Creating eBooks with Accessible Graphics Content

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ABSTRACT
We present a new model for presenting graphics in eBooks to blind readers. It is based on the GraViewer app which allows an accessible graphic embedded in an iBook to be explored on an iPad using speech and non-speech audio feedback. We also introduce a web-based tool, GraAuthor, for creating such accessible graphics and describe the workflow for including these in an iBook. Unlike previous approaches our model provides an integrated digital presentation of both text and graphics and allows the general public to create accessible graphics.

Categories and Subject Descriptors

General Terms
Design, Human Factors

Keywords
eBook, accessible graphics, authoring

1. INTRODUCTION
One of the most disabling consequences of being blind (by whom we mean any person whose level of vision does not allow them to easily read printed text or graphics even when magnified) is a lack of access to information presented graphically. Computer applications like DAISY or Apple’s VoiceOver screen reader allow blind people to access digital textbooks, web pages and other textual material by using speech or refreshable braille displays. However, reading graphic elements with VoiceOver or DAISY is still limited to reading an alternative textual description associated with the graphics.

Despite accessibility guidelines the vast majority of on-line graphics either do not include an alternative text description of the graphic or the text is very general and not helpful [11]. Even when provided such a description can only summarise the information in the graphic and necessarily loses information contained in the original graphic. It is also difficult to use a textual description to build a mental model of the layout of the graphic’s elements. For these reasons accessibility guidelines recommend the use of tactile graphics for presenting graphics in which spatial relationships are important, e.g. maps, plans, technical drawings etc [17].

Tactile graphics are usually printed on swell or embossed paper and allow the blind reader to feel the graphic elements and to understand their spatial layout. Unfortunately they suffer from three significant disadvantages. The first is that they form a bulky, separate addendum to the main text. The second is that they use Braille which most blind people cannot easily read [8]. The third disadvantage is that they require special purpose printers or paper for their production, and so are relatively expensive (around US $5 a sheet.)

Tactile graphics were combined with an eBook for, we believe, the first time in 2014. The Space Telescope Science Institute (STScI) partnered with the SAS Corporation, the National Braille Press, and the National Federation of the Blind to create an accessible iBook “Reach for the Stars” [12]. VoiceOver is used to read the book while tactile overlays can be laid over selected graphics on the iPad and the reader obtains audio feedback when they touch the overlay. While this certainly provides a more integrated presentation of text and graphics the need for expensive tactile overlays remains a significant disadvantage of this approach.

Here we present a new model for combining accessible graphics with eBooks that does away with the need for tactile overlays. Rather than using an overlay we use the GraViewer app [5] to present an accessible version of the graphic on an iPad using audio feedback. Here, we extend our previous research into GraViewer by considering how it can be used to present graphics from eBooks. Our main technical contributions are to present a web-based authoring tool, GraAuthor, for creating accessible graphics that can be viewed using GraViewer on the iPad and the workflow for integrating these graphics into an iBook.

An important feature of GraAuthor is that it is designed to be used by the general public. This is in contrast to the current state of affairs for tactile graphics where most tactile graphics (including the tactile overlays in “Reach for the Stars”) are created by trained transcribers. While GraAuthor can be used by transcribers it has been designed so that it can be used by teachers, friends, colleagues and family of a person who is blind. In combination with iBooks Author this allows these people to easily create eBooks with fully integrated accessible graphics.
To illustrate the usefulness of this approach, our running example is an accessible version of the instruction manual for a cordless phone. Better access to the illustrations in such manuals is a frequent request by blind people. Unfortunately, at present the use of trained transcribers and tactile graphics makes the cost of producing such an accessible instruction manual prohibitive. GraAuthor addresses this by allowing a friend or family member to quickly construct an accessible digital version for no cost apart from their time. Board game layouts, fictional and non-fictional maps and plans are examples of other material that might also be usefully transcribed using GraAuthor.

2. RELATED WORK

Presentation technologies for accessible graphics fall into four main categories: tactile graphics, e.g. [2], audio only presentation which is either based on a textual description of the graphic or sonification, e.g. [10]; tactile overlay on top of a pressure-sensitive screen which provides audio feedback when a graphic element is pressed, e.g. [13]; haptic presentation using devices like the phantom, e.g. [14]; or presentation on a touchscreen device using a mixture of haptic or audio feedback as the user explores the graphic, e.g. [6, 4]. The advantage of the last approach is that it does not rely on expensive tactile graphics or overlays but still allows the user to use both hands to explore the graphic and build up a mental model of it. This is the approach that we use.

Currently most tactile graphics are created by trained transcribers using tools like CorelDraw. Production is a time consuming iterative process in which the graphic is tested with blind proof readers. Researchers at the University of Washington have built an image processing tool (TGA) that can be used by transcribers to extract and replace text from scanned graphics by the equivalent braille [7]. There has been some previous research into automatic generation of accessible graphics from on-line images. This has focussed on automatically generating a textual summary or audio presentation of on-line bar charts (Interactive SIGHT) [1] and (iGraph-LITE) line graphs [3]. Recently a tool for automatically generating an accessible floor plan from an on-line floor plan was described in [5].

Our work differs in its focus on creating an authoring tool that can be readily used by non-professionals to create graphics for a blind friend, colleague or family member and by the ability to tightly integrate the accessible graphic into an eBook.

3. READING AN ACCESSIBLE EBOOK

Screen readers like Apple’s VoiceOver and eBooks and new standards like ePub 3.0 are revolutionising access to books and other textual material by blind readers. However, access to graphics in these materials is currently not well supported. In this section we give a new model in which accessible graphics are embedded in the eBook, allowing a fully integrated reading experience as shown in Figure 1. Our implementation utilises eBooks because Apple products are widely used in the blind community due to their comprehensive accessibility support.

Our model makes use of an application called GraViewer which we previously developed for accessible presentation of information graphics on the iPad [5]. It is based on prior research into audio and audio-haptic presentation of graphics on touch screen devices [6, 5] and street maps on mobile devices [15, 9]. GraViewer’s user interface is designed to be consistent with the iOS accessibility framework: it utilises standard iOS accessibility gestures for menu navigation and application control as well as using VoiceOver for speech.

GraViewer allows a blind user to explore the graphic with both hands, much like a tactile graphic. Whenever a graphic element is first touched or subsequently queried, audio feedback describes the element. A sharp click indicates when a graphic element is entered or left and a volume gradient along the boundary helps the blind user follow the boundary of a shape or a line. When a graphic is first opened a textual overview of the graphic is read to the user. This is in line with guidelines for tactile graphics which recommend providing a Braille overview to help the blind reader quickly build up a mental model of the graphic.

GraViewer displays graphic content specified in SVG (the W3C standard for Scalable Vector Graphics) and uses metadata associated with the shapes to control the interaction. The metadata associated with a shape is: its ID, audio volume level for the interior of the shape and for its boundary, the text string to be read out when the shape is queried, and the name of a (non-speech) audio file and/or the color code for generating the sound associated with the shape during navigation.

Figure 1: Reading an iBook with an embedded accessible graphic. The image on the left shows the iPad screen as a blind person uses iBooks with VoiceOver to read an instruction manual. A standard placeholder image indicates that the graphic can be opened in GraViewer. When the user double taps on the image the graphic is shown on the iPad using GraViewer (on the right.) As the reader touches the graphic elements the associated text is read aloud. The user returns to the iBook using the Home button.
Because GraViewer displays an SVG file, it fits well with HTML5 and ePub 3.0. In our implementation, an accessible graphic is embedded in an iBook as an HTML widget.

When reading an iBook the blind user can select the widget by double tapping on it and it will be displayed using GraViewer as shown in Figure 1. Once they have finished viewing the graphic they can use the home button to exit from GraViewer and return to their current location in the iBook. For the first time accessible graphics are fully integrated with text presentation.

4. ACCESSIBLE EBOOK CREATION

Accessible graphics are created by trained transcribers. However we wanted to “democratise” their production so as to allow teachers, friends, colleagues and family of the blind person to easily create eBooks with fully integrated accessible graphics. The intent is to support access to the many graphics that are encountered day-to-day like diagrams in instruction manuals, maps in travel guides, board game instructions etc that are currently not available to blind people because of prohibitive production cost.

Our model for creation is built around GraAuthor which is shown in Figure 2. This is a web-based graphics authoring tool that allows a sighted person to quickly create an accessible graphic suitable for display with GraViewer. GraAuthor has two interesting features.

The first is that the author can import an image of the visual graphic for which they wish to create the accessible version and use this to guide the construction. The faded out image is shown in the background and by tracing lines and shape boundaries the author can quickly create the accessible version.

The second interesting feature is that GraAuthor allows the author to provide a textual overview of the graphic and to associate a textual description and non-speech audio file with each graphic element. These are the basis for the audio feedback provided by GraViewer when the graphic is displayed.

Once the graphic has been created in GraAuthor, it can be exported as an HTML widget. Then when authoring an iBook using iBooks Author, the HTML widget can be inserted into the page at whatever location the author desires – see Figure 2(d). Once the iBook is finished it can be exported to the iPad of the blind reader as an email attachment, through a file sharing service like DropBox, or published through the iBooks store.

It is worth pointing out that creating an understandable accessible graphic is not straightforward. Obviously colour and texture must be replaced by a textual description while the much lower resolution of touch means that the accessible version must abstract and simplify the original graphic. Furthermore, devices like perspective are not easily understood by blind people and so should be replaced by an orthogonal view [16].
To help the novice author, GraAuthor comes with examples of common kinds of information graphics: tables, floor plans, maps, line graphs which can be used as the basis for creating new graphics. Furthermore our model allows the person creating the graphic to quickly publish the graphic to an iPad and obtain feedback from the blind reader, and modify or improve it as necessary.

5. EVALUATION

Both GraViewer and GraAuthor were developed using a participatory design methodology with blind end-users and transcribers. Blind users have used GraViewer to understand a wide variety of graphics including line charts and floor plans, some of which are shown in Figure 3. In [5], 8 participants were presented with floor plans of large houses with 10 rooms, and asked questions to determine whether they could find the number of the rooms, point to a particular room, show the path from one room to another, and describe the overall layout. All participants answered all the questions correctly, except two who made a mistake in the first question.

6. CONCLUSION

We have provided a new model for presenting graphics in eBooks to blind readers and described two tools, GraViewer and GraAuthor, that support this model for iBooks. Unlike previous approaches our model provides integrated delivery of both text and graphics and allows non-professionals to create accessible graphics. We believe our model and tools have the potential to dramatically improve access to a wide range of digital information graphics.

However there is still considerable work to be done. This includes more extensive user studies trialling the use of GraViewer and GraAuthor in real-world contexts, such as school or work, and integration of image processing and OCR into GraAuthor so as to semi-automate transcription.

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8. REFERENCES