Mobile Web

Tiago Guerreiro and Luís Carriço and André Rodrigues

Abstract Mobile devices are the tools of the trade to access services and contents on the Internet, already surpassing their desktop counterparts. These gadgets are always available and provide access to social networks, messaging, games, productivity tools, among many others. Accessing the Web with mobile devices, either through a browser or a native application, has become more than a perk; it is a need. Such relevance has increased the need to provide accessible mobile webpages and (Web and native) applications; failing to do so would exclude people with different abilities from a world of opportunities. In this chapter, we focus our attention on the specific challenges of mobile devices for accessibility, and how those have been addressed in the development and evaluation of mobile interfaces and contents. We finish with a discussion on future directions in the field, that outlines the need to learn from the fast emergence of a mobile world, and be prepared for the impact of other upcoming technologies.

1 Introduction

Mobile devices paved their way into our daily lives becoming crucial tools in a variety of contexts. These powerful handheld devices have gone long past their initial purpose - one-on-one communication - and are now full-fledged computers. Not so long ago, people would use their desktop computers to play a game, review and edit documents, or check their e-mails; they now also, and likely more often, do it on a mobile phone Johnson and Seeling (2014). The portability and communi-

Tiago Guerreiro
LASIGE, Faculdade de Ciências da Universidade de Lisboa, e-mail: `tjvg@di.fc.ul.pt`

Luís Carriço
LASIGE, Faculdade de Ciências da Universidade de Lisboa, e-mail: `lmcarrico@fc.ul.pt`

André Rodrigues
LASIGE, Faculdade de Ciências da Universidade de Lisboa, e-mail: `afrodrigues@fc.ul.pt`

cation capabilities alongside the bundle of sensors enabled the creation of novel interaction methods and applications. What was once not common or existent for personal computers, has become a feature leveraged daily by many (e.g., geolocated or motion-based games and applications, camera-based social interactions). Mobile devices constant availability, portability, connectivity, interactivity, and individuality has enabled us to improve how we work and learn, e.g. mobile learning, beyond what other ICT could do Terras and Ramsay (2012).

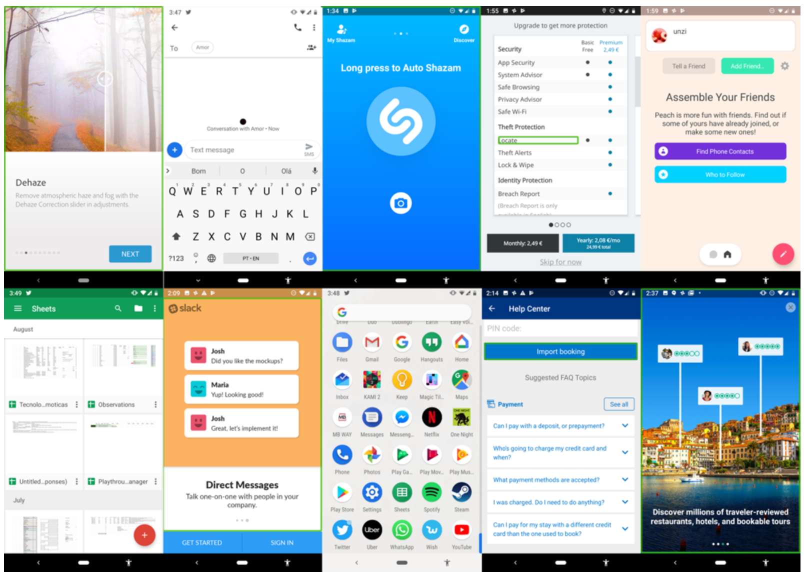

Fig. 1 Variety of smartphone applications interfaces that users have to interact with)

The opportunities created for ubiquitous and enriched access to an ever-increasing world of applications comes along with a variety of challenges. Mobile devices are smaller which makes them challenging in a multitude of ways Nicolau et al (2014a); Rodrigues et al (2015). The sheer amount of applications and tasks (Figure 1), adding up to the small size of the display, makes them cognitively challenging Page (2014). Mobile devices are also often used under challenging conditions, so called situationally-induced impairments and disabilities Sears et al (2003); Yesilada et al (2010, 2011), and even more so if you already face a health-induced disability Nicolau (2012); let's call those situationally-augmented impairments and disabilities. Consequently, mobile accessibility affordances need to be carefully understood to maximize the inclusion of all. When we do so successfully, we might even be enabling people who were previousy excluded from common usages and tasks to access the Web Naftali and Findlater (2014).

Mobile devices and their applications have been evolving at an extremely fast pace pushed by major companies like Microsoft, Nokia, and more recently, Apple and Google. This industry-driven evolution is also characterized by a lack of convergence and standardization which has impact in how accessibility has been taken into account. There have been sparse efforts to provide guidelines and recommendations for the specific case of mobile accessibility at a local level, e.g, BBC, Android, iOS Mobile Accessibility Guidelines. At a more global level, only recently the most accepted sources of accessibility guidelines in the Web have started to pay special attention to mobile accessibility, e.g., Web Content Accessibility Guidelines 2.1 (WCAG 2.1) discussed in Standards, Guidelines and Trends chapter.

Accessing services and contents on the Web with a mobile device can be done through a browser or a native application. The aforementioned challenges are mostly associated with the device characteristics and applicable to both those types of access. The development of webpages has evolved, with mobile devices as propellers, with a variety of approaches, e.g., mobile-dedicated versions, where a different version is served when the user-agent is a mobile device; non-dedicated versions, i.e. responsive design, where the output is differently served depending on the device characteristics. Native applications, on the other hand, are developed with a set of platform versions in mind. In the case of the former, accessibility benefits from the maturity already attained on Web development. In the case of the latter, accessibility benefits from a deeper integration with the operating system and its native accessibility services. A third breed is an hybrid: an application that is natively packaged but which inner contents are a Web view and thus structured in a way that can follow accepted standards and guidelines. Still, in all cases, access to the Web in a mobile device is still limited.

In this chapter, we focus our attention on the challenges that make mobile accessibility a unique endeavour, as well as the state of art in developing, evaluating, and overall researching towards an accessible mobile world. Mobile accessibility is not a given, today. Yet, what we have learned from the disruption caused by the overwhelming growth of mobile devices and applications, should prepare us for future technological revolutions. We discuss the mobile accessibility panorama and point future directions for research in this space.

2 Specific Challenges of Mobile Accessibility

For several years, access to the Web was achieved through a desktop/laptop computer with reasonably standard input and output affordances. The keyboard and the mouse, rich in tactile cues, complemented each other but also were enablers of access on their own when coupled with a suitable output interface. Access to the Web on mobile devices started with an attempt to mimic such access, although with less input bandwidth, i.e., using the available keypad and eventually joypad Trewin (2006). Quickly, the affordances on mobile devices mutated and, with the overwhelming emergence of touchscreens, direct manipulation over a flat screen became the norm. This brought up challenges for accessible interaction, to add to the ones of size, already a problem in the early mobile phones. We focus our attention in three main challenges that influence the current panorama on mobile accessibility: size and I/O, contexts of use, and lack of convergence.

2.1 Device Size and I/O

One of the important differences of mobile devices to personal computers is their size. It has been changing throughout the years, from larger to smaller and back to larger, but still way smaller than their desktop counterparts (Figure 2). This fact impacts content delivery in several forms.

Fig. 2 Device Size Evolution, from 2002 to 2014 (retrieved from Wikimedia Commons)

The contents that can fit a mobile device screen, in a way that they are still perceivable, are limited. The approaches to deal with this challenge varied. Early approaches argued for liquid design, where the screen contents would adapt to the device dimensions and resolution. For the majority of websites this would mean that the first render of a webpage would be unreadable (due to its small size), upon which a zoom to a readable level would be required, which can be cumbersome and highly inaccessible. The option to just render a webpage at a readable level leads to the need for continuous scrolling, vertically and horizontally, which can also be damaging for accessibility (e.g., physically and cognitively).

More recently, responsive design, an approach that makes interfaces render differently depending on the device characteristics, had increasing success and adoption (Figure 3). Although not a synonym for accessibility, responsiveness of the design contributed to the overall improvement of the usability of webpages delivered on mobile devices, to everyone. A parallel approach, that also gives adequate relevance to mobile Web, is the creation of mobile-dedicated webpage versions, most often simpler and with more focused content Fernandes et al (2015), which has been previously associated with higher accessibility Lopes et al (2010).

The approach generally followed in the development of native mobile applications merges the two aforementioned approaches applying responsive design to a selection of contents and widgets normally made available through webpages.

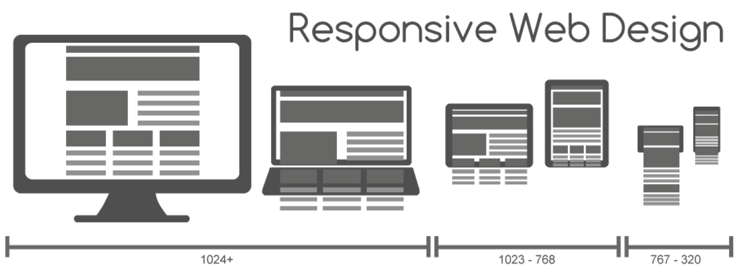

Fig. 3 Responsive Web Design. Layout on different devices (retrieved from Wikimedia Commons)

A positive consequence of these most recent approaches to mobile design is that decisions are made regarding which contents are a priority and need to be quickly accessed. Conversely, it is still a challenge to place all the important information available to the users in such a small screen. This creates issues of clogging the screen, applying new metaphors that can be unclear to users (e.g., navigation drawers with cryptic or inexistent affordances), or creating the need to endless scrolls, sometimes bi-dimensionally Díaz-Bossini and Moreno (2014); Zhou et al (2012).

A second consequence of reduced device size relates to user input. Mobile devices include a screen occupying their entire front face and have fully adopted direct manipulation. To interact with the device, users are required to tap, double tap, or long press interactive elements, as well as performing a set of gestures. Deriving from this limitation, a first challenge is in defining or adapting target sizes in a way that they can be directly selected by their users. Several researchers have leaned over this problematic, some with particular attention to older people and people with motor impairments Kobayashi et al (2011); Zhong et al (2015); Montague et al (2014); Nicolau et al (2014a); Mott et al (2016), people with visual impairments Rodrigues et al (2016), or people under situational impairments Kane et al (2008b); Goel et al (2012).

In parallel, the lack of an always-available keyboard drastically reduces the set of input commands that could allow for more effective navigation. For example, shortcuts on desktop screen readers allow for more usable and fine-grained navigation between page elements than what is conceivable or even possible with a keyless mobile device. This is even more drastic in applications, with visually impaired users being left to either be aware of the position of an element onscreen (or search for it), or to navigate element by element until they find it Rodrigues et al (2015).

Of particular relevance in the mobile context, is the set of gestures used to navigate a webpage or application. As aforementioned, the dimensionality of such set is limited to the users ability to memorize and perform them. An additional problem comes with the possibility for each developer to define gesture recognizers for their webpages and applications, which can be hard to identify and execute. Although there are slight differences in the basic gesture set of iOS and Android applications, for example, we have been witnessing a convergence. This accepted set is a result of past research that has explored which gestures would be more natural to perform Ruiz et al (2011). Other researchers have focused on how to adapt the gesture-based interaction to cooperate with a screen reader, and thus enabling non-visual access to touchscreens Kane et al (2008a); Gonçalves et al (2008). SlideRule Kane et al (2008a) was the stepping stone for the non-visual interaction of today's mobile screen readers. Operation of a touchscreen by older adults has also been a matter of study, with a recognition to its inherent complexity Stöß and Blessing (2010). What is clear is that these stereotypical difficulties faced by different populations should be known by developers so that webpages and applications are designed to be at least, stereotypically accessible.

2.2 Contexts of use

Mobile devices are used in a variety of contexts Dey (2001). These can be extremely challenging and limit how devices and interfaces can be operated. The awareness to the impact of context on mobile interaction brought up the discussions around situationally-induced impairments and disabilities Sears et al (2003), their similarities with physical and sensorial impairments Nicolau et al (2014b); Yesilada et al (2010); Nicolau (2012), and solutions to overcome these temporary limitations in ability Goel et al (2012); Kane et al (2008b). Common examples of situational impairments include the usage of mobile devices outside under high brightness, while walking or taking a public transportation, or even with interacting with gloves.

To design for mobile accessibility, context needs to be fully considered as a sum of the users' abilities, the device, interface, application being used, and the environment where the interaction is taking place. Situationally-augmented impairments and disabilities have had limited attention. Concrete examples are of a blind person commuting and using the phone, seeking to input her password privately but without wearing headphones, or of a user with limited motor abilities seeking to input text via eye-tracking while paying attention to his surrounding environment Abdolrahmani et al (2016).

2.3 Lack of convergence

Mobile devices are not only different from desktop computers, they are also vastly different from each other. With the popularization of smartphones, the variety of devices and platforms rose and segmented the user base. Currently, there are two major mobile operating systems market leaders, Android and iOS (Mobile Operating System Market Share Worldwide StatCounter (2018d)), that are very different from each other.

iOS is a closed-source operating system that only allows access through its APIs, apps are only published via their online store and devices are only produced by a single entity (i.e. Apple). Android is open sourced with manufacturers able to adapt its operating system and commercialize devices with a wide range of specs. Android developers are able to create other stores and have more control over the device; consumers are able to choose from a broader set of devices and applications. However, while the iOS ecosystem remains stable, and Apple ensures continuity between devices, the Android market is heavily segmented. In September 2018, 64% of users are on the latest version of the OS with the rest of the versions having at most 7% (Mobile & Tablet iOS Version Market Share Worldwide StatCounter (2018c)), while on Android, the latest version only accounts for 12% with 5 different versions having above 10% market penetration and the highest with just 22% (Mobile & Tablet Android Version Market Share Worldwide StatCounter (2018b)).

The consequences of the differences in versions and features for accessibility are that developers and researchers often have to deal with a variety of requirements simultaneously to ensure the Web content created is accessible to users of all versions and devices Rogers et al (2016). At times this can prevent developers from taking advantage of the device latests features or requires them to provide different experiences depending on capabilities, similar to what had previously happened with different browsers having support for different features. In addition, these updates to features and devices are constant and often in the mobile ecosystem.

3 Developing for Mobile Accessibiliy

Previously, developers only had to take into account a limited set of browsers to ensure their content was accessible on desktop/laptop computers. However, the panorama shifted, with the introduction of the variety of mobile devices and technologies; the problem became vastly more complex Nielsen (2012). The need to target devices with different affordances spawned a variety of approaches (e.g. dedicated mobile sites, responsive Web design, native applications), each with their own benefits Charland and LeRoux (2011). In 2011 Mikkonen and Taivalsaari (2011) anticipated a "battle" between two opposing approaches, native development versus open Web. However, we have yet to witness one approach becoming the one solution.

As predicted by Charland and LeRoux (2011), in the recent years, we have instead seen the rise of hybrid solutions where Web based content is packaged in native applications. There is no perfect approach as each has their own set of challenges. Native approaches often struggle with fragmentation of platforms, versions, and devices; Web solutions struggle with the ability to take advantage of devices features (i.e. compatibility); and hybrid, to a lesser extend, struggles with compatibility Ahmad et al (2018).

There have been efforts to provide a standardized set of guidelines (WCAG) that ensures Web content is accessible by all and easily leveraged by assistive technologies on desktop computers. In the advent of mobile devices, in an effort to unify best practices, in 2008, W3C released the recommendation for Mobile Web Best Practices 1.0 (MWBP Rabin and McCathieNevile (2008)). A year later, to consolidate WCAG 2.0 with their MWBP W3C released "Relationship between Mobile Web Best Practices (MWBP) and Web Content Accessibility Guidelines (WCAG)"Chuter and Yesilada (2009) a report describing their similarities and differences. These were only the first steps, as W3C continued to work towards a single recommendation that would encapsulate all platforms.

In July 2018, W3C released a new recommendation, WCAG 2.1Kirkpatrick et al (2018) that now takes into account the variety of devices, modalities and features that are used by contemporary mobile devices (e.g. guideline 1.3.4 Orientation about screen orientation). The core technologies of the Web, such as HTML5 and CSS, are developed at W3C, the same organization responsible for the Web Content Accessibility Guidelines. However, the access points to Web content are no longer just the traditional Web browser, with native and hybrid applications taking a significant role. The lines have blurred to whom is responsible for what, with applications having to take on roles previously hold by user agents and vice-versa. For example, the guideline 2.4 - Provide text search from UAAG 2.0Allan et al (2015) which previously user agents were responsible for, on hybrid and native applications, is up for content developers to implement.

Many of the accessibility efforts for mobile have also been industry led, particularly for native applications. Google, with the vested interested in their mobile operating system (Android), has provided developers with a set of guidelinesGoogle (2018b) that, when followed, ensured their native assistive technologies are compatible and fully accessible. Apple goes beyond guidelines and provides developers with many predefined controls (e.g. add a contact, detailed info) and views that harmonize the experience throughout different applications Apple (2018a). Other private companies have made clear guides in an effort to ensure their content is accessible in all device types - BBC guidelines for developersBBC (2018). Overall, when developing for mobile, one should also take into consideration the native guidelines to maximize compatibility with the native assistive technologies provided in each.

As with traditional Web development, integrated development environments can have an impact in the usability and accessibility of content Gibson (2007). As reported by Ross et al (2017), when we use an epidemiology lenses to look for the accessibility problems that plague the mobile ecosystems, we become acutely aware of the impact the current main development environments and common use libraries have (e.g. iOS with Xcode Apple (2018b) and Android with Android StudioGoogle (2018a)). Similarly, the work by Richards et al (2012) revealed that improvements to Web accessibility came has a side effect of changes in coding practices or trends. Duarte et al (2016), more recently, explored the impact of development technologies on the accessibility of applications. Moreover, in a era where content is created by users as much, if not more, than by developers, we need new ways to ensure new content remains accessible to all. There is an opportunity to further explore how we can shift development and content authoring practices to have accessibility embedded into its core.

Developers should also be aware of the different modalities and services available for users to consume and create content. Mobile devices are highly integrated platforms with different applications leveraging features from each other (e.g. "Share on Facebook", "Sign in with Google"). In recent years, speech has also become a common modality of interaction; mobile devices are equipped with voice assistants that are able to access content and request services (e.g. Google Assistant on Android and Siri on iOS). These technologies can be leveraged to provide access to many people. If a Web app or a native application with Web content limits its interaction to just the inside of the app or browser, and does not look forward to opportunities to mesh and collaborate with other services, it can negatively impact its accessibility. For example, in the specific case of a voice assistant, when speech is the only modality available to someone, enabling access through it might be the only way to effectively reach the user.

A different approach towards mobile accessibility is to create accessibility services that change the way users interact with content. Some are looking into adapting how content is rendered Zhang et al (2017); Zhou et al (2014) or navigated Zhong et al (2014); Rodrigues et al (2017b), compensating for the accessibility issues introduced by careless developers; others are providing additional Q&A capabilities on top of existing content Rodrigues et al (2017a). These services are akin to Web plugins.

One thing is for sure, mobile applications are every day more intertwined. With one piece of content leading to another in a different app and interface; floating windows appearing with extra content from a different service or app. While traditionally on the Web one would not have to consider the interactions between services, other then embedded content, one must always do so on mobile. Nowadays, more than ever, when developing any Web content, accessibility should not be an afterthought.

4 Evaluating Mobile Accessibility

Webpages developed for desktop devices quickly became unusable on mobile devices. This fact, and the overwhelming prevalence of mobile device access to the Web, increased the need for webpages that adapt to the device size, and that focus and reorganize contents for maximum benefit both for the user and the provider. In parallel to the creation of mobile representations of webpages or other types of high responsiveness to device characteristics, the development of native mobile applications accounts by design with the device size restrictions.

Despite the awareness of the relevance of adapting the Web to the mobile reality, the seek for empirical evidence of the different approaches has been limited. There is a large body of work focusing on touchscreen accessibility, text-entry, and other parallel tasks, and less on the impact of design alterations to maximize accessibility. This may be related with the bias of Web accessibility guidelines towards a more traditional setting, i.e. desktop, and the only recent effort to provide guidelines applicable to mobile settings, both webpages and native applications.

There are notable exceptions. Johnson and Seeling (2014) performed one of the first studies comparing desktop and mobile representations of webpages, with the goal of comparing them over time. Most of the differences found related to network demands, particularly, to a lower number of objects (and with smaller size) requested in mobile settings; this study had no particular focus on accessibility. Fernandes et al (2012) compared the accessibility of mobile and desktop representations of webpages, using an automated evaluator Fernandes et al (2014), analyzing the success in complying with standard accessibility guidelines (i.e. WCAG 2.0). This study found that, even without using mobile-specific guidelines, mobile dedicated representations were less accessible than mobile non-dedicated representations. The latter tend to be simpler, a common consequence of responsive design, but reuse the accessibility knowledge, practices, and code of desktop representations. These results illustrate that the effort to design from scratch for a mobile reality has brought back past challenges for accessibility; the same reality has been patent in the emergence of mobile native applications, that show a multitude of errors that were also common on webpages Ross et al (2017).

Automatic evaluations, as those mentioned above, are performed similarly to mobile webpages and desktop representations, most of the times resorting to the same evaluators Fernandes et al (2015). However, past work has recognized the differences of the mobile web, particularly by developing evaluators that would take device characteristics in consideration Vigo et al (2008). While for mobile webpages are accessible, i.e., its stucture and contents can be accessed and processed, to common evaluators, native applications were used for years without the existence of suitable automatic evaluation tools. Nowadays, there are alternatives to assess the accessibility of the applications for the major operating systems, iOs and Android, but still limited when comparing to webpage evaluators, in their verification of the accepted guidelines Feiner et al (2018); Ross et al (2017).

Several authors have argued for the importance of more in-depth usage analysis, with users, in mobile contexts when evaluating the accessibility of a webpage or application. The reasons for that related with the suggested inadequacy or incompleteness of accepted guidelines for a mobile context Clegg-Vinell et al (2014) and the need to evaluate within context. One example of such studies is the work by Akpinar and Yeşilada (2015) where 50 users participated in a study where they had to interact with original and transcoded versions of webpages, to assess the benefits of an eye-tracking based transcoding approach.

The multitude of contexts where mobile interaction takes place has only recently started to be taken into account in mobile accessibility evaluation. Particularly, this has been achieved by capturing how people with disabilities interact with mobile devices and their applications in real life settings Kane et al (2009); Rodrigues et al (2015); Naftali and Findlater (2014). This allowed researchers to delve into challenges that were not considered nor evaluated in laboratorial or automatic evaluation contexts.

The need to assess the accessibility in context has been brought up before in desktop settings Hurst et al (2008, 2013); Vigo and Harper (2013) but has further implications in mobile contexts given their imprevisibility and variety. The consideration of mobile interaction contexts as determinant to understand mobile accessibility is only patent in recent work, and particularly in the way research is conducted Naftali and Findlater (2014); Rodrigues et al (2015); Montague et al (2015, 2014); Nicolau et al (2017). These works are characterized by using multiple methods that seek to capture a deeper perspective of the impact of the solutions they are assessing. They include observations, interviews, questionnaires; performed through time; sometimes in parallel with objective data collection.

5 Discussion

The rise of mobile devices brought not only new challenges to the way Web content is accessed and developed, it also lowered the entry barrier to access Web content. Mobile devices can be cheaper and easier to obtain than desktop computers. In August 2018, worldwide, mobile (smartphone + tablet) already account for 57% of the market share**?**), and in some countries, mobile users already represent over three quarters of the total users (Desktop vs Mobile vs Tablet Market Share IndiaStatCounter (2018a)). The trend has been for mobile devices to become the primary access point to Web content. The variety of devices, platforms and applications that have permeated into our daily lives can no longer be an afterthought when developing for the Web.

The standardization and evaluation of the accessibility of Web content have paved the way for changes on how Web content was previously developed on desktop computers and its stereotypical input methods. However, even the less complex context in which interactions take place on desktop computers, guidelines compliance does not translate into an accessible experience. In Power et al (2012), guidelines only accounted for 50% of the problems 32 blind people encountered when interacting with a variety of websites. We have to continue the efforts towards accessibility but taking into account the complexities that come with mobile technology.

The efforts in research and development since the introduction of smartphones have been mostly targeting the size variance Kobayashi et al (2011); Zhong et al (2015); Montague et al (2014); Rodrigues et al (2016) and the novel input modalities Kane et al (2008a); Gonçalves et al (2008). However, work that explores the issues with mobile devices in real-world context Kane et al (2009); Rodrigues et al (2015); Naftali and Findlater (2014) has been scarce. One of the possible causes is the complexity of conducting such studies, with concerns to privacy (e.g. collecting user daily text-entry), safety (e.g. texting while driving) and ability to collect data in-situ at the right moment. The lack of convergence of the mobile platforms will only increase with the introduction of new devices. While some work has proposed to assess the impact of different development practices and tools Ross et al (2017); Richards et al (2012), there seems to be a gap in knowledge to what are the consequences of the fragmentation of user basis across platforms, versions and apps.

Multiple methods research may be leveraged as part of a quest for a deeper understanding of the accessibility issues people are facing in the real-world. Part of the solution may come from further development of new evaluation metrics for accessibility; automatic evaluators capable of assessing native and hybrid content; and real-world data collection services. Evaluations will need to change in order to keep up with the fast pace at which applications, features, operating system and devices are being release and updated. The time of static evaluations conducted on a secular version of the system will no longer be relevant. Nowadays, it is time we look beyond traditional contexts where interaction used to take place. Interactions are happening everywhere at any time, and if we neglect working towards accessible models that encapsulate them, we will be excluding a vast number of people.

6 Future Directions

With the understanding of the impact of past decisions on the impact of the accessibility, comes a responsibility and an opportunity. It is clear today that the accessibility of a mobile webpage or application is not a localized issue; it is the result of standardization, education and training, development environments, platform accessibility services, awareness to contextual factors, among several others. It is the sum of a set of premises. The first steps to improve the accessibility of current platforms and their contents is to work on these premises, leaving no excuses left for failing. The rise of new technologies, mobile or not, should be informed by the accidented path towards mobile accessibility, and do better, e.g, integrated development environments designed from scratch to enable accessibility.

As reiterated throughout this chapter, mobile devices are embedded in our daily lives. In the foreseeable future the variety of devices and features will keep on rising, with the introduction of new wearables (e.g. skin wearables), augmented (AR) and virtual reality (VR) devices. The contexts in which mobile interactions take place are complex enough that we have yet to standardize accessibility requirements, or develop tools to evaluate accessibility in-situ accurately. With new sensors, interactions methods, and the debut of AR and VR, the contexts in which interactions take place will become a complex intertwining of real and virtual that will present us we a new set of challenges. With new challenges come great opportunities to innovate and think about the possibilities for work, leisure, communication and assistive technologies.

In the age where everyone has a powerful computer in their pocket, we have not yet seen a true realization of solutions that cater to the individual. With the advances in data science and artificial intelligence in general, it is odd that everyone is still given a predefined solution that works for most but not all. Accessibility of Web content to all does not mean equal interaction or layout. We are all a sum of our experiences, with different abilities and preferences. It is time technology catches up to the real-world understanding us in-situ, catering for our individual needs and abilities Wobbrock et al (2011); Oliveira et al (2011).

7 Authors' Opinion of the Field

Accessing the Web with a mobile device has become too common and relevant to be seen as a secondary concern. In the past, with a focus on content alone, accessibility to the mobile Web was not considered as being that different from accessing the Web on any other device. The contexts where mobile devices are used, the complexity and interwinding of applications, the I/O capabilities of these devices, proved otherwise. To add to it, the lack of specific guidelines and standardization lead to a disparity of approaches, from platforms to devices and even between application versions, that only increase the problematic of providing accessibility to the mobile context. Only now, circa 2018, we are witnessing clear efforts to standardize having mobile devices, and their idiosyncrasies, in consideration.

It is timely and relevant to learn from the past experiences and be on the lookout for novel contexts, technologies, and usages, that can render accepted guidelines and procedures as inadequate. With novel technologies emerging (e.g., Virtual, augmented and mixed reality), it is important to consider them, their authoring environments, guidelines for development, and evaluation tools, with a challenging eye to what is known and accepted today.

The matters of context, highly focused in this chapter, are only one example of the importance of a broader view when designing and evaluating with accessibility in mind, on mobile contexts (or other novel contexts we may imagine). The steps given in uncovering associations between emergence of new authoring tools, development technologies, or more broadly diverse aspects than can influence the accessibility of a product, as in the case of an epidemic, call out for wiser discussions around the impact of what is made available.

One particular concern for both practice and research is how mobile accessibility is being evaluated. Beyond the aged discussions on the differences between manual (expert) and automatic evaluations, in challenging contexts, it becomes paramount to assess in-context. In the age of data science, there is an opportunity to continuously assess products, their usages and failures, with a variety of methods, able to uncover accessibility barriers that would be unfindable even by experts using them in their cosy offices.

8 Conclusions

The emergence of mobile devices took us all by surprise. From one device to the other, there was rarely time to consolidate and work towards the accessibility of these devices and the contents therein, as it was not a priority. However, these devices have become so relevant in today's society that it is irresponsible to continue this path.

Recent work has presented several ways to improve the accessibility to mobile devices and its contents, and evidence on how these advances can benefit everyone. It is exciting to witness increasing awareness to mobile accessibility; it is with careful excitement that we expect the emergence of new technologies and work towards a less accidented path, with accessibility at the forefront.

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