Accessibility challenges and technological solutions for people with low vision when visiting museums

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Abstract

People with low vision (i.e., functional yet impaired sight) often find it challenging to visit museums. It may be difficult for them to view, and experience exhibits the way they were designed or to navigate their way through the museum. In order to better understand their challenges and needs, we conducted a semi-structured interview with 11 individuals who have low vision. Our primary aim was to investigate their experience within the museum environment, and to gain insights into how they navigate and interact with the various exhibitions and displays that are on offer. During the interview, we delved into various aspects of their museum visits, including their use of tools and assistive technologies that can aid them in their exploration of the exhibits. Additionally, we also inquired about the types of resources and accommodations that are provided by museums to make the visit more effective and enjoyable for individuals with low vision. Through these interviews, we gathered valuable feedback and suggestions that could inform the development of technological solutions for more accessible and inclusive museum environments for people with low vision.

Keywords

Low vision, vision impairment, accessibility, museum.

1. Introduction

Low vision refers to a condition of vision impairment that cannot be corrected by medical or surgical treatments or eyeglasses, but the person still has remaining and functional sight. Low vision may entail various sight issues such as tunnel vision, blurriness, blind spots, light sensitivity, loss of ability to see in the dark, poor peripheral vision, and more. Low vision affects employment and daily activities from mobility to shopping [5, 7, 13]. and social ties as well as emotional and mental health [5]. Moreover, the prevalence of low vision is projected to increase as many low vision conditions are age related and the proportion of older adults in the population is increasing globally. Although people with low vision face a variety of challenges, little work has been dedicated to the accessibility of leisure and culture related activities.

In the current study, we focus on the understanding of the challenges people with low vision face when visiting cultural heritage sites in museums and the ways in which technology can alleviate these challenges. The current work is the first part of a larger project looking at how to design technology to enhance the visiting experience of people with low vision. Our long-term goal is to develop augmented reality-based assistive technologies to support people with low vision in visiting and touring museums. To understand current practices and challenges, we conducted semi-structured interviews with 11 visually impaired people at the Hecht Museum (Figure 1), a small-to-medium sized museum located at the University of Haifa. We describe the challenges listed by participants and discuss various ways in which technologies can be used at the museum to help low-vision participants.

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Figure 1*:* Hecht Museum (om the left big staircase in the entrance, on the right: Ramp with small slope which can be difficult to see by people with low vision)

2. Related work

Little work has examined understanding the experiences, challenges, and strategies of people with low vision in museums and cultural heritage sites. Prior work on museum visits for people with visual impairments has often examined together people with low vision and people without any remaining sight (i.e., blind), although the needs and strategies of these two populations highly differ [12, 13]. In general, museums are designed for sighted people and mostly not accessible to people with visual impairments. Factors such as dedicated tour guides, audio guides, and haptic/tactile experiences are known to enhance the accessibility of museum visits [1].

Several researchers have suggested dividing the accessibility challenges of museums into two categories: mobility issues and exhibit or artwork accessibility [2, 11]; although the two should be addressed simultaneously [11]. Overcoming these two types of accessibility challenges has overwhelmingly focused on tactile and auditory modalities. Several studies have used a monomodal approach to facilitate museum visits either with tactile methods or auditory methods. Tactile methods often use 3D printed materials such as 3D printed aerial views of archeozoological sites [14] or 3D printed versions of ancient artifacts [8]. Auditory methods include accessible audio tour guides (i.e., with accessible and descriptive verbal information) or enhanced auditory information such as an NFC triggered audio guide with path descriptions as well as interactive soundscapes that are used to enhance a tour in a botanical garden (e.g., sounds of animals [3]). Notably, each modality can be used to enhance both mobility in the museum and accessibility of the exhibits.

In recent years, there has been more work towards creating multimodal experiences, including the use of manual movements that are detected using sensors to control audio information. In one study, the fingers' location on a conductive surface controlled the description of a van Gogh painting and even activated ambient feedback like wind [4]. In another study, Rector used the Microsoft Kinect to track both depth in space and manual movements to control and activate complex auditory experiences that provide different types of information about 2D paintings, which the authors called proxemic audio interface for eyes-free art [9]. A recent study with 72 people with visual impairments, has also stressed the importance of multisensory experiences for visitors with visual impairments at different stages of the visit from planning, on-site visit, and post-visit [4]. However, although several studies have raised the importance of multisensory experiences, all focused on auditory and tactile modalities and none on enhancing the visual modality, likely because the target audience included both blind and low-vision people. One recent study has examined specifically the needs of people with low vision versus people who are blind, but the main recommendations for accessibility did not include technology and focused on on-site modifications in the museum (e.g., increasing the contrast of signs, increasing font size, and modifying light levels; [6]).

Augmented reality holds great potential to increase the experiences of people with low vision. In several studies, augmented reality has been demonstrated to enhance activities such as

shopping [17], navigation [16], and climbing stairs [15]. However, how augmented reality can assist and facilitate museum visits, has not been examined. As a first step in designing such a system, we conducted interviews with low-vision participants to understand their unique visual needs when visiting museums.

3. Method

We conducted semi-structured interviews to examine the assistive technologies and experiences of visually impaired individuals in their everyday lives. Then, we focused our questions on their previous encounters with museum visits and the various accessibility challenges that they had encountered in such settings. Our goal was to provide potential solutions and recommendations for improving the museum-going experiences for visually impaired visitors. We also collected demographic information from each participant, including age, impairment, level of technological proficiency, occupation, and visual acuity where possible. The list of participants and their details is provided in Table 1. Interviews were transcribed and analyzed using an open coding approach [10].

Table 1
List of participants

#	Age	Visual Impairment	Occupation	Visual Acuity
1	25	Ocular Albinism	Student	-
2	23	Retinitis Pigmentosa (RP) & Nystagmus	Student	-
3	25	Ocular Albinism	Student	6/60
4	62	Retinitis Pigmentosa (RP)	pensioner	3/60
5	52	Childhood cataract	mortgage consultant	-
6	58	Oculocutaneous albinism		20/25
7	47	Retinal degeneration		20/80
8	63	Oculocutaneous albinism	pensioner	20/200
9	55	Retinal degeneration	Human Resources	-
10	28	Ocular Albinism & cataract	Sound technician	-
11	57	Marfan syndrome	Housewife	20/32

4. Results

We note there were several challenges in the museums and almost half of the participants said that they do not go to visit museums without help from friends and family. All participants expressed their desire for the museum to be more accessible. In particular, participants wished the museum would offer personal tour guides who could assist them in navigating the facility, provide detailed and more accessible descriptions of the exhibits, and read aloud the explanatory signs for each display. Below, we describe the main themes revealed in the interviews.

4.1. General accessibility in the museums for low vision

Museums are generally ill-prepared to accommodate the needs of visually impaired individuals, as they lack braille text signs, speaking signs, and specially trained staff. The most used tool for visually impaired visitors is the hearing handheld, which is available and designed for the public in several, but not all museums. These handheld devices, provide prerecorded tours and focus on providing information about the museum. For example, p3 said, “Most of the museums do not

have tools for the visually impaired, but sometimes they have audio guides which can also help us."

However, the audio tour device may not always be very helpful as it assumes that visitors have visual capabilities, and therefore fails to provide information about the items on display and a general overview of the exhibit. Moreover, it typically lacks directional information. and does not assist in navigating through the museum's corridors.

4.2. Walking around the museums

Many participants described feeling anxious about walking in museums independently. Participants said that it may be difficult for them to navigate and be oriented in an unknown and complex location. In addition, participants attested that they fear of accidentally tipping over and damaging expensive items on display. For example, P1 said "I'm afraid to walk alone in the museum, I may break one of the items or fall and cause a mess.". This fear is exacerbated when the lighting in the museum is not suitable for their condition. For instance, a brightly lit environment can be overwhelming for a person with albinism, whereas a very dimly lit space may pose difficulties for someone with Retinitis Pigmentosa (RP). These examples illustrate the challenges of accommodating low-vision visitors and creating an ideal lighting environment across low vision conditions.

4.3. Visual complexity of museums

Several participants we interviewed expressed concern over the excessive visual stimulation in museum exhibits, for example, some exhibits could include several small items displayed very close to each other without any buffers. This hinders the ability of the visually impaired to recognize objects and differentiate between them. Another factor that affects their experience is the distance between the standing or viewing position and the objects on display. At times, this distance can be quite far due to museum limitations, as buffer spaces are designed to restrict visitors from touching or damaging the exhibited items. However, this affects the experience of visually impaired individuals in the museum as it makes it more difficult for them to see the exhibits. For example, P10 said, "There was a lot of instruments shoved together with others stuff, it was hard to focus on one item to see it better."

4.4. Assistive technologies in museums

The use of technology can be a powerful tool for people with visual impairments, and many of our participants reported using a variety of devices to assist them when visiting museums. Among these devices, the smartphone was the one mentioned most frequently used due to its versatility and accessibility [3]. For example, visually impaired people often use their smartphone as a magnifying glass to better view items. In the museum, visually impaired visitors may use their smartphone to take pictures of objects, signs, or documents that are not clear enough for them to see in the museum environment. They can then zoom in on the image to get a better understanding of what they are looking at. However, some museums prohibit the use of smartphones during the visit, which can limit the visitor's ability to fully explore and engage with the exhibits.

Some of our participants suggested that museums could provide accessible information about the exhibits for visually impaired visitors. This information could be downloaded to the visitor's smartphone and would include images of the objects in the exhibitions as well as informative text. By using Zoom, visitors would be able to explore the images and text on their own, without requiring assistance from another person. This solution would provide a more autonomous and inclusive experience for visually impaired visitors, allowing them to fully engage with the

museum exhibits. For example, P10 described the positive experience he had with an audio-visual museum guide: “The museum [In Portugal] had audio and visual explanations in English and Portuguese. Visitors could browse the explanations and listen to music using simple headphones. The museum focused on the unique music of Portugal and used audio descriptions to complement the visual exhibits” (P10).

5. Conclusions

Overall, technology has the potential to enhance the museum experience for visually impaired visitors. By leveraging accessible digital tools, museums can create a more inclusive environment that empowers visitors to explore and appreciate the exhibits on their own terms. Prior research has pointed to solutions that focus on enhancing accessibility through tactile and audio information, yet these solutions are not optimized to the needs of people with low vision, given that they have remaining functional sight.

Our study reveals that accessibility challenges for low vision still prevail across cultural heritage museums. Participants mentioned mobility related challenges caused by the layout of objects and rooms in the museum as well as lighting conditions that are designed to enhance the experience of sighted people and create dramatic experiences (e.g., dimly lit rooms or brightly lit exhibits), but impair sight for low vision visitors. Although designing accessible spaces should be a goal in the public sphere, it is unlikely that museums would redesign their exhibits or build new accessible buildings. Moreover, the variety of low vision conditions means that it would be virtually impossible to create an optimal design for all visual conditions. Instead, a better solution would be to design a flexible and wearable solution, such as smart glasses, that would be personalized to the needs of the low vision visitor.

In terms of accessibility to exhibits, participants mentioned the difficulty of seeing details and the feeling of visual clutter that accompanies seeing exhibits. Participants wanted to be able to see the artifacts details *in situ* and suggested a smartphone application with high-resolution pictures of artifacts. However, even with high-resolution digital images, panning with Zoom remains an accessibility challenge [12]. Moreover, as an experience it would mean looking at the digital device with the image, rather than seeing the artifact better *in situ*. Augmenting details of the artifact using augmented reality, may be a possible solution to enhance the visibility of objects. In our next step of this research project, we will examine whether and how augmented reality can assist people with low vision when touring a museum.

Figure 2: Person with low vision using the Microsoft HoloLens at the Hecht museum.

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