Entertainment for All: Understanding Media Streaming Accessibility

Claire Kearney-Volpe
Department of Occupational Therapy
New York University, New York, NY
claire.kv@nyu.edu

Shannon Holloway
Department of Technology, Culture and Society
New York University, New York, NY
shannon.holloway@nyu.edu

Amy Hurst
New York University, New York, NY
amyhurst@nyu.edu

ABSTRACT

Despite the increased demand, popularity, and cultural significance of streaming media and digital entertainment, many individuals with disabilities are unable to experience this content. Specifically, many video streaming technologies require input devices and content browsers that are inaccessible to individuals with sensory and physical impairments and do not work with their current assistive technologies. Our team of engineers, designers, and clinicians took an inclusive approach to assessing and redesigning these streaming service products, with the aim of creating more universally accessible experiences.

"The whole app experience is very frustrating. It's never easy to use the app"

Figure 1. Quote from participant using commercially available streaming product

CHI'19 Extended Abstracts, May 4–9, 2019, Glasgow, Scotland Uk

ACM ISBN 978-1-4503-5971-9/19/05.
https://doi.org/10.1145/3290607.3312882

KEYWORDS
User-centered Design; Accessible Interfaces; Research Through Design; User Study; Evaluation; Prototyping

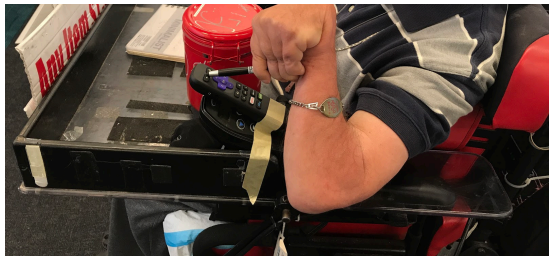

Figure 2. Picture of wheelchair user's technique to improve accessibility of commercial remote-controls (taping a television remote next to their joystick).

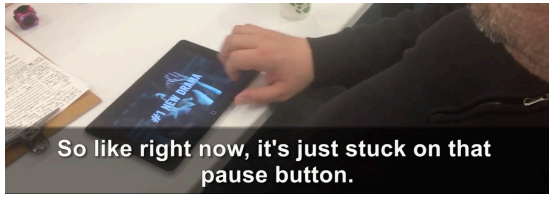

Figure 3. Image of participant being frustrated while trying to access streaming content using commercially available content browsers.

We recruited 9 participants with diverse abilities to evaluate the accessibility of a large telecommunication company's commercially available video streaming products. This evaluation revealed significant accessibility barriers and informed the design of a participatory design activity to create accessible remote-controls, an onboarding assistance prototype, and a content browsing prototype that is screen reader accessible and supports audio descriptions. We evaluated these accessible prototypes with 11 additional participants and found they were more accessible, flexible, and enjoyable to use compared to the off-the shelf products. In this paper we summarize these findings and discuss how future streaming technology must support customization and follow established accessibility guidelines and standards.

INTRODUCTION

While media consumption is an increasingly common activity, individuals with cognitive, sensory, and physical impairments face accessibility challenges with home video streaming [7]. For example, many screen-based interfaces are not optimized for speech synthesis, and many physical remote-controls are overloaded with ambiguously labelled buttons and require fine motor dexterity to operate. Recent video streaming viewership trends towards internet-enabled devices, and new technology creates opportunities and challenges for accessible entertainment. In this paper, we explore these challenges and potential solutions with 20 individuals with diverse abilities. We first present an accessibility analysis of commercially available streaming devices, and discuss common challenges reported by our participants. We then apply these findings in the design of participatory design activities and prototypes that directly address the accessibility issues discovered for remote-controls and accessing content. The overall response from participants was positive, and they expressed interest in using the redesigns for improved accessibility.

RELATED WORK

Our work builds on past research to understand viewership trends and streaming accessibility.

Viewership Trends: As our homes are flooded with internet enabled devices, Cesar posits that customization/configurable user preferences based on individual human factors can and should contribute to greater accessibility of video streaming for home entertainment [2]. Chorianopoulos [3], proposed a set of user interface design principles for emerging interactive TV applications, based on a desire to achieve both efficiency and enjoyable interfaces by design. These principles relate to interactive, navigational, scheduling, social viewing, attentional, aesthetic, and infotainment aspects of the home entertainment experience. This work has informed our team's design and enriched our considerations of accessibility above and beyond technical compliance with WCAG 2.0 for multimedia content and hope that guidelines are elaborated on for universal access in future work.

Table 1: Participant Demographics: Gender, Age, Disabilities (B = Blind, LV = Low Vision, CA = Cognitive Attention, MI = Mobility Impairment, D = Deaf, HH = Hard of Hearing), Time (days watched per week), and Methods (O = Online Streaming, M = Mobile, S = Set-Top Box, D = Digital Media Players). P1-P9 evaluated Commercial Streaming Products, P10-20 (shaded background) evaluated prototypes created by the research team and engaged in a participatory design exercise.

ID	Gender	Age	Disabilities	Time	Method
1	Female	36	B	4	O
2	Male	42	LV, CA	3	D, O
3	Male	38	B	7	O
4	Male	31	B	3	S, O
5	Male	44	B	7	D, O
6	Male	48	MI	7	M, O
7	Female	30	MI, CA	7	S, O
8	Male	28	MI	7	S, D, M
9	Male	64	MI	7	S
10	Male	36	B	2	S, O
11	Female	65	B	4	S, O
12	Male	38	B	7	S, O
13	Male	52	LV	7	S, D
14	Male	30	MI	7	S, O
15	Male	58	CA	7	S, D, M
16	Female	66	LV	5	S, O
17	Male	48	D	7	S, O
18	Male	38	MI	7	S, O
19	Female	36	D, MI	6	S, O
20	Male	35	MI, CA	7	S, O

Video Streaming Accessibility: Research on the accessibility of video streaming for home entertainment has largely focused on early interactive or web supported television for older adults and people with visually impairments [5, 6]. As television services rely on highly visual interfaces, interaction and accessibility issues arise for these populations. Although efforts to understand, and remediate existing visual interface problems are important, more work needs to be done to understand and support multimodal interactions [1], accessibility, and usability for a range of abilities.

DATA GATHERING METHODOLOGY

To better understand the current challenges of existing streaming products, and how they can be addressed, we conducted two evaluation sessions with 20 diverse participants (5 female, average age 43 years) who stream TV using multiple methods (Table 1). The first session (P1-P9) focused on identifying areas of accessibility challenges with commercial streaming products and the second (P10-P20) on prototypes of accessible streaming solutions developed by our research team. The second group (P10-P20) participated in a collaborative design activity where they designed remote-control prototype with pre-cut shapes, tape and glue and talked through their design process (Figure 4). Our investigations revealed that the main accessibility challenges were lack of customization support and standardization. We present these topics in more detail in the next section.

Understanding Participant Habits and Experience

All participants completed brief one-on-one interviews with a member of our research team to gather demographic, disability-related, video streaming viewing behavior information. Participants reported watching TV or streaming content an average of 5 times a week (with 13 reporting daily usage), using a combination of methods including streaming online through a web app, mobile apps, set-top boxes, or digital media players (including smart TVs). Online streaming or using a set-top box were the most common methods employed by our participants to watch TV.

Evaluating Commercial Technologies

Participants P1-P9 were asked to perform common streaming tasks using sponsor products on television with a set top box, Roku, Xbox, mobile application on an iPad, and web application on a laptop with full keyboard. Tasks included navigating to a specific channel, finding a specific program, and adjusting settings, volume, and playback. Using the Thinking Aloud Protocol [4], participants described their actions and thought processes as they performed study tasks.

Evaluating Prototypes of Accessible Streaming Solutions

We applied findings from the evaluation of commercial technologies to inform the design of accessible prototypes by focusing on challenges regarding customization of input devices and supporting standardizations while browsing streaming content. Eleven individuals (P10-P20) participated in these evaluations.

Figure 4. Participant and researcher co-create a low-fidelity remote-control prototype using art supplies and a pre-cut toolkit of buttons and controls created by the research team out of cardboard.

Figure 5. Eleven remote-control prototypes created by P10-P20 using the cardboard toolkit. While many contain similar layouts as standard remotes, there are significant differences in button placements across participants.

Remote-Control Design: We investigated input device design through a participatory design activity where participants designed low-fidelity prototypes of their ideal remote-controls. They used a kit our research team developed out of cardboard that included a base remote-control, and interface controls in multiple pre-cut sizes and shapes, color markers, tape, and fabric bandages to apply texture if needed. Participants were asked to use these materials to design their ideal remote and describe their decisions as they worked (Figure 5).

Accessing Content: We created an accessible in-browser media player and program guide interface. Participants repeated tasks used to evaluate commercial technologies with our prototypes.

SUPPORTING CUSTOMIZATIONS WITH REMOTE-CONTROLS

In the evaluation of commercial tools, participants with mobility-related disabilities (P6-P9) experienced difficulty operating the controls for the TV set top box, Roku, and Xbox. Participants found the remotes challenging to hold, actuate buttons, and to make the correct selection due to poor mapping between user inputs on the remote and on-screen navigation. These participants also struggled to use the iPad application due to the layout and size of elements, and made several selection errors. They reported physical fatigue while performing these tasks due to the motions and precision required to interact with the controls and scroll through content. All participants reported that it seemed unlikely that they would ever use all of the buttons on the set top box remote given their personal use. Some participants voiced their preference for using their mobile phones, which are personalized to their needs, to control their TV at home.

Custom Remote-Control Designs

Based on our evaluation derived from interviews and think-aloud sessions, it was clear that current remote-control designs were problematic and there was an opportunity to create input devices that would be more comfortable, and efficient. Given the diversity of our participants' experience, we chose to explore the design of remote-controls with a participatory design approach in which participants build their own cardboard prototypes (Figure 5) of ideal remotes. Through this activity, we observed that participants had a strong sense of established design conventions for the remote which guided their designs.

While participants designed remotes toward conventional layout, each was unique based on their ability and preferences. Power, menu and accessibility buttons tended to be clustered around the top of participant designs, with navigation and volume just below. Number keys for direct selection were placed toward the lower-middle section, with video controls spread throughout the lower half. Participants described a desire for customization, reduction in buttons, and flexibility of form factor. For example, P11 and P12 explained that their designs included programmable voice control. P12 also wanted a remote that when rotated, would rotate the orientation of inputs. P14 wanted a QWERTY Keyboard on the back of the remote, programmable functions, and a touchscreen for additional programmable functions, and settings.

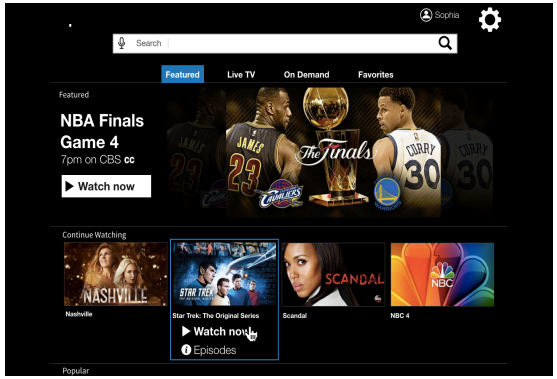

Figure 7. Prototype of Accessible Content selection interface that was screen reader accessible, included video descriptions, and had carefully designed visual and organization elements. This prototype was tested on both an iPad and Laptop computer and enabled participants to select and watch pre-selected content. It included a guided tutorial, an accessible and visually prominent search feature, consistent navigation, logical heading structure, labelling of form controls, alternative text descriptions of non-decorative images, sufficient color contrast, 18-point text or 14-point bold text, resizable icons, and we removed auto-playing video content, and hover/ cursor-state dependent interactions.

Extended Video Descriptions (EVD) were created using crowd-sourced audio-descriptions gathered via NYU email lists, and IBM-Watson's Tone Analyzer API for key scenes. Text descriptions of complex visual information which was necessary for understanding the action in the scene, were crowdsourced and run through the IBM Watson Tone Analyzer to select the best option. The favored description was converted **to a mechanical voice using Watson's Text to Speech API, and added to the video to pause action and narrate the scene.**

STANDARDIZING CONTENT NAVIGATION

In our first evaluation, we also found the off the shelf products ranged from difficult to use to completely inaccessible for some participants. Specifically, the TV set top box, Xbox, iPad, and web products were unusable for blind participants because these interfaces were not self-voicing, and did not pair with screen reader technologies. While the TV set top box was not audibly accessible, the other products were inaccessible due to issues such as improper labelling of elements and modal dialog windows not detected by screen readers.

Blind participants experienced difficulty navigating due to the inability to control Roku Voice Guide (Roku's built in screen reader) and TV audio streams separately, and the voice quality and speech rate contributed to user error. This is a critical issue as it excludes an entire user group. Both participants with low-vision had difficulty discovering the search icon and completing the task to find a specific program. The majority of sighted participants had difficulty using program guides, identifying the search feature, parsing large amounts of text on each screen, and orienting to the application.

Accessible Content Selection Interface Design

To address these issues, we developed an accessible prototype of a graphical user interface with functioning content, a guided tutorial, and crowdsourced and AI derived video descriptions (Figure 7). We prioritized cross-platform experiences and the application of Web Content Accessibility Guidelines (WCAG 2.0), in each [8]. In contrast with the difficulty our first round of screen reader participants (P1, P3, P4, P5) had, all three screen reader participants (P10, P11, P12) were able to access content, access it quickly, and had positive reactions to the experience. Participants made comments like "that was so awesome, I wish I could take this home." We found that our prototype's adherence to Web accessibility standards had a dramatic, positive impact on the overall user experience. We observed improved task completion and users reported increased user satisfaction. Many usability issues identified in the first usability testing session with the sponsor's products could have been prevented by following standards set out by WCAG 2.0 success criteria.

DISCUSSION

This process revealed a number of accessibility issues and participant's narrative feedback provided our team with opportunities to innovate and improve these products. Our work demonstrates a need for designers to incorporate a balance of customization and accessibility standards.

Methods Employed: The human-centred/inclusive design methods used provided our team with detailed insights into the user's experience of inaccessibility and usability of our prototypes. Our qualitative process directed our focus on user needs and interaction modalities, rather than any particular technology, which became imperative to creating a unified and accessible system that can be applied across devices and account for complexity of use. We have laid important groundwork for designers working in the area of video streaming to employ similar methods.

"That was so awesome, I wish I could take this home."

Figure 8. Quote from participant using the screen reader accessible prototype

"Amazing...I was watching with my ears."

Figure 9. Quote from participant using the audio description prototype

ACKNOWLEDGEMENTS

We thank our participants, funders, and collaborators in this work. In particular, we thank Lauren Baff, Paul Arthur Myers, Gabriella Cammarata, Serena Parr, Olivia Maria Cabello Gorchs, and Kalila Shapiro, the NYU Ability Project and its faculty, the NYC Media Lab, and Charter Communications for their funding.

Accessibility in Video Streaming Services: A good user experience is critical in accessibility, and goes beyond technical compliance to include qualities that are hard to quantify and predict. However, the World Wide Web Consortium (W3C), has put forward a comprehensive set of Web Content Accessibility Guidelines that include success criteria for the creation of accessible multimedia content and interfaces. If used in the design and development of streaming service interfaces, customization and these guidelines will account for the accessibility issues and user experiences common in video streaming systems like the home entertainment products of our sponsor.

CONCLUSIONS AND FUTURE WORK

The design of communications technologies affects many people in their everyday lives. Unfortunately, many people with disabilities have become used to accommodating to the design of a system rather than it meeting their needs. We presented common frustrations users experienced while trying to complete basic tasks associated with streaming home entertainment, and described how an inclusive design process yielded more accessible and enjoyable interfaces. The increased personalization of new technologies for video streaming will has the potential to generate new user types that are not bound by traditional interfaces and experiences. The application of web accessibility standards in streaming products can lay the foundation for perceivable, operable, easily understood and robust streaming interfaces. Achieving a balance of user defined customization and standardization across streaming products is a likely necessary to create more accessible products.

REFERENCES

[1] Pradipta Biswas, Pat Langdon, Carlos Duarte, and José Coelho. 2011. Multimodal adaptation through simulation for digital TV interface. In Proceedings of the European Conference on Interactive TV and Video Pages (EuroITV '11), 231-234. http://doi.org/10.1145/2000119.2000167

[2] Pablo Cesar, Dick Bulterman, and Luiz Soares. 2008. Introduction to special issue: Human-centered television—directions in interactive digital television research. ACM Trans. Multimed. Comput. Comm. 4,4: 2-7 http://doi.acm.org/10.1145/1412196.1412197

[3] Konstantinos Chorianopoulos. 2008. User Interface Design Principles for Interactive Television Applications. International Journal of Human-Computer Interaction. 24(6):556-573. https://doi.org/10.1080/10447310802205750

[4] Clayton Lewis. 1982. Using the "Thinking Aloud" Method In Cognitive Interface Design. IBM Watson Research Center Technical Report RC-9265. IBM, Yorktown Heights, NY.

[5] Mark Rice. 2003. Television and visual impairment: The prospects for the accessibility of interactive television. In Proceedings for the HCI International (2003), 800-804. https://doi.org/10.1145/1350843.1350849

[6] Mark V Springett, Richard N Griffiths. 2007. Accessibility of Interactive Television for Users with Low Vision – Learning from the Web. In Proceedings of the European Conference on Interactive TV and Video Pages (EuroITV '07) 76-85. https://dl.acm.org/citation.cfm?id=1763017.1763029

[7] The United States Department of Justice. 2017. Information and Technical Assistance on the Americans with Disabilities Act. Retrieved March 2, 2018 from https://www.ada.gov/ada_intro.htm

[8] The World Wide Web Consortium (W3C). 2017. Understanding WCAG 2.0. Retrieved March 2, 2018 from https://www.w3.org/TR/UNDERSTANDING-WCAG2