ACCESSIBILITY LAYERS: LEVELLING THE FIELD FOR BLIND PEOPLE IN MOBILE SOCIAL CONTEXTS

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Introduction
Enabling access to a computing device is likely to have a huge impact in the quality of life of a person. Every once in a while, new technologies are devised and impact the way we communicate, work and even, how we have fun. Paradigmatically, it is often the case that a new technology empowers the general able-bodied user and fosters exclusion of people with disabilities. The emergence of touch-based smartphones as the de facto mobile interaction gadget created a gap between those that were able to use the device as it was deployed in the market and those that were not able to do so. The potential usages of these devices exploded and users that were at that time able to use mobile phones with physical keypads similarly to their peers, saw themselves living in the past of mobile interaction, from one day to the other. This was the case of blind people when smartphones started to dominate the market circa 2007.

It is not a surprise that the inclusion of VoiceOver as a built-in accessibility feature in the iPhone 3GS version is a major turning point in the recent history of accessible computing. At the time, when it was launched in 2009, smartphones were already established as a person’s handheld computer, way beyond a simple communication tool, and had an impact in people’s lives that could not be overseen. Apple democratized access to smartphones and the others followed, always a little behind. Researchers focused, for the following years, mostly on understanding the impact of the built-in accessibility features and enabling or improving specific tasks and applications (e.g., text-entry [16]), but generally accepting the VoiceOver modus operandi. This research was carried mostly in the laboratory limiting the understanding of the integration of these gadgets in one’s life, particularly to what respects the relationship with peers.

Besides the tools and applications paraphernalia that came along with these new devices, another reason to adopt them lingered: social acceptance. Feature phones became obsolete and, despite their recognized higher accessibility, became socially undesirable [8,19]. There are a number of online testimonials and videos on the benefits and proficiency of using a modern touch phone. On the other hand, little is known about the learning process of this new technology and, once again, what these users lost in their transition from older to newer devices and how long it took for them to regain a similar level of control over these new tools. Anecdotally, we have observed blind people that learned to manoeuvre them, feel victorious and proud, and, looking back, see a great evolution from the smartphone early days, when these were inaccessible to them. Compared to other challenges they faced in their lives, this is likely to be a minor one.

A side effect of this generalized idea (users, manufacturers, and society) that smartphones are now fully accessible and that, in the particular case of blind people, they have regained the control they once had with their feature phones, is that relevant layers beyond physical access to the device and its contents are overlooked.

In this article, I focus my attention on the shortcomings of current mobile devices, particularly in the social arena. I motivate and present work (performed in collaboration with others) in the areas
of security and privacy, inconspicuous interaction, and social context awareness. With the emergence of new technologies it is relevant to keep in mind that enabling physical access is not enough as social aspects, and other layers, need to be guaranteed. These layers beyond access need to be pursued and added until we are able to state that people with disabilities stand in par with others in social contexts and are not disabled by technology.

Layers of Accessibility
When presenting my own work on mobile accessibility, even to other researchers, I was several times faced with the question “but wasn’t that solved with the iPhone? I saw a blind person working with an iPhone, and boy, she was fast”. I have also seen several blind people interacting with such devices, more proficiently than I do. Conversely, when talking with blind people, I still witness a great deal of people reluctantly adopting a touch phone or waiting until they are forced to do so. The question that arises is what the meaning of solved is in the question posed by these well-intended people. If we are talking about physical access to a device, then yes, it has been solved. If we try to look deeper and understand how easy it is to start using such devices, it is dramatically harder to adopt and learn how to use them, than for a sighted person [16]. In that sense, no, it is not solved. If we try to look at the daily experiences of using a smartphone non-visually, we witness several barriers, some of them unsurpassable without help from a sighted person. In that sense, no, it is not solved. If we consider a social context, where everyone should be able to decide what to be made available to others and what should be private, blind people face the decision between postponing mobile interactions or expose themselves to others. In that sense, no, it is not solved.

The following sections cover the work we have been doing to go beyond physical access levelling the field for blind people in the mobile social arena.

Accessible Privacy

Privacy is the ability of an individual or group to seclude themselves, or information about themselves, and thereby express themselves selectively.

— retrieved from Wikipedia

Mobile devices contain an increasing amount of personal information stressing the need for their owners to secure access. While authentication methods are available to address the threats by the probable adversaries, they fail in the case of a closer threat (e.g., friends, family, or lovers) where device and passcode sharing is common [11]. Privacy also goes beyond physical access to these devices: while interacting with a mobile device, our private information may be exposed to others. There is the need for inconspicuous ways of interaction. This need is drastically augmented in particular cases like the one of blind people: the de facto assistive technology, screen readers, alongside the need to be aware of the surrounding environment (making headphones undesirable), makes mobile phone usage by blind people a highly conspicuous one, severely jeopardizing the right to privacy.

Accessible Authentication
Travelling back in time to the era of physical keyboards, a blind person could input a PIN by feeling the keyboard, while maintaining the audio feedback muted. As with several other
interactions, this was easier and more effective in the past than what is achieved nowadays. The advent of mobile touch phones came with new challenges in respect to guaranteeing security to blind owners. The modus operandi of these devices supposes that the keys are read out loud when touched; if this does not happen, it is hardly usable. In an authentication setting, where others can be looking or eavesdropping, this authentication method is inadequate or highly demanding. Previous research has looked at this challenge seeking to provide alternatives that were not dependent on the step-by-step feedback provided by traditional methods [3].

Our first project explicitly in the area of accessible privacy sought to develop an authentication method resilient to smudge and shoulder-surfing attacks that could be used non-Visually [9,10]. This method relied on unbounded tap phrases (requiring a single template) and proved to live up to the expectations by disabling observers to mimic the authentication rhythmic key. While these alternative methods provide a barrier for access that is more usable to the blind user and still, and even more so, resilient to attacks, it is a single barrier that does not totally address the possible social scenarios that have been reported extensively in the usable privacy literature [1,6,11]. One particular scenario, very common for novice blind users [17], is the one of device sharing, for example, when asking for help. In these settings it is paramount to find new methods that allow blind people to maintain awareness, similar to the one achieved visually, of what is and was accessed by the one holding the device momentarily. Future work should address awareness on non-owner usage to mimic the close control achieved by blind people.

Private & Inconspicuous Interaction
The non-visual usage of mainstream touch-based smartphones is closely tied to the usage of a screen reader, i.e., auditory feedback. This is due to the absence of physical cues in the screen along with a reasonable set of targets spatially located onscreen. When we consider tasks like text-entry, the number of targets is large and their size is small, rendering non-visual localization without alternative feedback impossible. Gestural approaches have been presented [15] and although they do not require onscreen localization, without auditory feedback, maintaining state of the evolution of the writing would also be a herculean task.

Recently, we have witnessed the appearance of approaches based on Braille [4,5,15,16]. The representation of a Braille cell and the analogy with writing on a Perkins Brailler are the basis for these approaches and they enable blind people to input chords, which is arguably performed without the need for confirmation. Approaches vary in the way a chord is entered: dot by dot [15], row by row [12], column by column [4], and full cell at a time [5]. One of the main issues with such approaches has been its low accuracy when compared to input with traditional methods.

In this context, we have developed our own version of a one-step Braille input method [15], similar to BrailleTouch [5], but with the ability to adapt to the user’s changing finger positions, as with Perkinput [4]. Although this approach could slightly improve accuracy it was still not usable, in a sense that one could not efficiently and effectively write a comprehensible message. To tackle this, we developed B#, a correction system for multitouch Braille input that uses chords as the atomic unit of information rather than characters [15]. This method builds on the way chords are performed and outperforms a popular spellchecker (Android’s) by providing correct suggestions for 72% of incorrect words (against 38%).
Building on the rebirth of Braille as a tool for inclusion in the 21st century, we placed our efforts in understanding if the Braille alphabet could also be used to enable reading on mobile devices. As with Braille input, previous projects have explored reading a Braille character by providing feedback of the touched dot (marked or not) on the graphical onscreen representation of a Braille character [7] or by issuing sequential vibrotactile patterns to transmit a character [2]. Searching for a method that enabled inconspicuous but efficient output of information, we presented and evaluated UbiBraille (Figure 1, on the left), a method that could deliver a Braille chord, all dots at once [13]. This prototype was composed of six rings to be used in the user’s fingers (the ones used to input a character with a Perkins Brailler) that vibrated simultaneously to issue a letter. Besides achieving a number of interesting results on character and word recognition, anecdotally, users could read complete sentences by feeling characters with a 250 ms stimuli and a 250 ms interval between them.

Being able to input and receive information privately was at this point available by resorting to Braille and its renewed usages. HoliBraille (Figure 1, on the right) was our last effort to provide inconspicuous input and output of information: a holistic approach to enable Braille I/O with mainstream mobile devices [14]. To this end, we built a case with 6 vibrotactile motors combined with damping materials to be attached to current capacitive touchscreen devices enabling multipoint localized feedback on the user’s fingers. Results on perceiving Braille chords were in par with the ones achieved with UbiBraille revealing that the prototype could be used for Braille output but also to transmit other semantic information [20].

Inconspicuous interaction for blind people is desirable and within reach. The advent of other mainstream devices attached to one’s body, devices that are socially accepted as they are to be used by everyone (e.g., smartwatches and bracelets [21]), are an opportunity for more subtle and intimate interaction methods that can built on the research presented here.

**Outlook**

Although there is a large body of work on non-visual interaction with mobile devices, they are still a challenge for blind people, particularly when in search for a subtle interaction in social settings. The built-in accessibility features rely on audio feedback which is still demanding in public environments and results in high exposure of the blind person and her information. The advent of new devices along with the research in the area should consider what was conquered to and by people with disabilities and build upon that knowledge to maintain and provide new layers of
accessibility. The future promises change in how people interact with their devices and surroundings; new challenges and opportunities arise.

**Challenges**
History shows that, with new mainstream technologies, a period of exclusion is likely to occur. Depending on the relevance of the new technology, the impact on the disabled populations varies. There is a growing tendency for accessibility-by-design and the inclusion of accessibility built-in features. However, several accessibility layers remain unattended and are only, if ever, addressed in later versions. Today, we are witnessing an increasing usage of wearable devices, like smartwatches or bracelets. Tomorrow, other futurables will appear. It is a challenge to maintain the attained inclusion with older devices and halt the accessibility rollercoaster, on these newcomers, and devices of the future. Particularly, awareness of accessibility layers required in the social arena need to be built-upon rather than ignored in future designs.

It is also a challenge to maintain awareness of the real state of the accessibility provided by new technologies. As our research with smartphone adoption by blind people [17] revealed that this process is still far from being fast and easy, other misconceptions may be in place. Research that seeks to understand the in-the-wild difficulties and coping mechanisms of people with disabilities is needed as laboratory measurements are not enough nor is stating it to be solved by witnessing success, if people battled exhaustively to achieve it. Others may not be able to.

**Opportunities**
Considered as a challenge, new devices also provide opportunities for improved accessibility. Considering physical access, these devices can benefit from the lessons learned with previous ones. Particularly, in the case of smartwatches, the novelty comes with size and placement, as touch and other sensors were already available in their companion devices, i.e., smartphones. The iWatch is already incorporating VoiceOver enabling blind people to use these devices out-of-the-box; an example of using wearables and lessons learned as an opportunity to promote inclusion. Regarding other layers, and particularly to what concerns security and privacy, these devices are even more personal and intimate than their in-pocket counterparts, providing clear opportunities for inconspicuous interaction methods.

Research shows that stigmas and misperceptions towards assistive technologies affect their usage and acceptance [8,19]. *Mainstream* was the way to go and the iPhone is a success case of a device being used proficiently by sighted and blind people, at a distance of a simple software-based assistive technology. This is and was not always the case for other assistive technologies that are often awkward and bulky. It seems that somehow technology and social acceptance may be meeting in the middle; the advent of smartwatches, Google Glass, and tracking devices, wearables, once seen as assistive technology, are now becoming mainstream. This unveils novel opportunities for the development of accessible solutions that are accepted both by the user and society.

The emergence of new sensors is also likely to go beyond providing access to a device and can bridge the information gap blind people face in social settings, where knowledge of the environment, particularly to what concerns people in the whereabouts, is dependent on reliance on social norms and etiquette, which does not always happen [18].
Future Work
Our future work will focus in enabling and improving subtlety in non-visual interaction fostering a usable combination of efficient access, and inconspicuity and privacy. To do so, we will explore new mainstream devices like smartwatches and enrich them with layers. Further, we acknowledge the importance of mobile devices and personal contents they detain, and will seek to provide blind people with monitoring and auditing tools that enable them to be more aware of the usages of their devices as well as using them to provide awareness of the surrounding environments. Overall, we will continue pursuing the goal to have blind people interacting with their devices in par with their sighted fellows.

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References


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