HAPTIC & TANGIBLE INTERACTION FOR TACTILE EXPLORATION OF 3D MAPS WITHOUT VISION

Keywords

Tactile & haptic interaction, user-centered design, visual impairments, prototyping, evaluations, Spatial cognition.

Context

Wayfinding is a major issue for people with visual impairments (PVIs). In addition to tools such as long canes or dogs to assist mobility, PVIs need assistance to be oriented and find their way to a destination. They can rely on tactile maps for preparing the journey, and they can rely on a personal mobility device (GPS) during the journey to be guided. However, none of these tools is sufficient to provide total independence. In addition, tactile maps are missing because their production rely on craft handed techniques mastered by professionals (mainly Orientation and Mobility Instructors as well as Tactile Document Makers). Finally, recent observations show that interactive tactile maps can be of major interest to provide independence.

The ANR ActivMap (2020-2023) focuses on the issues of orientation and mobility of people with visual impairments. Today, thanks to the availability of open and collaborative data, combined with different means to produce maps augmented with adapted interactions (Fig.1), it is possible to consider the development of adapted and usable multimodal interactive maps in a semi-automatic way.

Several approaches will be explored in ACTIVmap to adapt the automatic map design process to the specific needs of users with various visual impairments and their potential contexts of use, including different representations of space: raised-lines maps and diagrams, additive printing, verbal descriptions, etc. These artefacts will be augmented with multimodal interactions (tangible, haptic or sound) in prototypes, which usability will be evaluated by users in different contexts.

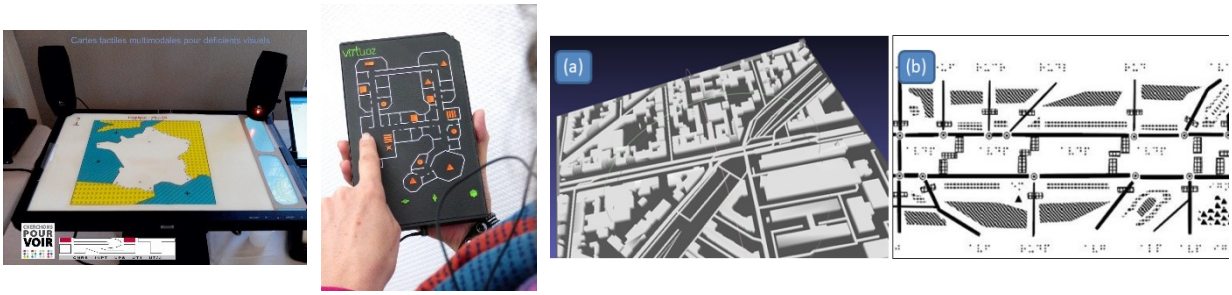

Figure 1. Prototype of interactive tactile map designed by “Cherchons pour Voir”(1); Virtuoz device designed for enhancing spatial awareness during indoor mobility (FeelObject) (2);. The surroundings of IGN from touch-mapper.org (3-a) and same area manually generalized, stylized to be better readable for VIPs (Touya et al. 2018)(3-b).

Objectives

The PhD project aims at investigating multimodal eyes-free interaction with tactile maps. We will address two scenarios of usage: 1/ general spatial learning and preparation of a pedestrian journey (i.e. before departing), and 2/ orientation, guidance and spatial description during a pedestrian journey. These scenarios can occur, for instance, during Orientation & Mobility lessons where: 1/ a teacher and a PVI prepare a journey before departing; 2/ the PVI is experiencing the journey with a mobile device. Different prototypes as well as consequences on spatial cognition will be evaluated in different contexts.

The main objectives of the thesis project are:

- The user-centered design and prototyping of a multimodal interactive device adapted to non-visual spatial learning. Previous work in the field [Bro+15, Bru+18] showed that this scenario relies on a large tabletop device (A3 size) adapted to display large topographical maps but also more specific maps related to mobility. In that task, the main challenges consist in designing haptic and tangible interaction techniques allowing to explore complex and heterogeneous spatial maps corresponding to different contexts of use (general spatial learning, overview of a journey, exploration of selected crossings, etc.) In addition, we will also consider the fusion of event-related data dynamically extracted from open databases (e.g. Wikipedia, Wikidata, OpenEventDatabase) providing names and description of paths, crossroads and buildings, opening times, on-going events, etc.
- The user-centered design and prototyping of an interactive mobile device providing two different types of information according to the progression of the mobility. The first type of information is a general and simple map representing the whole journey including important orientation cues (e.g. starting and ending point, and presence of a complex crossroad on the path). The second type of information is a map of, for instance, a selected complex crossroad including a functional schematic description of the crossroad as well as mobility and orientation cues to manage that crossroad. This device will rely on the GPS position to provide the user with the “You Are Here” position as well as contextual cues (selection of the overlay to apply on the device, and then verbal description of the complex crossroad, etc.)
- User evaluations including usability of the devices (HCI and cognitive ergonomics research field) and assessment of spatial learning (cognitive sciences research field) following exploration of maps before the journey and during the journey.

Student profile

Master or Engineer diploma in Cognitive sciences, Computer Science (HCI), Design, Psychology, Ergonomics.

This internship is granted by the ANR ActivMap project.

Timing

3 years starting from September or October 2020

Location

IRIT - Cherchons pour Voir lab, in Toulouse, France, with regular travels to the LIMOS, Clermont-Ferrand, France.

Contact

Please send :

- CV
- Letter of motivation
- Transcripts from L1-M2 (or prepa, 1st-3rd year)
- The report of a previous internship
- One or two references eventually

To :

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References

[Bro+14] A. M. Brock et al. "Interactivity improves usability of geographic maps for visually impaired people". In: *Human–Computer Interaction* 30.2 (2014), pp. 156–194.

[Bru+18] Emeline Brulé et al. "An Exploratory Study of the Uses of a Multisensory Map with Visually Impaired Children". In: Multimodal Technologies and Interaction 2.3 (June 2018), p. 36. issn: 2414-4088.

[Gir+17a] S. Giraud, A. M. Brock, et al. "Map Learning with a 3D Printed Interactive Small-Scale Model: Improvement of Space and Text Memorization in Visually Impaired Students". In: *Frontiers in psychology* 8 (2017), p. 930.

[Gir+17b] S. Giraud, P. Truillet, et al. ""DIY" Prototyping of Teaching Materials for Visually Impaired Children: Usage and Satisfaction of Professionals". In: *Int. Conf. on Universal Access in Human-Computer Interaction*. Springer. 2017, pp. 515–524.

[KJ97] Robert M Kitchin and R D Jacobson. "Techniques to collect and analyze the cognitive map knowledge of persons with visual impairment or blindness: Issues of validity". In: *Journal of Visual Impairment Blindness* 91.4 (1997), pp. 360–376.

[Ory+18] Ory, J., Christophe, S., Fabrikant, S., and Bucher, B. (2018). Modèle de conception cartographique intégrant l'expérience utilisateur. In CIST 2018, Représenter les territoires / Representing territories, 22-23 Mars 2018.

[Ory+15] Ory, J., S. Christophe, S.I. Fabrikant and B. Bucher. (2015) How do map readers recognize a topographic mapping style?, The Cartographic Journal. 52(2):193-203, May 2015. DOI:10.1080/00087041.2015.1119459.

[T+18] G. Touya, S. Christophe, et al. "Automatic derivation of on-demand tactile maps for visually impaired people: first experiments and research agenda". In: *International Journal of Cartography* (2018).