and implementation, not a lack of possibility.

Coming back to our example, it is particularly important to note that accessing weather conditions is crucial for persons with vision loss and other impairments, because temperature and precipitation have major impacts on the choices they make about their route, clothing, and assistive technology for the day. For example, knowing that there is a chance of rain may allow a person with visual impairment to choose a different white cane, or perhaps bring a raincoat for their guide dog. Heavy rain or snow may cause visually impaired or wheelchair-using commuters to alter their routes altogether [3].

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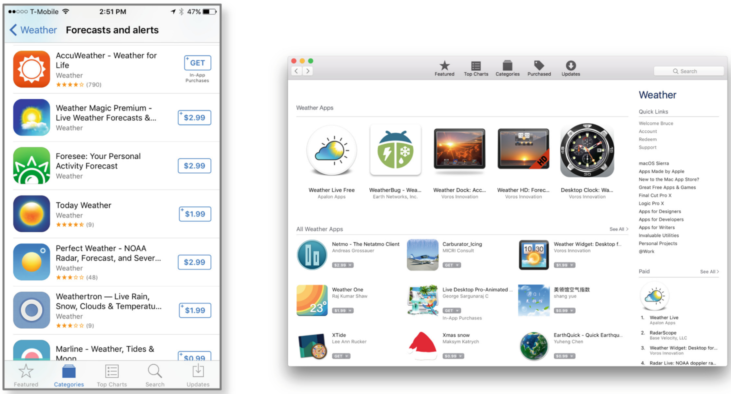

Fig. 1. Screen capture of just some of the many weather app available in the mobile online marketplaces (left: in this case, iOS App Store), and even desktop apps (right). Most weather apps share some common features, but also have unique attributes.

In the case of low-vision and blind users, screen reader accessibility features on mobile devices can speak aloud the text on the screen, thereby providing some access to a device. However, there is often a much larger issue with mobile apps, in that they are not designed to support the *informational needs* of users who cannot see the screen. The screen reader typically is forced to present the information in the order it is displayed visually. Often this results in additional time or steps wasted to get to the intended information, if it is even possible. For users with other unique needs, different from the canonical (sighted) user, the specific information that is most important may be quite different from what other users need; it may also be different on different days, or in relation to different tasks (e.g., going to work versus going to the soccer field versus working in the garden) [4].

To address this larger issue of effective and appropriate access to the needed information, and to serve as a proof of principle for universally designed apps (weather, and otherwise), we designed and developed a weather app from scratch, with universal design—including accessibility for visually impaired users—as prime design directives. We chose to implement a weather app since it is such a common service, and to point out that despite many apps available, there were really none out there that would equally serve the need for those who could and could not see the screen. We started with an Android app (see figures later in this paper, for screen captures), including iterative evaluation and redesign cycles; we have subsequently implemented the final design on iOS, as well.

2 Visual Design Leads to Access Issues

Most existing weather apps display a combination of numbers, text, buttons, and icons on the main page. The most important information (according to the designer), such as current temperature, is often shown in the middle or the bottom of the screen. Typically this is displayed in large text accompanied by visual icons that represent other current weather status. As an example, see Fig. 2. Such a presentation allows sighted users to perform a quick visual search, drawing their attention to the salient data first [5]. Weather icons are another way to quickly convey weather information to the typical (sighted) user [6]. Beyond the initial glance, a user can look for more specific details: other temperatures, wind, rain probabilities, etc. Most weather apps also present a way to check the forecast, including multi-day projections. These are often on different tabs or placed out of sight, accessed by swiping or scrolling. In general, most mobile weather apps are designed to present information in a quick, simple, and visually pleasing way. The emphasis, of course, is on "visual", since most, if not all, of the apps are clearly designed with canonical sighted users in mind.

Fig. 2. Example of a common information layout for the main screen of a mobile weather app. Note that often the information is embedded into an (inaccessible) image.

The user experience is not necessarily as straightforward for someone using a mobile screen reader: the user will generally hear the text items read left to right, top to bottom (or in some scrambled order). In the example presented in Fig. 2, if the user wants to know what the current temperature is, she might expect to hear the screen reader speak out "Today button" first. Swiping right, she would hear "12 h button," then swiping again, "10 Day button." The next swipe might be expected to speak the current weather condition "Fair," but in many apps the conditions data are embedded into an image, causing the screen reader to ignore the information or say something generic like "image." A few more swipes and the user may eventually hear the current temperature. This order of information presentation is not suitable for a user (especially one with a disability) who wants to quickly get an update on the current conditions.

Indeed, we have found that the top weather apps for Android and iOS required between 2 and 17 swipes just to get to the current temperature [2]. We should note that even though some weather apps provide the current conditions within a few swipes, most also chunk additional data together so that the listener has to wade through an extended list of atmospheric conditions before the most relevant data are presented. Blind and visually impaired users routinely waste time with information that is presented out of context, out of order, or unlabeled; or guessing about completely inaccessible items.

3 Broad-Based Needs Analysis

To try to approach an app design from a more universal design perspective, it is imperative to start by performing an *information needs analysis* with a broader range of potential weather app users than is typically considered. In the weather app design effort we discuss in [2], blind and low vision users supplemented the typical visual users. In our research and design work, we often use broad-reaching online questionnaires, typically supplemented with follow-up discussions via email. When we ask about issues with current mobile apps, a majority of respondents (from all user categories) tend to report that their major challenge is either the accessibility or appropriateness of the information, or the design of the app interface itself. Users have told us that some weather apps are missing "obvious" features such as providing an accessible hourly or 7-day forecast, or the ability to check details like wind speed, wind direction, and rainfall throughout the day (see [2], for example). Users with some other disabilities (e.g., hearing loss) have reported that wind direction and speed are also important for safety reasons, and this may be distinct from what "typical" sighted, or even visually impaired, users require.

This demonstrates the need to consider a broad range of uses, and to structure information in a suitable and flexible manner. Figure 3 shows the main page of the new Accessible Weather App, highlighting the simple and straightforward layout, the default high-contrast color scheme, the appropriate and flexible information order, and nested basic/detailed views. In terms of the color scheme, it is crucial to consider the range of needs. The high contrast (white words on a dark background) helps users with low vision read the content with less eye strain [7]; at the same time it is effective for users without vision impairments. Beyond the look and feel, there is the functionality: for instance, most users, regardless of impairment or lack thereof, want a way to check the weather conditions at a different location. This is, perhaps surprisingly, an issue some have reported as being difficult in existing apps.

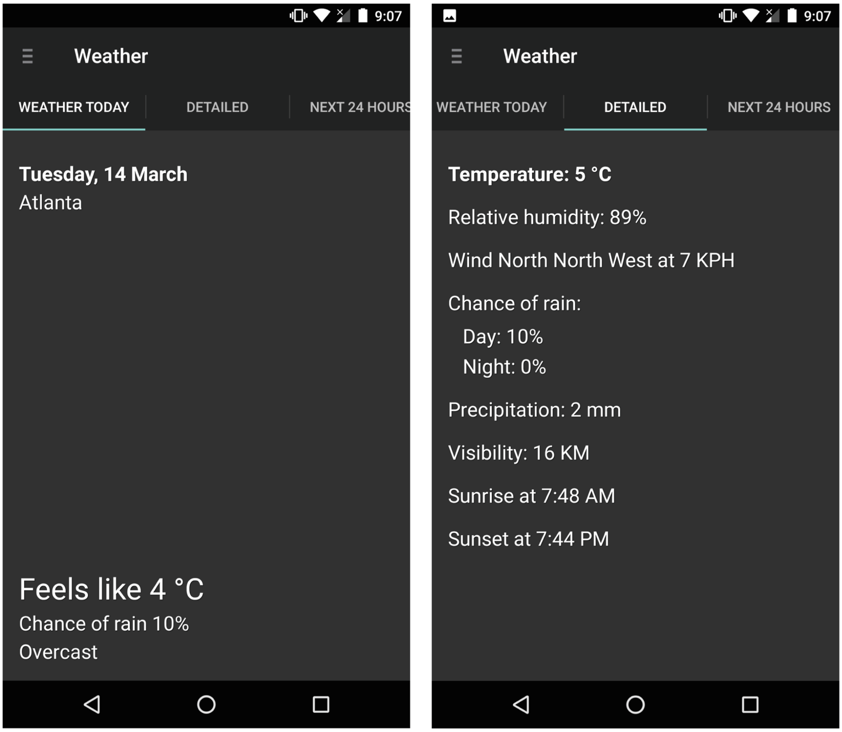

Fig. 3. Current version of the Accessible Weather App, showing the weather today in overview and detailed view. Note the default high-contrast color scheme, which is both universally appealing and effective. Other color schemes can be selected.

4 Multimodal Weather Display Design

In addition to our goal of creating a weather app that is designed from the ground up to be accessible for mobile screen reader users, in our Accessible Weather App project we were interested in enhancing the user experience for all users, by creating *multimodal* weather displays that provide functionality similar to that of visual-only weather icons, but in a more broadly available and even more engaging format. Figure 4 shows the visual layout. Note that auditory components are also present to conveyweather data in an efficient and multimodal manner. That is, we created a “glanceable” [8] way for users of **both** visual and audio interfaces to find out about the weather condition, by including icons and *sonifications*, in addition to the speech produced by the screen reader. Sonifications are intentional sounds that use non-speech audio to convey information or data to listeners [9]. They have been used in many applications and fields (often science) to convey trends and patterns of data, including weather information [10–12]. In the past, though, sonifications have usually conveyed longer patterns of data. Here, though, we employed short sonifications to support universal glanceability, for all users. The sounds (and the rest of the interface components) were

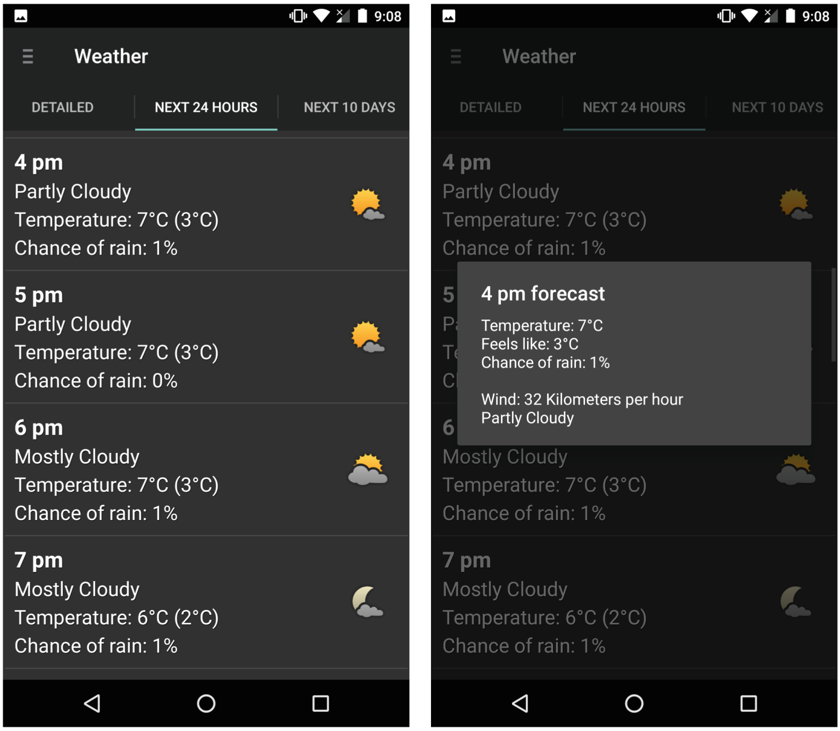

Fig. 4. Current version of the Accessible Weather App, showing the weather for the next 24 h (left) and with a detailed view (right), with slightly different ordering of data. Note the visual icons that are consistent with other apps, yet have high contrast. Sonifications are also present (though not evident in the visual screen capture), to display data and conditions using sound for those users who prefer it.

developed through a participatory design process, and thoroughly and systematically evaluated, before being included in the overall multimodal interface design.

Validation is a crucial step, when using interface designs that may be less familiar to some users (but that are necessary to ensure broader access). We often vet our sound designs before deploying them into an application, using variations of participatory design approaches. One example is using sound-sorting tasks [13] in order to assess candidate sounds. Participants listen to a variety of sounds that we have designed, and indicate which weather conditions they feel those sounds best represent; this helps us understand how the users think about the weather, and about the interface [14, 15].

5 Evaluation and Iteration

As with all our software and hardware projects, the Accessible Weather App was evaluated in the field: Blind and sighted smartphone users downloaded and installed the app onto their device, and used it for at least a week (ranging from 1 to 10 times per day). Testers then completed an extensive (63 question) survey, followed up by email discussions with the researchers. We asked about the app (in general), the TTS wording, and their satisfaction and frustration levels for the different features within the app. As a summary of the feedback (again, see [2] for more details), all respondents stated the app was similar to, or better than, the weather app they had previously preferred. They appreciated that the core features of having access to basic hourly conditions, details, daily, and extended forecasts were available and easy to use (see Fig. 5, showing 10-day forecasts). Many of the specific comments related to the features being more closely tuned to their diverse needs (reflecting the universal design ethos), and more accessible information.

Fig. 5. Current version of the Accessible Weather App, showing the weather for the next 10 days (left) and with a detailed view (right), with slightly different ordering of data. Note the consistency of interaction, and flexibility of data display.

The app has been refined since the main evaluation, with bug fixes and feature requests rolled in. A range of visual preferences have also been incorporated, such as different colors for font and background; high contrast; and location search preferences. Figure 6 shows the Android version of location selection (iOS is also available), leveraging the well-known and oft-used interaction methods (e.g., a side drawer for favorites), extended to include multimodal interface elements. These options address

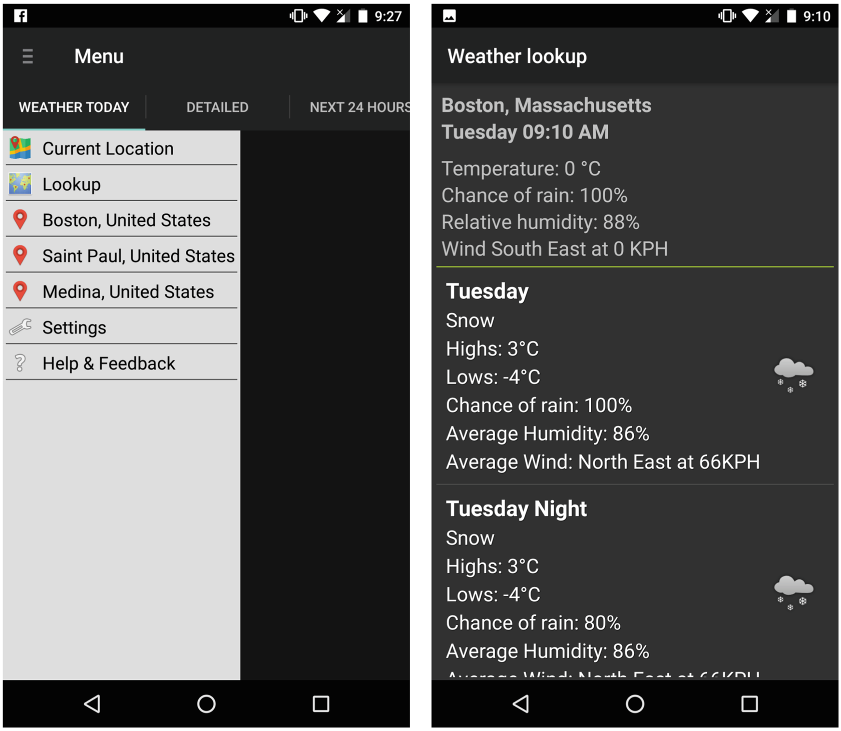

Fig. 6. Current version of the Accessible Weather App, showing favorite locations (left), and details for a given location (e.g., Boston). Note that the app is congruent with the mobile operating system (in this case, Android), but extended to be more universally accessible.

even broader sets of users, such as those who may not use the screen reader function, but still have problems with the typical visual design, such as the seemingly ubiquitous black text on a white background. As seen in Figs. 3, 4, 5 and 6 (with the now-default high contrast white-on-black color scheme), the app is very appealing visually, as well as auditorily, and is a very useful weather app for all kinds of users. This, we believe, is a truly successful example of universal design in action!

6 Conclusions and Final Thoughts

Accessing weather conditions and forecast is a common part of nearly everyone's day, and for many users with a variety of needs and limitations, it can be a crucial source of information. Unfortunately, even though many of the multitude of weather apps may comply with accessibility requirements (largely by inheriting default accessibility features of the mobile operating system), they have not been developed from the ground up to be more universally accessible. By focusing on a broader range of users, including those accessing the device through a screen reader, those who may have print disabilities yet do not use a screen reader, and those whose weather data needs might be different from the “typical” weather app user, we were able to create a more fully accessible, and indeed one may say more universal, weather app. Here we show examples of the design features that we have implemented in the Accessible Weather App, which are based on solid evidence, collected through considerable engagement with a wide array of users. However, the message here must not be just about this one app; rather, it is about the approach. The design philosophy we have embraced, the research and development strategies we employ, and the iterative evaluation we routinely conduct with a range of users, can certainly be applied to the creation of any other type of mobile app. Indeed, we strive to employ these universal design approaches in nearly all our projects, well beyond the bounds of mobile devices! We hope that these kinds of success stories will inspire other researchers and developers to follow similar steps to create better, more universal experiences for all users, regardless of any impairment (or lack thereof) those users may have.

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References

1. Böhmer, M., Hecht, B., Schöning, J., Krüger, A., Bauer, G.: Falling asleep with Angry Birds, Facebook and Kindle: a large scale study on mobile application usage. In: Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services (MobileHCI 2011), pp. 47–56. ACM (2011)
2. Tomlinson, B., Schuett, J., Shortridge, W., Chandran, J., Walker, B.N.: “Talkin About the Weather”: incorporating TalkBack Functionality and Sonifications for Accessible App Design. In: Proceedings of the 18th International Conference on Human-Computer Interaction With Mobile Devices And Services (MobileHCI 2016), pp. 377–386. ACM (2016). doi:http://dx.doi.org/10.1145/2935334.2935390
3. Williams, M.A., Hurst, A., Kane, S.K.: Pray before you step out: describing personal and situational blind navigation behaviors. In: Proceedings of the 15th International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS 2013), p. 28. ACM (2013)
4. Rodrigues, A., Montague, K., Nicolau, H., Guerreiro, T.: Getting smartphones to talkback: understanding the smartphone adoption process of blind users. In: Proceedings of the 17th International ACM SIGACCESS Conference on Computers & Accessibility (ASSETS 2013), pp. 23–32. ACM (2015)
5. Healey, C.G., Enns, J.T.: Attention and visual memory in visualization and computer graphics. In: IEEE Transactions on Visualization and Computer Graphics, 18(7), pp. 1170–1188. IEEE Press, New York (2012)
6. Matthews, T.L.: Designing and evaluating glanceable peripheral displays. In: Proceedings of the 6th Conference on Designing Interactive Systems, pp. 343–345. ACM (2006)
7. WebAIM: Visual disabilities: Low vision. http://webaim.org/articles/visual/lowvision#highcontrast 28 August 2013
8. Plaue, P., Miller, T., Stasko, J.T.: Is a picture worth a thousand words?: An evaluation of information awareness displays. In: Proceedings of Graphics Interface 2004, pp. 117–126. Canadian Human-Computer Communications Society (2004)

9. Walker, B.N., Nees, M.A.: Theory of sonification. In: Hermann, T., Hunt, A., Neuhof, J.G. (eds.) The Sonification Handbook, pp. 9–39. Logos Publishing House, Berlin (2011)
10. Flowers, J.H., Whitwer, L.E., Grafel, D.C., Kotan, C.A.: Sonification of daily weather records: issues of perception, attention and memory in design choices. In: Proceedings of the 2001 International Conference on Auditory Display, pp. 222–226. ICAD (2001)
11. Schuett, J.H., Winton, R.J., Batterman, J.M., Walker, B.N.: Auditory weather reports: demonstrating listener comprehension of five concurrent variables. In: Proceedings of the 9th Audio Mostly: A Conference on Interaction With Sound. ACM (2014)
12. Walker, B.N. Kramer, G.: Mappings and metaphors in auditory displays: an experimental assessment. In: Proceedings of the 3rd International Conference on Auditory Display (ICAD 1996), pp. 71–74. ICAD, Palo Alto (1996)
13. Lewis, B.A., Baldwin, C.: Comparison of traditional psychophysical and sorting methods for in-vehicle display design. Proc. Hum. Factors Ergon. Soc. Annu. Meet. **59**(1), 1312–1315 (2015). SAGE Publications
14. Barrass, S., Kramer, G.: Using sonification. Multimed. Syst. **7**, 23–31 (1999)
15. Barrass, S., Vickers, P.: Sonification design and aesthetics. In: Hermann, T., Hunt, A., Neuhoff, J.G. (eds.) The Sonification Handbook, pp. 145–177. Logos Publishing House, Berlin (2011)