# HapticRiaMaps: Towards Interactive exploration of Web World maps for the Visually Impaired

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## ABSTRACT
Existing information on the Web and especially maps are graphically-orientated and in most cases visually impaired users have very restricted access and find it difficult to recognize this kind of visual representation. For visually impaired people and especially for blind users alternative information presentation ways must be found, which would replace visual information. We investigate the potential role of haptics in augmenting the visualization of maps exist on the Web. *HapticRiaMaps* is a free open source web application enforces the accessibility of maps for the visually impaired users. Issues of multimodal interaction, relevant sonifications, and haptic technologies enable efficient map exploration of preferable and well known 2D maps (retrieves maps from OpenStreetMap web application).

## Categories and Subject Descriptors
K4.2 [**Social Issues**]: Assistive technologies for persons with disabilities; H.5.2 [**Information Interfaces and Presentation**]: User Interfaces

## General Terms
Design, Human Factors

## Keywords
Haptic navigation, Web maps, haptic interaction, blind users, visually impaired users

## 1. INTRODUCTION
In the past few years the scientific community turned its interest to non-visual forms of representation, using the haptic and the auditory information channels. However, only recently a substantial decrease in price has allowed a strong diffusion of these technologies into the accessibility domain. The adoption of haptic devices into people with disabilities and especially to visually impaired users, who meet huge obstacles in accessing the Web, can efficiently support the symbolic information, like Web 2D maps. In this respect, existing Assistive technologies and multimodal interactions constitute valuable tools to provide visually impaired people with an intuitive interface dedicated to the improve their visualization of Web maps. In particular, they can take advantage of haptic force feed-backs and audio sonifications when interacting (touching) with the cartographic information of a Web 2D map.

Some studies showed that visually impaired and especially blind users may be able to recognize simple objects [1] using a haptic device such as the Phantom[1]. For example, Jansson [2] attempted to enable blind people to touch virtual geographical environments with a haptic mouse and with a Phantom Omni device, but the benefits of these new devices do not show real improvement. Later Jacobson [3] et al. use a force-feedback mouse and auditory labels or directions to give a mixed modal interface that allows more comprehensive feedback [4].

However, when the environment becomes more complex, the need for additional information becomes imperative. The FP7 HaptiMap project[2] is aimed at making maps and location based services more accessible by using several senses like touch, hearing and vision. Moreover, authors et. al. [5] developed a standalone application for visually impaired that accepts as input a 2D map (in a specific zoom size) and improves the map exploration through haptic devices without however supporting Web 2D maps or providing any additional spatial data and/or POIs.

Also, Scalable Vector Graphics (SVG) maps have also been proposed for the navigation and partially support of the visually impaired. Scalable Vector Graphics maps contain sound effects as also description tags and are based on SVG, which is a modularized language for describing two-dimensional vector and mixed vector/raster graphics in XML.

The goal of the implemented *HapticRIAMaps* application is primarily to real-time support the efficient haptic exploration of conventional 2D maps found on the web (retrieves real-time maps from the online OpenStreetMap web service[3]). As the user explores the maps data interactively under the guidance of interactions and forces displayed by a haptic device, in combination with other User Interaction mechanisms (sonification, etc.), we believe that user can understand better the road environment of a place (building, roads, crossroads, POIs) that he/she would like to visit.

## 2. HAPTIC EXPLORATION OF ONLINE WEB MAPS
The *HapticRiaMaps* has the ability to provide an online 2D map exploration through synchronous haptic devices, multimodal interactions and typical Web browsers. The supported haptic interaction allows the system users to perceive the structure of the road environment (including POIs, crossroads, road names, etc.) based on the usage of typical web browsers and favorable Web map applications (e.g. OpenStreetMap).

When a person with visual functional limitations uses the *HapticRiaMaps application*, it is analogous to a sighted person looking at a tactile map in their home. Therefore, the system essentially gives blind people access to online maps. The user

1 http://www.sensable.com/haptic-phantom-omni.htm

2 http://www haptimap.org

3 http://www.openstreetmap.org/


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can 'explore' the map using haptic devices functionalities, cursor keys, and the system will describe the road, junctions, and directions through different modalities. Additionally, the map has information points which give useful details about the environment - e.g. house numbers, names of shops, locations of crossing points and bus stops, and the surface-type of the pavement. This is very important because it gives to the visually impaired the opportunity to navigate and interact through the internet maps in a way that makes navigation really accessible.

The user is able to search for a specific address or provide the exact longitude/latitude of the desired map area through the OpenStreetMap functionality (Figure 1).


**Figure 1. Map area selection**

A haptic-aural representation of the map is then created from an exported area of OpenStreetMap. All raw data of the specific area (nodes, ways, relations, road names and tags) are returned in XML format. A 2D map is created according to the returned road structure, during the 2D visual rendering step and finally, a pseudo-3D map is generated and haptic rendering of the pseudo-3D map is enabled. Figure 2 presents the step of the map analysis, which contains a pseudo- 3D map model construction. The 3D representation of the map is generated as a grooved line map [6].

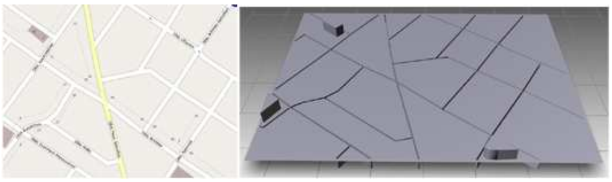

**Figure 2. Pseudo-3D map automatic creation**

The visually impaired user explores the 3D map using a haptic device (e.g. Sensable Phantom, Novint Falcon, etc.), as depicted in Figure 3.

In addition to displaying the map data to the user through visual and haptic channels, our work makes use of a number of information visualization and multimodal techniques, for instance, the audio messages (sonifications) which inform the user about cursor's current position on the map. Thus, some of following sounds are being supported: (a) A high pitch sound for informing the user that the distance from next crossroad is <= 25m, (b) A medium pitch sound for informing that 25m < distance from next crossroad <= 50m, (c) A low pitch sound for 50m < distance from next crossroad, (d) A unique sound when user is at a crossroad and (e) A unique sound if there is no visible crossroad in user's moving direction.

Design choices in *HapticRiaMaps* were made in order to test the following hypotheses: **I.** Since the map environment is not static, and because sometimes a user may need to zoom in/out to explore a portion of map, a zoom in/out function is supported by the proposed framework that allows a user to zoom in/out and navigate to the portion of map. **II.** Haptic representations of certain kinds of data (e.g. POIs, Informs the user if there is no visible crossroad in current moving direction, etc.) can reduce visual overload. Furthermore, augmenting visual representations with haptics and sonifications improves the exploration need of visually impaired people. **III.** Haptics can be used to help guide and/or confine exploration to areas where interesting areas exist. This improves the learning and knowledge capability of system users (e.g. the current distance (in meters) from each POI, the position of each POI relatively with user's current position, North, south, west, east, north-west, north-east, south-west, south-east). **IV.** Haptic representations provide significant improvement upon purely visual representations in enabling users to notice and remember relationships between different kinds of data variables.

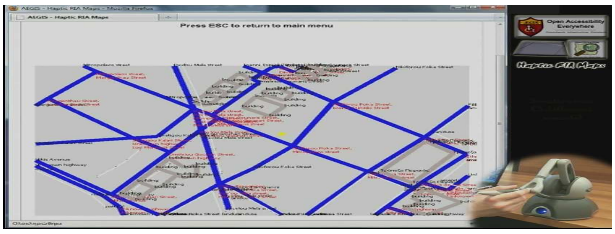

**Figure 3. Map Haptic Exploration**

An initial evaluation has been performed with the participation of ten visually impaired users. During system's evaluation, the participants were asked to perform 2D maps exploration for route planning purposes and to explore unknown environments. All of their useful comments have been taken into consideration while a next evaluation phase will be performed within the next two months.

## 3. FUTURE WORK

Ongoing work is currently being done in several components in the system, including the extension of the system to cope directly with Google 2D maps as requested by our users. A number of interesting questions are still to be addressed in the application such as the support of routing guidance between two locations and in the optimization of the adopted TTS technologies (incorporate a better and clearer TTS mechanism).

## 4. ACKNOWLEDGMENTS

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