Sonification System of Maps for Blind

Gintautas Daunys and Vidas Lauruska

Siauliai university, Vilniaus str. 141, 76353 Siauliai, Lithuania
vidas.lauruska@tf.su.lt

Abstract. Presentation of graphical information is very important for blind. This information will help blind better understand surrounding world. The developed system is devoted for investigation of graphical information by blind user using a digitiser. SVG language with additional elements is used for describing of maps. Non-speech sounds are used to transfer information about colour. Alerting sound signal is issued near two regions boundary.

Keywords: blind, sonification, digitiser, maps.

1 Introduction

With the increasing usage of multimedia systems, there is a real need for developing tools able to offer aids for visually impaired or blind people in accessing graphical information. This technological development opened new prospects in the realization of man-machine interfaces for blind users. Many efforts have been devoted to the development of sensory substitution systems that may help visually impaired and blind users in accessing visual information such as text, graphics, or images.

Some of them are based on transformation of visual information to auditive signal. These approaches assume a sufficient knowledge of both visual and auditory systems. At present time, we can consider that the various solutions suggested for text access are acceptable. However, the information presented in the form of graphics or images presents a major obstacle in the daily life of blind users.

1.1 Transformation of Visual Information

One of approaches is based on the sound screen concept [1]. Its principle rests primarily on the auditive localization of virtual sound sources (VSS). The sense of hearing presents many analogies with the parameters intervening in the vision. The human being exploits this resource very much, in particular with the speech which transports important semantic components, just like the text with the vision. If all the parameters intervening in hearing are not used by the speech, on the other hand, the music exploits all the related resources at artistic ends. However, an important advantage with visual space is that one can represent a particular semantic in a graphical form. Whereas, there is no equivalent graphical representation of auditive semantic in the sound space. Here, as an alternative solution, we propose an audiodisplay system based on sound localization which allows to represent some

C. Stephanidis (Ed.): Universal Access in HCI, Part II, HCII 2007, LNCS 4555, pp. 349–352, 2007.

graphic information in the sound space. The basic idea is to project graphics on a virtual sound screen.

Other approach is coding scheme based on a pixel-frequency association [2]. The sensory substitution model can now be summarized as follows. According to our model of vision, the acquired image matrix is first convolved by an edge detector filter and, second, converted into a multiresolution image. Then, coupling between the model of vision and the inverse model of audition is achieved by assigning a specific sinusoidal tone to each pixel of this multiresolution image; the amplitude of each sine wave is modulated by the grey level of the corresponding pixel. Finally, according to the inverse model of audition, the left and right complex sounds consist of weighted summations of these sinusoidal tones.

In the TeDUB project (Technical Drawings Understanding for the Blind) [3] the system was developed, which aim is providing blind computer users with an accessible representation of technical diagrams. The TeDUB system consists of two separate parts: one for the semi-automatic analysis of images containing diagrams from a number of formally defined domains and one for the representation of previously analysed material to blind people. The joystick was used for navigation through drawings. Very interesting approach and ideas are combining haptic and auditory [4].

1.2 SVG Format

Mapping represents a perfect application of SVG (abbreviation for Scalable Vector Graphics), because maps are, by nature, vector layered representations of the earth. The SVG grammar allows the same layering concepts that are so crucial to Geographic Information Systems (GIS). Since maps are graphics that depict our environment, there is a great need for maps to be informative and interactive. SVG provides this interaction with very high quality output capability, directly on the web. Because of the complexity of geographic data (projection, coordinate systems, complex objects, etc.), the current SVG specification [5] does not contain all the particularities of a GIS particularities. However, the current specification is sufficient to help the mapping community produce open source interactive maps in SVG format.

Nowadays vector graphics format is widely used to store digitized maps. Often rich interactive maps are published in web using SVG file format. SVG is an XML markup language for describing two-dimensional vector graphics. It is an open standard created by the World Wide Web Consortium. The available fill and stroke options, symbols and markers enable higher quality map graphics. Most suitable software for browsing interactive SVG maps is plug in Adobe SVG Viewer, available for all major platforms and browsers (Linux, MacOSX, Solaris, Windows) which can be downloaded free from the Adobe SVG homepage [6]. Exist and commercial products as MapViewSVG from ESRI [7].

The analysis of SVG technology application in education is presented in A. Neumann paper [8]. Already were attempts to apply SVG formats of maps for blind users [9].

2 Method

Our aim was to develop widely available graphical information presentation system for blind user. We tried to use most common and cheapest hardware and open source or free software components.

First we consider the system hardware. Computer mouse is optional graphic-input device. The device use relative motion, so when the user hits the edge he or she need merely pick up the mouse and drop it back. It is convenient during usual work with computer applications, but maps exploration system is one of exceptions. In our application we need devices which give absolute coordinates. For graphical input we selected digitiser (tablet). Other hardware is a standard PC computer with sound card and speakers.

For graphical information description we selected SVG language because of reasons as was described earlier. Because we aimed achieved high interactivity, we don't use standard products with SVG implementation as Adobe SVG Reader. We developed software using Visual C++ environment from Microsoft Visual Studio.NET.

As a XML based language, SVG supports foreign namespaces. It is possible to define new elements or add new attributes. Elements and attributes in a foreign namespace have a prefix and a colon before the element or attribute name. Elements and attributes in foreign namespaces that the SVG viewer does not know, are ignored. However, they can be read and written by script. Foreign namespaces are used to introduce new elements (e.g. GUI elements, scale bars) and for the attachment of non-graphical attributes to SVG graphic elements [8]. The SVG file prepared for our system could be seen on other SVG viewers.

3 Maps Sonification System

Important and coherent points during design process were to choose intermediate structures for parsed SVG code storing and define additional elements to SVG specification. Selected graphical features are projected into indexed bitmap. The index of pixel colour also is a key to text and nonverbal sounds, which are bounded to selected region of map. For each region text about it features for speech synthesis is prescribed. The musical melodies can be attached during SVG editing or selected automatically in run-time. They help for user navigation over the map and also bring features of jocosity. The melodies are played when digitiser's pen is over selected region.

For easier navigation through the map, the alerting system about region boundaries was implemented. System permanently tracks, how far user input coordinates are from region contours. The intermediate bitmap helps for this purpose. If user's pen is near boundaries an alert signal is issued. The volume of alert signal depends on distance from boundary. Volume is increased, when pen of digitiser is closer to boundary.

The parsing of SVG document was implemented using XML parser Expat [10]. Graphical rendering to intermediate bitmap was implemented with Windows GDI functions. We used DirectX for output of non-speech sounds, which are musical melodies and alerting tonal signals. Speech synthesis currently is implemented using free product - Microsoft SAPI 5.

4 Conclusions

Our investigation has demonstrated that SVG format is flexible and it is suitable for combining graphical and other kinds of information about maps. The conversion of graphical information to auditory signals can be implemented via generation of intermediate bitmap layer. The software prototype which uses SVG format files as input was implemented using Microsoft Visual Studio.NET. Usability test is our nearest future task. To improve speech synthesis quality and include language choice menu is other our task. It seems that MBROLA tool [11] is suitable for the purpose.

Acknowledgement. This research is supported by FP6/IST STREP project Multimodal Collaboration Environment for Inclusion of Visually Impaired Children (MICOLE).

References

1. Liard, C., Beghdadi, A.: An Audiodisplay Tool For Visually Impaired People: The Sound Screen System, International Symposium on Signal Processing and its Applications (ISSPA), vol. 1, pp. 108–121. Kuala Lumpur, Malaysia (2001)
2. Capelle, C., Trullemans, C., Amo, P., Veraart, C.: A Real-Time Experimental Prototype for Enhancement of Vision Rehabilitation Using Auditory Substitution. IEEE Trans. Biom. Eng. BME-45, 1279–1293 (1998)
3. Horstmann, M., Hagen, C., King, A., Dijkstra, S., Crombie, D., Evans, D.G., Ioannidis, G., Blenkhorn, P., Herzog, O., Schlieder, Ch.: TeDUB: Automatic Interpretation and Presentation of Technical Diagrams for Blind People. In: Hersh, M. (eds.): CVHI'2004, Granada, Spain (2004)
4. Jansson, G., Larsson, K.: Identification of Haptic Virtual Objects with Different Degrees of Complexity. In: Wall, S.A., Riedel, B., Crossan, A., McGee, M.R. (eds.): Eurohaptics 2002. In: Conference Proceedings, Edinburgh, pp. 57–60 (2002)
5. Scalable Vector Graphics (SVG) 1.1 specification.http://www.w3.org
6. Adobe downloads page.http://www.adobe.com/support/downloads/main.html
7. ESRI homepage.http://www.esri.com
8. Neumann, A.: Use of SVG and EcmaScript technology for E-learning purposes. In: ISPRS Workshop Tools and Techniques for E-Learning, pp. 37–48. Potsdam, Germany (2005)
9. Campin, B., McCurdy, W., Brunet, L., Siekierska, E.: SVG Maps for People with Visual Impairment. In: SVG OPEN Conference (July 2003)
10. The Expat XML parser.http://expat.sourceforge.net
11. The MBROLA project homepage.http://tcts.fpms.ac.be/synthesis/mbrola.html