Considering Privacy Implications of Assistive Devices for People with Visual Impairments

Tousif Ahmed
School of Informatics
Indiana University
touahmed@indiana.edu

Kay Connelly
School of Informatics
Indiana University
connelly@indiana.edu

Roberto Hoyle
School of Informatics
Indiana University
rjhoyle@indiana.edu

David Crandall
School of Informatics
Indiana University
djcran@indiana.edu

Patrick Shaffer
School of Informatics
Indiana University
patshaff@indiana.edu

Apu Kapadia
School of Informatics
Indiana University
kapadia@indiana.edu

Abstract
Many assistive devices for people with visual impairments are created with a singular purpose: helping them to navigate in an environment that requires sight. It is important, however, to understand that these assistive devices may have privacy implications that impact their users. In this extended abstract, we focus on the privacy concerns and needs of people with visual impairments. Design issues may arise that create privacy concerns that would not have existed without the presence of the assistive device. We report in this extended abstract findings from a set of surveys that we performed, including privacy issues caused by assistive devices and design considerations that need to be taken into account before building these devices.

Introduction
People with visual impairments can now live their lives more independently with the help of several assistive devices and technologies, including computing devices such as the Orcam[1], Victor Reader Stream[2], Voice Stick[3], Viio Travel Aid[4] and others.These assistive devices address several accessibility concerns of people with visual

[1] www.orcam.com
[2] www.humanware.com/streamLE
[3] www.tuvie.com/voice-stick
[4] www.tuvie.com/viio-travel-aid

impairments but do not focus on privacy. As a result, several privacy concerns have arisen from the intended functionality of these assistive devices, such as screen magnifiers allowing bystanders to shoulder-surf, screens or screen readers reading out a person's activity [1].

In our first study [1], we conducted interviews with 14 participants with visual impairment and identified privacy concerns that they had. We separated these concerns into three categories, a) those in the physical world, such as bystander eavesdropping of a private conversation; b) those in the virtual world, such as concerns relating to detecting legitimate URLs; and c) the interface between these two, such as a bystander shoulder-surfing from a devices screen. We conducted a followup study with 19 people with various visual impairments to gain insight about a camera based solution that could potentially address some of the reported privacy concerns. In both of these studies, we explored privacy issues associated with assistive devices and found several design considerations which we present here. Specifically, in this abstract we discuss:

- Three privacy issues caused by assistive devices that our participants reported in our interviews.
- Several important design considerations that need to be considered before implementing assistive devices.

Privacy Issues of Assistive Devices

In this section, we mention privacy risks that either come about because of the assistive devices or are made worse because of them. These issues show that currently available assistive solutions lack privacy in their design, or do not take into account the considerations of people with visual impairments.

Eavesdropping

While accessing computing devices, people who are blind are largely dependent on screen readers like VoiceOver, which reads text out loud to the person. People with low-vision are mainly dependent on screen magnifiers, which make text large enough to be distinguishable. Both of the solutions have privacy implications [1, 2, 4]. With screen readers, those nearby may be able to hear the text that is voiced out, while magnifiers make reading text from a distance easier for those behind the reader. While people with visual impairment can protect their privacy either by relocating themselves or by using technologies like Screen-Curtain and Headphones, these mechanisms are not always readily available or inhibit natural interaction with these technologies.

Misclosure

A "misclosure" occurs when information is disclosed in error [3]. Some assistive solutions require the person to take photos using cameras and share the photos over crowdsourcing platforms to identify the information contained in the images. These systems can be used to find items, identify money and for other daily purposes. Privacy concerns for people with visual impairment include sharing an unintended photo with the crowdworkers, with accidental privacy implications.
FiXme Fatal: Find an example from Study 1 instead.
For example, in our study, one participant shared an embarrassing story of her friend who accidentally used a photo on Viwziz [5] showing her naked because she didn't realize there was a mirror catching her reflection. She was trying to differentiate between a conditioner and a shampoo in a hotel, but ended up sharing a naked selfie unintentionally . Similar occurrences of misclosure may

[5] http://www.vizwiz.org/

also arise when people with visual impairment need to share information without knowing its content.

Unwanted Exposure
Assistive devices tend to be found in common platforms used by sighted people as well. Additional functionality that is present for sighted people may be uncomfortable for some people with a visual impairment. For example, some participants expressed their concern with the cameras embedded in laptop computers and smartphones. The feedback mechanisms that indicate that these devices are recording are visual in nature, and therefore not detectable by those with a visual impairment, leading them to be uncertain on whether the camera is recording them or not at any given moment.

Design Considerations

The following desired attributes could be useful while designing accessibility solutions.

Discreet
As Shinohara and Wobbrock reported [5], end-users of assistive devices do not want to be marked as different; they prefer less noticeable assistive devices and are particularly sensitive about others' reactions towards them. While exploring the design considerations for a camera-based solution, our participants also expressed the necessity of discreet solutions, preferring devices that were less noticeable. They do not want to look weird or draw attention to themselves.

Simple and Configurable
People with visual impairments tend to focus more on other functionalities than privacy when using assistive devices. Therefore, if the designer wants to incorporate privacy features with the device it is important to keep the privacy attributes simple as well as configurable. A privacy feature that can be easily triggered or configured is more appropriate for people with visual impairments as the privacy preference may vary from person to person. In our study, some participants mentioned that they felt overwhelmed with notifications while managing their text messages in assistive mode and needed to have them disabled. Other respondents preferred to be notified instantly, not being as inconvenienced by it.

User-initiated vs. Automatic
The operation mechanisms can be *user initiated*, requiring a user to look for the requested information from the system or *automatic*, continuously sensing for the intended information and notifying the user as necessary. While designing technologies for people with visual impairments, the designer also needs to consider that the operation mechanisms can be completely dependent on different scenarios, e.g., in a private space a user may want to trigger an action, whereas, in a public place automatic triggering of actions can be more preferable.

Feedback
The type of feedback is important when designing an assistive tool for people with visual impairments. Although the use of an auditory channel to provide feedback is now widely accepted, it has several privacy implications; it may therefore be preferable for designers to explore alternate solutions. Some participants reported interest in haptic/taptic feedback, while others preferred existing auditory solutions, e.g, some participants preferred bone conducting headphone as it allows them to sense the environment as their ears are not obstructed by the headphones.

Informed decision
To prevent misclosure, it is important for people with visual impairments to understand what information is

being collected and what information is leaving the system. By analyzing the collected information, it is possible to filter sensitive information, allowing non-sensitive information to be disclosed based on the user's preference. The user may then take an informed decision on whether or not to disclose sensitive information. For example, if a camera-based system can automatically analyze the contents of a photo, it may notify the operator that an image contains sensitive information, possibly preventing misclosure. If there is anything sensitive detected by an assistive system, it should notify its sensitive content to the person before sharing that information with another entity.

Conclusion

Assistive devices for people with visual impairments have the potential for improving a person's quality of life and independence; however, care must be taken to ensure that this assistive technology does not create or aggravate privacy concerns. Proper assistive technology design while honoring privacy requires a careful balance of features and controls to best serve this vulnerable population. Often the focus is on the "fix" and less on privacy. In this paper we have shown several examples of unintended consequences to privacy from assistive technologies for people with visual impairments. These examples, and many others provide sufficient motivation to include privacy by design up front and early in the design process for any assistive device.

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