A Review of Literature on Accessibility and Authentication Techniques

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ABSTRACT

Reliable and accessible authentication techniques are required to maintain privacy and security. This is paramount as technology plays an increasing role in our lives. In this paper, we examine the previous work on accessible authentication techniques for blind/low vision people, deaf/hard-of-hearing people, people with cognitive impairments, and people with motor impairments. We seek to identify gaps in the current research to advocate where future efforts are needed to create authentication techniques that will work for everyone. We found a lot of variability in prior work investigating the accessibility of authentication techniques, including shortfalls and gaps in the literature. We make recommendations on the directions future research should take.

CCS CONCEPTS

• **Human-centered computing** → **Accessibility**; • **Security and privacy**;

KEYWORDS

Accessibility, Privacy, Security, Authentication

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1 INTRODUCTION

Authentication is an important component of securing systems and keeping our personal files private. The usability of authentication mechanisms has been thoroughly studied over the past twenty years [20, 25, 46]. However, many popular authentication methods present accessibility barriers for disabled people. For example, entering a pin on a smooth touchscreen device can be challenging, but could be improved with tactile feedback [13]. People differ in how anxious [9] or trusting [35] they are toward the privacy and security of their systems, and authentication is one way to put the end user at ease. New technology also provides opportunities for new authentication methods [38], but first we need to understand what accessibility research has explored with authentication.

Although research into accessible authentication techniques exists, it is not clear where current research has focused its efforts and where future research is required. Digital technologies continue to enhance many aspects of people's lives and it is important that disabled users are given adequate methods to protect themselves.

In this paper, we review accessibility literature that has focused on authentication to ascertain the current state of progress within the wider topic of inclusive privacy and security. We reviewed publications that covered visual, hearing, cognitive, and motor impairments. We identify a range of different research that seek to understand problems with authentication accessibility and that introduce new accessible authentication techniques. However, the amount of research varies across different impairments. For example, more work has focused on addressing visual impairments than other impairments. Furthermore, we identify cases where there were absences of usability evaluations, small sample sizes, or participants that did not represent the target audience.

The contributions of this paper are: (1) a survey of accessibility and authentication research to provide an overview of current progress, (2) identification of shortfalls in prior work, and (3) recommendations to the community on the necessary directions for future research to improve authentication accessibility.

2 METHODS

Inclusion and Exclusion Criteria: We identified 64 papers that broadly focus on accessibility and privacy/security by searching the keywords *privacy, security, accessibility, authentication techniques, passwords, deaf, hard of hearing, blind, low vision, visually impaired, cognitive impairments, and motor impairments* on Google Scholar and within accessibility and usable security proceedings (e.g., ASSETS [4], CHI [2], SOUPS [3]). We then narrowed our focus to

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authentication. In total, 25 papers remained on authentication and accessibility spanning the past 13 years.

3 ACCESSIBILITY OF AUTHENTICATION

In this section, we categorize prior work by impairment type. We found 25 papers on accessibility and authentication, and, when we felt it was necessary for clarity in the subsections, we included additional references for a broader discussion on the topic.

3.1 Blind and Low Vision

A majority of prior work investigated authentication for blind and low vision (BLV) people. Being blind involves *the reduced ability or complete inability to utilize their visual system and having low vision implies reduced field of vision* [1].

Prior work has taken important steps to understand the challenges presented by common authentication techniques. Screen readers and magnifiers are widely used by BLV users during authentication, but they can be an inconvenience [21] as they do not protect them against snooping and observant attacks [6, 11, 14, 28]. BLV people sometimes create passwords using family names and telephone numbers [15], which is a very common password strategy used by many that is vulnerable to attacks. Researchers found that fingerprint scanning is the most accessible authentication method for BLV users while PINs and iris scanning are least accessible [15, 37].

Researchers have also spent time investigating new accessible authentication techniques for BLV users. Braille Passwords [8] and Braille inspired passwords [11] were created to overcome shoulder-surfing. Unipass [12] is a password manager specifically designed for BLV users with highest task completion rate and shortest time taken to authenticate compared to the other popular services like StrongPass and LastPass. Brain-computer interfaces and gesture-based authentication have also been explored to support blind users [39, 47]. Head mounted devices can be used to magnify the screen privately to facilitate authentication [44]. Other novel authentication techniques that have been explored rely on tactile interaction [14, 31, 47] and audio [10, 30]

Prior research has found that some BLV people do not consider their privacy and security a threat among family and are transparent with their data [7]. As such, integrating the previously mentioned authentication techniques into mainstream devices is imperative [43].

Although there has been promising work done in accessible authentication for BLV users, researchers need to increase usability testing with BLV end users to identify their challenges and produce solutions [26]. When usability evaluations were presented, sample sizes were often small (e.g., 3-4 blind participants [39, 47]) or sighted participants used in place of BLV users [31]. In some cases this was because the work is in its early stages [12, 14, 47]. Recruiting for accessibility research is challenging, but evaluating with non-disabled participants is not an appropriate substitute [40].

3.2 Deaf and Hard of Hearing

It was challenging to find much prior work on accessibility and authentication for Deaf and Hard of Hearing (DHH) people. Being deaf involves *little to no hearing and being and hard of hearing involves the reduced ability to hear sounds* [5]. It is possible that there was a larger focus on the accessibility of authentication for BLV users since the device's screen is involved in authentication.

Nevertheless, when we consider the different types of authentications that exist, there are instances of accessibility barriers for DHH users. DHH may find it challenging to input particular keystrokes given by auditory instructions [37]. Furthermore, shoulder-surfing is often an approach used by people to steal passwords and other sensitive data [32].

More qualitative studies would allow researchers to better understand the experience of DHH users with authentication and eavesdroppers. A purposely designed study to collect this data may uncover DHH concerns and inaccessible systems that could be addressed in future work.

3.3 Cognitive Impairments

Authentication can be easy to remember (e.g., biometric) and complex (e.g., alphanumeric), and as a result, some work has looked at the implication of authentication in the context of cognitive impairments. Cognitive impairments *involve difficulty remembering, reasoning, thinking and paying attention* [23].

People with cognitive impairments can find it difficult to remember passwords or to type, may lack awareness of errors occurring, and may forget to log out [27]. A guideline for creating strong passwords can also be problematic [28] and seeking help from others introduces additional risks [35]. Dyslexia might hinder understanding the process of authentication [37]. Down syndrome users find graphical passwords difficult but are capable of using textual and mnemonic passwords [33, 34].

Additional training might be required for users with intellectual disabilities to use authentication technologies efficiently [16]. However, it is also possible to design technological solutions to support people with cognitive impairments. For example, password managers can reduce cognitive load of remembering passwords [27], and musical passwords are more memorable [24].

It would be valuable for additional exploratory research with a focus on collecting qualitative data to deepen our understanding of the requirements for users with cognitive impairments, the reasons for failed attempts, and importantly what their user preference would be [34] with possibly a bigger sample size [33].

3.4 Motor Impairments

We typically interact with our devices in a physical way, and so there are many opportunities for a person with a motor impairment to face accessibility barriers to authentication. Motor impairments involve *the partial or total loss of function of a body part or limb* [22].

An important part of research in this area is running observational studies to understand the touch behaviors of users with motor impairments. People with upper extremity disabilities have difficulty typing [28], which can make entering a password challenging. Although gesture input can be more flexible for people, users with motor impairment require more time and can draw inconsistent gestures [45]. Finger scans and iris scans may be difficult to successfully use since the device must be held steadily to authenticate the users [37].

New accessible authentication techniques are needed, and some progress has been made in this area such as speech-based authentication, and smart touch and shift. Speech-based authentication have been created to aid users with motor impairments [48]. Smart touch and smart shift help with the precise touch with the help of visual feedback [36]. Simply changing the size and layout of the keyboard could be enough to help make it easier during typing authentication [28].

However, additional and in-depth research is needed to understand the response of users with upper-body motor impairments since the usability tests conducted were not with the target audience [48]. As universal design supports accessibility, Guidelines to Developing Accessible Mobile Applications (GuAMA) were created for visually impaired users and later extended to hearing and motor impaired users [18]. However usability tests were not conducted to validate them [18].

4 DISCUSSION AND CONCLUSION

In this paper, we reviewed publications on authentication with visual impairments, hearing impairments, cognitive impairments, and motor impairments. Our findings highlight that although accessible authentication has been a focus in research over the last decade, there is still progress to be made. We identified issues in methodological approaches and an imbalance in the amount of research across different impairments.

Authentication continues to increase in importance as we rely more on our devices. It is vital that nobody is left vulnerable to privacy and security attacks. Accessibility needs to be considered from the outset when developing new authentication techniques, and well designed studies to understand the needs of disabled users is an important first step, followed by evaluations of new systems with disabled users. Empowering disabled users to engage in the design process of new accessible authentication techniques and designing the solutions to be part of part of common technologies will ensure greater success in this area [42, 43].

We focused our efforts on understanding the literature within four common areas of accessibility research. We did not focus on older adults because although older adults can live with impairments, many live without them, and older adults is a very broad age category, which can result in a lot of variability in age related impairments [19]. However, we do recognize that older adults can have a combination of the aforementioned impairments [37] and often rely on others to help manage their passwords [35]. Fingerprint readers are not a straightforward solution because aging alters the fingerprint and causes login failures [18, 37]. Future work should look into a review of the literature of older adults and authentication. We also did not focus on situational impairments [41] and authentication. During COVID-19, people quickly realized that they had to chose between wearing a mask and unlocking their device with facial recognition [17]. However, situational impairments do not equate to congenital impairments [29], and so while it is another important literature area to review, it is outside of the scope of this paper.

It is well known that accessibility tends to be an afterthought in the design and implementation of services and systems. Therefore, we anticipate that other area of privacy and security research are also likely to fall short in producing acceptable and rigorous investigations into existing accessibility barriers, as well as solutions to those issues. Our paper provides several contributions to the inclusive privacy and security research area. The contributions are: (1) a survey of accessibility and authentication, (2) identification of shortfalls in prior work, and (3) recommendations for necessary future research directions.

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