Using SVG and a Force Feedback Mouse to Enable Blind People to Access “Graphical” Web Based Documents

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Abstract. We present a system that enables a blind user to access 2D WEB based “graphical” documents. After introducing the SVG format and the Force Feedback Mouse, we present how, in a WEB browser application, we associate force, voice and sound feedback.
Our approach is applied with two kinds of graphical information: geographical and musical information. In both application, after a training phase of the mouse handling, the user can make his own mental construction of displayed data. When the user knows the relative position of different elements, he can move the mouse pointer towards the region he wants.

1 Introduction

In a classical situation, a blind user uses to handle a keyboard to operate a computer. The machine answers him by a voice synthesis and/or a braille display. The text reading is adapted to these methods. When browsing the WEB, a blind user will have accessibility problems with graphical documents. The W3C has proposed guidelines [1] for web authors to design their WEB sites. For instance, graphical data have to be linked with a textual description. So, a graphic document may be presented to him by long and tiresome descriptions, when they are available.

The force feedback devices are used within the context of the accessibility for the blind users because they enable a more direct interaction based on sensory capacities.

Many works [2] [3] [4] [5] [6] [7] aim at using a force feedback device to make a haptic feedback to the visual elements displayed on the screen. For example, passing of the pointer of the force feedback mouse on an icon will cause a small jolt in the user hand. Moreover, Dufresne showed the interest of the audio-haptic bimodality for blind users [8].

We will first set the main definitions of the haptic perception. We propose a specific context of use for these devices: relative localization. We will show some technical precisions about our system. Then we will present two prototypes that enable blind people to access geographical and musical documents in a web context. Lastly, we will conclude by presenting the outlooks which we consider.

2 Definitions of Haptic Context : Relative Localization

The tactilo-kinesthetic or " haptic" [9] system is the synthesis of the movements of exploration of the motor system and of perceptions of the tactile system. The haptic sense is thus both effector and receptor. It consists of :

1. the cutaneous sense: it is the touch sense. It allows to feel the temperature, the pressure or the pain, and is relayed by sensory receptors located under the skin.
2. the kinesthetic sense: it is the sense related on the position and the movements of the body. It enables us for example to know the weight of an object we're handling and its position. It is relayed by receptors based in the muscles, the tendons and the articulations.

The handling of force feedback pointing devices as a mouse is based on the kinesthetic perception of the arm. This perception enables us to visualize the position of the hand in space. Thus, if an haptic event, like a vibration or a shock, occurs during a move of the arm, we can mentally represent the position that the hand had when the event occurred.

Associated with a voice or sound synthesis, and thanks to the sensory memory, this approach will allow the rebuilding of a mental image of an object from the relative positions of the elements of this object.

The two applications which we will present are founded on this context.

3 Technical Aspects

3.1 SVG Format

We use the SVG format (Scalable Vector Graphic [10]), which is an application of XML (eXtended Markup Language). A SVG file is coded in marked-up plain text and is read by the client computer as a text file. Indeed, its contents can be indexed by search engines and it can be generated. Moreover, SVG supports the DOM (Document Object Model) and can react to the user events via a script programming. SVG files can be displayed on an Internet browser with the plugin from Adobe [11].

In our applications, the graphical elements are defined explicitly in SVG file as lists of coordinates. It is a real advantage compared to the image bitmap formats.

Thanks to its features, the SVG format is yet used in an accessibility context [12] [13].

3.2 Wingman Forces Feedback Mouse®

This force feedback mouse (figure 1), was created by Immersion Corporation [14] and marketed by Logitech.

The mouse is interdependent of its base. The effective surface of work is of 1.9 X 2.5 cm and the forces can reach 1N in peak. The Wingman® formerly was a game device, but its use was diverted toward research on the accessibility [2] [4] [3] [12] [13].

Fig. 1. Wingman force Feedback Mouse

Immersion Corporation proposes a plugin for the Internet navigators, which gives the possibility to control a force feedback device, via the script programming contained in a HTML page [15].

3.3 Architecture of our Applications

In a WEB context, the architecture we use is a Client-Server Scheme on a Local Area Network (Figure 2).

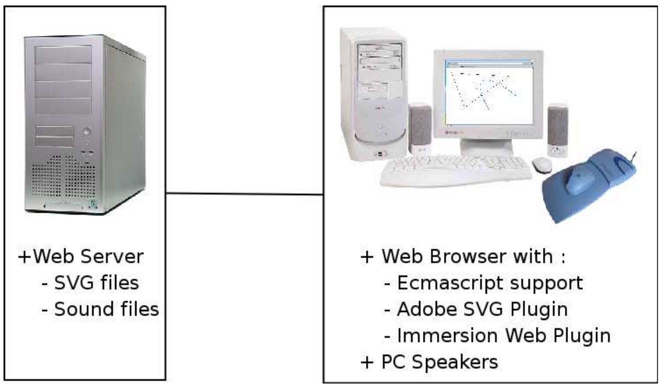

Fig. 2. System architecture

On the server side, we have the SVG files and the sound files. By now, the SVG files are stored on the server or generated on the client via an ECMAScript programming. We plan to generate all SVG files on the server via perl programming language, accessing to databases. For the sound files, in this first prototype, we use a speech and sound synthesis on the server to generate them. That may avoid any conflict. Indeed, in a general case, a blind user use his own screen reader and his own speech synthesis.

The client browser must have downloaded from the server the different plugins that enable our system to work : the "Immersion Web Plugin" [15] for the force feedback and the "Adobe SVG Viewer Plugin" [11] in order to display the SVG files.

4 Description of the Geographical Application

In our application (figure 3), a map is displaying the USA, showing the states. A blind user uses the force feedback mouse to explore the surface of the screen. The mouse can have two different behaviors. When the pointer of the mouse:

1. goes out of the map area, the user feels a texture effect in his hand.
2. pass on a region, it is "magnetized" towards its center.

A sound feedback gives the name of the state, via a screen reader and a voice synthesis. Now, when the user has his mouse pointer toward a region, he has to force to quit the state and either

1. falls into a region bordering.
2. leaves the map, and then feels an effect of texture

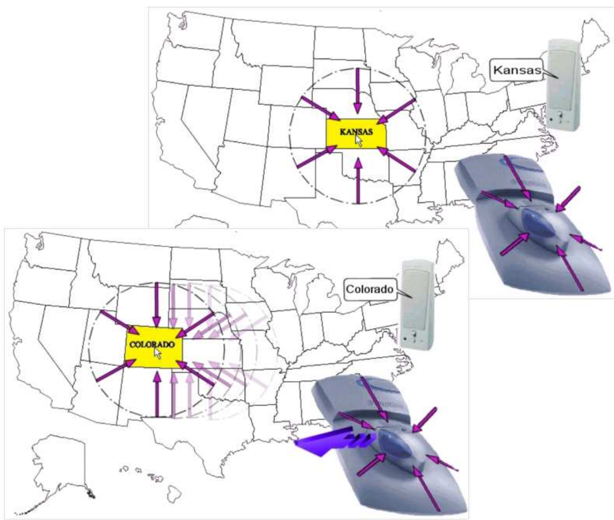

Fig. 3. Geographical Application

The study of geography is well adapted to the use of the mouse, as it may require a transfer of information from the computer to the user, via the mouse. With HTML tags and bitmap pictures, the blind user could only "reach" the links name through the screen reader with no logical order, with the TAB key. Using a force feedback mouse enables them to apprehend the layout of the links, and thus the layout of the regions.

5 Description of the Musical Application

In order to use the same approach in music, we needed a spatial view of musical data. Jean Marc Chouvel has showed a torus-shaped hexagonal representation of a musical score [16]. This representation provides some nice harmonic characteristics.

5.1 Hexagonal Representation of Musical Data

It is a instantaneous representation of the score. Notes are showed independently from eighth interval. They are displayed on an hexagonal lattice, showing on figure 4. It is also a torus representation : it loops horizontally and vertically.

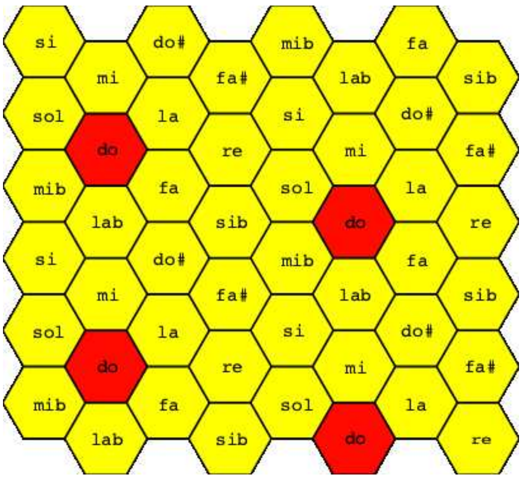

Fig. 4. Hexagonal Representation

Main features of this representation are described in [17] :

1. Vertical axis is made by major thirds. The cycle is long of 3.
2. Axis from the left bottom to the right top is made by minor thirds. It is 4 cells long cycle.

3. Last axis (from the right bottom to the left top) is made by fifths. This axis has got every notes and its long is 12.
4. From a note, its neighbors in the representation are notes with a strong harmonic relationship (third or fifth)
5. close chromatic notes (half tone and tone) are separate by one line between 2 hexagons.
6. when two shapes are identical, it is the same chord.

5.2 Implementation

In our prototype, we use the hexagonal representation in order to present the different chords to the user.

We have implemented the simplest chords : major, minor, augmented and diminished fifth, dominated, major, minor and diminished seventh. Thanks to the hexagonal representation, each chord has got a specific shape (Figure 5).

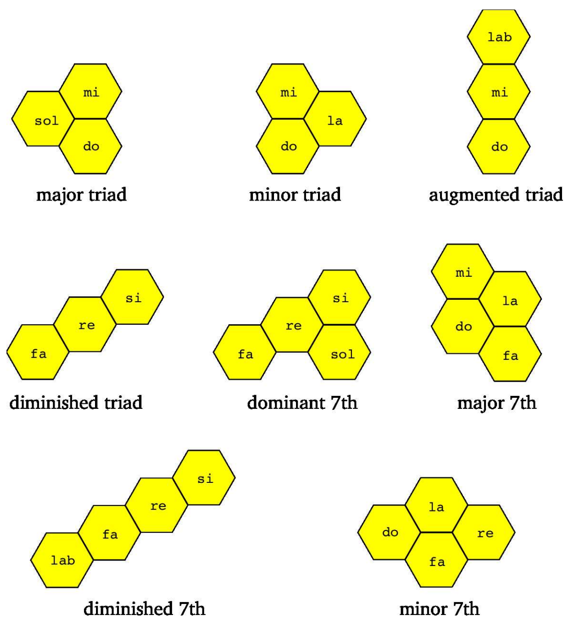

Fig. 5. Simple Accords

5.3 Haptic Feedback and Usability

When using our prototype, a blind user is able to explore the hexagonal draughtboard. Each note is materialized via the mouse by magnetizing the cursor on the center of the hexagon, while a sound synthesis play the note. In any moment, the user can build one of the chord available by pressing a key.

Once a chord created, haptic feedback changes. Then, user can recognize the specific shape of the chord.

6 Conclusion and Outlooks

In our approach, the layout of graphic elements is displayed thanks to a force and sound feedback. This enables blind users to access graphical information.

We plan to prepare a test protocol, to estimate how our applications can really improve the ability for blind users to access geographical or musical documents. However, for the geographical experience we have already tested our system with two blind users, and they admit that our system enables them to create a mental representation of a geographical map; that is very useful in a pedagogic situation.

For the musical application, we are about to extend the usability of our prototype. By now, only an explorative mode is available. Next, we plan to add a listening mode, in order to access and analyze harmonic scheme in a music. We will add also an editing mode. Some features of the hexagonal representation hadn't been used, such as spatial animation of cadences (an authentic cadence is a translation of a triangle by one cell).

Finally, we are working on a more general approach of our architecture. We are developing a software framework to create easier any haptic-SVG WEB applications. And we are still testing other speech and sound synthesis and SVG generation scripting methods.

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