Touching OpenStreetMap Data in Mobile Context for the Visually Impaired

Nikolaos Kaklanis[1,2]
[1]Information Technologies Institute, Centre for Research and Technology Hellas,
6th Km. Charilaou - Thermi Road, P.O. BOX 60361 GR - 570 01, Thessaloniki, Greece
[2]Department of Computing, University of Surrey, Guildford, United Kingdom
nkak@iti.gr

Konstantinos Votis
Information Technologies Institute, Centre for Research and Technology Hellas,
6th Km. Charilaou - Thermi Road, P.O. BOX 60361 GR - 570 01, Thessaloniki, Greece
kvotis@iti.gr

Dimitrios Tzovaras
Information Technologies Institute, Centre for Research and Technology Hellas,
6th Km. Charilaou - Thermi Road, P.O. BOX 60361 GR - 570 01, Thessaloniki, Greece
Dimitrios.Tzovaras@iti.gr

Abstract
In this paper, the "Mobile Open Touch/Sound Maps", an application that enables access to OpenStreetMap data for the visually impaired and blind users using a common mobile device (e.g. smart phone, tablet) that runs on Android, is presented. During map exploration, as user moves his/her finger on the touchscreen of the mobile device, he/she receives vibration feedback when finger is on a road or a point of interest (POI), while a sonification and a TTS module, provide audio feedback regarding the distance to the next crossroad and the name of current road/POI, respectively.

CHI 2013 Mobile Accessibility Workshop, April 28, 2013, Paris, France.

Author Keywords
Multimodal map; map exploration; accessibility; visually impaired user; haptic interaction; sonification

ACM Classification Keywords
H.5.2. [Information Interfaces and Presentation]: User Interfaces – Haptic I/O.

Introduction
The growing use of smartphones and tablet computers, which have great capabilities, like access to the internet, integrated GPS, high definition displays and high quality touchscreens, enables access to various information anyplace anytime. By accessing web mapping applications like the OpenStreetMap through such a mobile device, a sighted user can virtually explore a map area before actually go to the specific location or by using GPS in conjunction with a suitable application, user can explore the map area around his/her current location. However, users with severe visual impairments often meet great obstacles in accessing such information, as the interaction with this

kind of applications is performed mainly through the visual channel.

The present paper introduces a multilingual application (currently, English and Greek language is supported) that enables access to OpenStreetMap data for the visually impaired and blind users using a common mobile device running on Android. User can virtually explore a map area by simply moving his/her finger over the touchscreen. When user's finger is on a road/POI, vibration feedback is provided, while a sonification and a TTS module, provide audio feedback regarding the distance to the next crossroad and the name of current road/POI, respectively.

Related Work

The use of modalities other than visual for providing navigational information through mobile devices to both sighted and visually impaired users has been researched over the last years. Poppinga et al. [5] showed that vibration and speech feedback can be used, in order to make a digital map on a touch screen device more accessible. Pielot et al. [4] presented the PocketNavigator, a map-based pedestrian navigation system that uses tactile feedback to guide the user along a route. The key feature of the PocketNavigator is the Tactile Compass that provides continuous directional information, such as a compass, through vibration patterns, and that these patterns can be realised with the vibration motors of common mobile phones. Preliminary results from a field study showed that pedestrian can effectively use this Tactile Compass to reach a destination without turn-by-turn instructions. Haptic GeoWand [3], a system that provides user with location, orientation and distance information using vibration patterns through a smartphone with inbuilt GPS receiver, digital compass and an accelerometer, found to help users orient themselves in the direction of the destination and improve their spatial abilities.

A hardware/software module, which can be plugged into current PDAs to assist blind users in orientation during museum visits, was also presented in [1]. This module exploits two vibrotactile actuators and speech output, for moving along a path of RFID-tagged objects. Giudice et al. [2] presented a system that allows users to freely explore graphical information on the touchscreen of a commercially available tablet by using synchronously triggering vibration patterns and auditory information whenever an on-screen visual element is touched. Experiments conducted during this survey showed that the proposed vibro-audio interface is a viable multimodal solution for providing access to dynamic visual information and supporting accurate spatial learning and the development of mental representations of graphical material.

The present paper goes one step beyond the state of the art of the multimodal map interaction, as instead of supporting the exploration of predefined map areas, it enables the exploration of any map area around the world by using only a common mobile device running on Android and not any further special equipment. The proposed application provides vibration, sonification and speech feedback that help visually impaired and blind users virtually explore a map area by simply moving their finger over the touchscreen.

Mobile Open Touch/Sound Maps

The proposed application, which is called *Mobile Open*

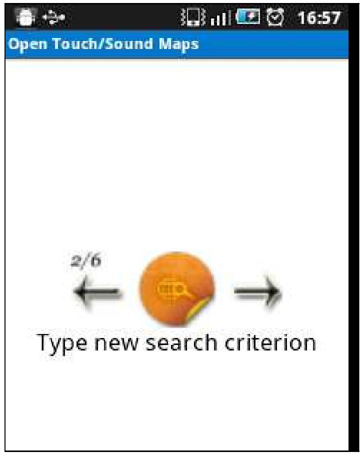

Figure 2: Mobile Open Touch/Sound Maps – Menu

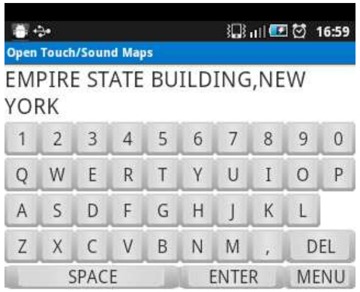

Figure 3: Typing a search criterion. As user moves his/her finger over the letters, the TTS informs him/her about the value of each letter and the letter is typed when "finger-up" event is triggered.

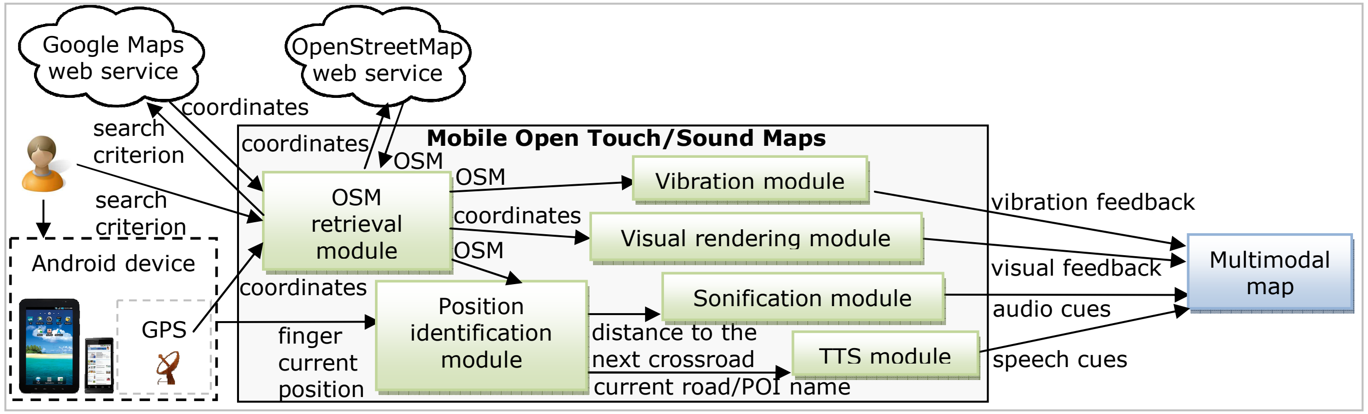

Figure 1: Mobile Open Touch/Sound Maps - Architecture

Touch/Sound Maps, enables the retrieval and the haptic exploration of any map area around the world for the visually impaired and blind users. The only prerequisite is that the specific area has to be supported by the OpenStreetMap, as the publicly available OpenStreetMap web service is used, in order to retrieve map information.

As depicted in Figure 1, user is able to provide the system with a search criterion that will be used for the map area retrieval. This search criterion is passed to the Google Maps[1] web service, which then returns the corresponding coordinates (this process is called geocoding) and these coordinates are passed to the *OSM retrieval module*. The Google Maps web service has been selected to be used for the search functionality, because it found to return much more accurate results compared with the corresponding OpenStreetMap search mechanism. User can also use the GPS, in order to get the coordinates of his/her current location.

The *OSM retrieval module* passes these coordinates to the OpenStreetMap web service, which then returns an OSM[2] file describing the desired map area in a XML format. After the OSM file that corresponds to the desired map area has been retrieved, the *OSM retrieval module* passes it to the *vibration module*. The *vibration module* uses the information stored in the OSM regarding nodes position, POIs and ways included in the map area, and provides vibration signals during map exploration, when user's finger is on a road/POI. Moreover, the corresponding coordinates are passed from the *OSM retrieval module* to the *visual rendering module*, which is responsible for the visual

---

1 https://developers.google.com/maps/documentation/geocoding/

2 http://wiki.openstreetmap.org/wiki/OSM_XML

Figure 4: Map exploration using a smart phone. The four buttons in the upper right corner help user move west, east, north or south.

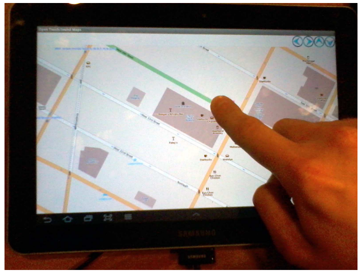

Figure 5: Map exploration using a tablet

representation of the map. The visual rendering module is based on the Mapdroid[3] open-source library.

While user is exploring the map (Figure4, Figure 5), the *position identification module* continuously performs the mapping between the position of user's finger on the touchscreen and the corresponding position on the map. It then identifies the name of current road/POI and also calculates the distance from current position to the next crossroad (taking into account the length of every road segment and also user's moving direction, which is identified by the application using user's different positions within a time frame). When user's finger is moving on a road, the *sonification module* provides 3D audio cues that help user identify the distance between current position and the next crossroad as well as crossroad's position. The sonification mechanism is based on the OpenAL[4] library. As cursor's distance from the next crossroad is changing, the pitch of a single frequency sound is also changing accordingly (as distance becomes smaller, sound frequency becomes higher). When cursor is on a crossroad, a unique sound (a music chord) is heard. Concurrently, the *TTS module* pronounces the name of current road/POI, as it is defined in the OSM file. The user interface of the application is fully accessible for blind users. More specifically, user can navigate through options by simply sliding his/her finger to the right or left (Figure 2), while the TTS informs user about current option at the same time. An option can be selected by single clicking on it. The virtual keyboard used for typing a search criterion (Figure 3) is also accessible.

---

[3] http://tedp.id.au/mapdroid/

[4] http://connect.creativelabs.com/openal/default.aspx

Conclusions and future work

In the present paper, the "Mobile Open Touch/Sound Maps", a tool that enables the haptic exploration of OpenStreetMap data for the visually impaired and blind users using mobile devices, was presented. The proposed tool enhances the accessibility of common maps by adding vibration, sonification and speech feedback. Possible further extensions may include the access to data coming from more web mapping frameworks and/or the use of various vibration patterns providing user with different positional cues.

Acknowledgements

This work is partially funded by the EU projects VERITAS (FP7-247765) and AEGIS (FP7-224348).

References

[1] Ghiani, G., Leporini, B., & Paternò, F. Vibrotactile feedback as an orientation aid for blind users of mobile guides. *In Proc. MobileHCI 2008*, 431–434.

[2] Giudice, N.A., Palani, H.P., Brenner, E., Kramer, K.M. Learning non-visual graphical information using a touch-based vibro-audio interface. *In Proc. ASSETS 2012,* ACM, 103-110.

[3] Jacob, R., Mooney, P., Winstanley, A. What's up that Street? Exploring Streets Using a Haptic GeoWand, Advances in Location-Based Services, Lecture Notes in Geoinformation and Cartography, Springer (2012), 91-105.

[4] Pielot, M., Poppinga, B., and Boll, S. PocketNavigator: Vibro-Tactile Waypoint Navigation for Everyday Mobile Devices. *In Proc. MobileHCI*, ACM (2010), 423–426.

[5] Poppinga, B., Magnusson, C., Pielot, M., and Rassmus-Gröhn, K. TouchOver map: audio-tactile exploration of interactive maps. *In Proc. MobileHCI 2011*, 545–550.