INTRODUCTION

Television and cable programming is still the principal way people connect to the outside world and remain informed about events in their community and around the world. [1,2] As a result, it is important that televisions and set-top boxes be accessible to people with disabilities. While there are regulations in some jurisdictions around the work that govern the accessibility of set-top boxes most of them apply principally to users with vision impairments and hearing impairments. [3] As the result, people with mobility impairments and cognitive impairments still face accessibility issues that need to be addressed. Smart Assistant devices such as the Amazon Echo and Google Home have increasing taken over from traditional environmental controls as a method for people with disabilities to control their environment. However, these digital assistants aren’t capable of communication with the set-top boxes directly and they still need to be connected to communication hubs or infrared controllers to control set-top boxes. Incompatibilities still exist in certain categories of Smart Assistant devices as they don’t support all the communication methods to completely replace traditional environmental controls and not all smartphone communication hub applications are developed according to accessibility guidelines to work using assistive technology devices.

This paper looks at different TV broadcasting services and the methods that Smart Assistant devices or other smartphone applications can be used to control TV broadcasting services. It also looks at the available functional features and the limitations of these Smart Assistant devices and smartphone environmental control applications. The compatibility and incompatibility of each combination of technologies: Smart Assistance device or Assistive Technology devices, communications hub and infrared controller were documented and characterized though an extensive and methodical testing process. A summary of the key compatibility and incompatibility issues are presented in this paper. The goal is to make the selection process easier for users to navigate and eliminate trial and error for users and assistive technology professionals trying to set up a controlled environment for a person with disabilities.

STUDY

In this paper, we have looked at IPTV and HDTV cable services and TV broadcasting services in Canada and the equivalent services in the United States to test the main features to operate set-top boxes using Smart Assistant devices and Assistive Technology devices. The services tested in this study includes: Telus Optik IPTV, Shaw Cable TV and BlueSky IPTV in Canada and their equivalent services includes Comcast/Xfinity X1, AT&T U-verse, TSC Cable TV, and Advanced media technologies (AMT) in the US. Table 1 shows the detailed list of tested Broadcasting services.

Table 1: List of tested TV Broadcasting services in Canada and their equivalent options in the US

<table>
<thead>
<tr>
<th>TV Broadcasting services in Canada</th>
<th>TV Broadcasting services in the US</th>
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<tbody>
<tr>
<td>Shaw Cable TV [6]</td>
<td>TSC Cable TV [7]</td>
</tr>
<tr>
<td>Telus Optik IPTV [8]</td>
<td>AT&amp;T U-verse and Advanced media technologies (AMT) [9,10]</td>
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</tbody>
</table>

Table 2: List of tested Set-top boxes and their TV Broadcasting service in Canada

<table>
<thead>
<tr>
<th>Set-top boxes</th>
<th>TV Broadcasting services</th>
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<tbody>
<tr>
<td>Cisco 430</td>
<td>Telus Optik IPTV</td>
</tr>
<tr>
<td>Cisco isb7104</td>
<td>Telus Optik IPTV</td>
</tr>
<tr>
<td>Arris VIP5662W</td>
<td>Telus Optik IPTV</td>
</tr>
<tr>
<td>DCX3200</td>
<td>Shaw Cable TV</td>
</tr>
<tr>
<td>DCX3510</td>
<td>Shaw Cable TV</td>
</tr>
<tr>
<td>Pace PXD01ANI</td>
<td>BlueSky IPTV</td>
</tr>
<tr>
<td>Arris XG1v4</td>
<td>BlueSky IPTV</td>
</tr>
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</table>

All of the tested set-top boxes are required to communicate through infrared to be controlled by third party hardware, but Smart Assistant and Assistive technology devices don’t have the built-in hardware to support infrared communication and...
require other hardware to enable them to communicate with set-top boxes. This means Smart Assistant devices such as the Amazon Echo and Google Home need to be connected to a communication hub device with infrared support as Smartphone’s don’t have the infrared support. The addition of communication hub devices adds another layer in the setup process and increases the cost of the complete system.

We looked at different communication hub devices available in the market including Logitech Harmony, AnyMote Home hub, Broadlink RM hub, and Kilkr hub in this study. The Amazon Echo and Google Home devices were linked to each communication hub device to activate the main features of TV broadcasting services. We also looked at performing TV broadcasting features through smartphone communication hub applications using adaptive switches and mouse cursor based Assistive Technology devices.

The tested adaptive switches and mouse cursor based Assistive Technology devices include: Swifty [11], Glassouse [12], and the LipSyne [13].

The tested set-top box features in this study were:
1) Enable and Disable Described Video, 2) Enable and Disable Closed caption, 3) Turn broadcaster device on and off, 4) Turn volume up and down, 5) Change channel up and down, 6) Select specific channel using numbers, 7) Access, navigate and exit channel guide, 8) Setup and input options, 9) Select channel through channel guide, 10) Set a recording, 11) Access and exit recording guide, 12) Navigate recording guide, 13) Play, stop, forward, rewind and pause recordings and 14) Access Video on Demand

METHODOLOGY
The Amazon Echo and Google Home smart assistant devices were chosen for this study as they have the largest market share [14] and are increasingly being chosen as a cost-effective alternative to traditional environmental control systems. [15] [16] Each of these devices were then interfaced to each of 4 communications hub devices: Logitech Harmony [17], AnyMote Home hub [18], Broadlink RM hub [19], and Klikr hub [20]. These were the only 4 communication hub devices available on the market at the time the testing was done. These combinations of devices were then tested with 7 different set-top boxes. These set-top boxes are the most commonly used set-top boxes in circulation at the 3 primary service providers in Canada. Note that there are only 4 major manufacturers of set-top boxes for service providers in North America. The devices in the Canadian market are re-branded versions of the devices available in the North American market, so the results of this study apply to the set-top boxes available in the United States. The output of each of the set-top boxes were connected to television sets from major television set manufacturers: Samsung, Sony, and LG. The televisions were set to a HDMI input in order to display the output from the set-top box. The set-top boxes themselves are controlled by proprietary infrared protocols. Each of the communications hubs had the ability to learn the infrared protocols or use the existing profiles with infrared protocols for each set-top box. The study examined whether each Smart Assistant and Assistive technology device was capable of controlling each communication Hub and each set-top box. The study also examined if the learning capabilities of each communications Hub was capable of duplicating the full breadth of commands necessary to control the key feature of each set-top box. The key features are listed above.

RESULTS
With 4 Communications Hub, 7 set-top boxes, 5 Assistance Devices (2 Smart Assistant devices and 3 Assistive Technology devices), and 14 key features to be tested, there are 1960 potential criteria cases that needed to be tested. In some cases, the communications hub devices were not compatible with the set-top boxes (350 cases). In other cases, the Smart Assistant devices were not compatible with the communications hub devices (392 cases). This reduced the testing cases to 1218 potential combinations.

220 cases of those 1218 potential combinations weren’t possible to be perform due to the lack of support for the features or buttons to perform the features when the Smart Assistant devices were linked with the communications hub. 196 cases of those 1218 potential combinations also didn’t perform reliable and consistent when tested more than once. Only 802 test cases were performed successfully in a reliable and consistent manner from 1960 potential criteria.
DISCUSSION

Different communication hub devices were tested in this study, but the majority of the devices weren’t reliable when used with Smart Assistant devices or had lack of support for Smart Assistant devices. We were able to produce reliable results for 4 main features including power control, volume control, channel increasing or decreasing, and playback features using the Logitech Harmony communication hub with built-in support for Amazon Echo and Google Home. Other reliable and successful results were produced using the Broadlink pro hub and Logitech Harmony communication hub when tested using Assistive Technology devices by means of mouse cursor or adaptive switches.

The Amazon Echo and Google Home were not able to perform all the features listed and only were able to perform the basic features including volume control, basic channel control, playback, and power on/off. The Amazon echo and Google Home lack the support for channel guide, navigation buttons, and menu option which means the users are not able to the access or operate channel guide, OnDemand programming, and recorded programs.

These Smart Assistant devices also don’t provide a method to customize the settings and features such as favorite channel option which means the communication hub application is the only method to customize the settings and features such as favorite channel option. This could be a problem for people with disabilities that cannot use other input methods and require assistance to customize the settings.

Assistive Technology devices can successfully be used to perform all the features when the user is able to react quickly and perform gesture actions as the application layouts are not all developed according to accessibility guidelines which means the level of disability can affect the ability to perform the features.

A more detailed breakdown of the results of the compatibility test will be available at: http://settop-access.neilsquire.ca/

Given the continued importance of cable and television as media to inform people, accessibility of the set-top technology is a critical accessibility issue that still needs to be addressed. Smart Assistant devices hold the potential to deliver cost effective control to people with disabilities but without an understanding of the breadth of the technologies that need to be controlled to ensure that people with disabilities have access to important activities of daily living, they risk being left behind, and another digital divide being created. This paper provides key information that affects assistive technology delivery and accessible policy development.

REFERENCES


[6] Shaw Cable TV: https://www.shaw.ca/television/packages/
