

Cognitive model of interaction without vision for tactile exploration of 3D maps

Keywords

Spatial cognition, interaction, user-centered design, visual impairments, tactile & haptic devices.

Context

[ANR ActivMap](#) (2020-2023) focuses on the issue of orientation and mobility of people with visual impairments (PVI), which has a real impact on their independence and quality of life. The appropriation of urban space is an essential element to improve their autonomy, because outdoor travel is a major issue. Synthetic and adapted representation with tactile maps and diagrams with adapted interactions is essential for greater autonomy. However, their design based on a traditional approach, craft handed by professionals, mainly Orientation and Mobility Instructors and Tactile Document Makers, in insufficient numbers to cover real needs.

Today, thanks to the availability of open and collaborative data, combined with the diversification of means to produce physical artefacts augmented with adapted interactions (Fig.1), it is possible to consider the development of a set of specialized methods and tools to design multimodal interactive maps in a semi-automatic way. This research project is based on an interdisciplinary approach between human computer interaction, cognitive sciences, geographic information sciences, computer sciences, and professionals in the field of visual impairments.

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, 3d printing, verbal descriptions, etc. These supports will be augmented with multimodal interactions (haptic or sound) in interactive prototypes, which usability will be evaluated by users such as instructors and PVIs in different use contexts.

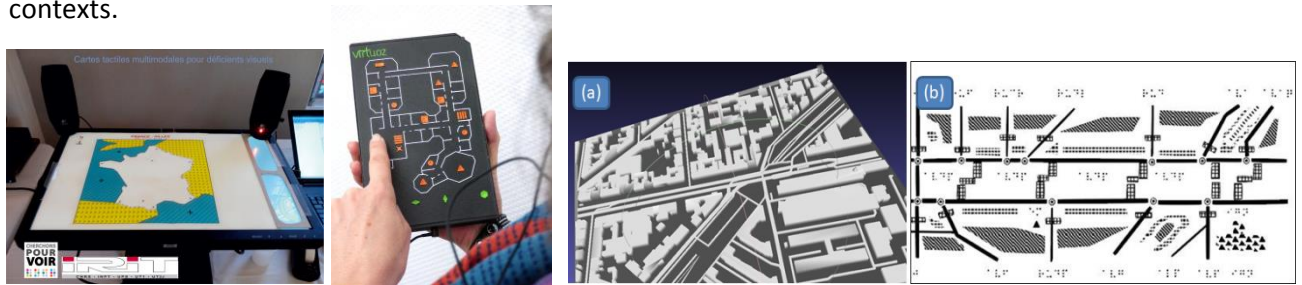


Figure 1. Prototype of interactive tactile map designed by “Cherchons pour Voir”(1); Virtuoz designed for enhancing spatial awareness during indoor mobility (FeelObject) (2);. The surroundings of IGN from touch-mapper.org (3-a) and same area manually generalized, stylized to be better readable for VIPs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

Objectives

The PhD thesis aims at investigating the ways how the spatial knowledge could be transferred for PVI's needs, from the map to the real-world and vice-versa, in order to provide them useful 3D maps augmented with interactions, for their mobility: the expected fitness for use of the semi-automatically produced 3D maps is related to the way the users mentally represent the urban spaces they move into, and the way they interpret and understand the graphic and tactile representation of these urban spaces. PVI's should also be given abilities to independently select and explore maps adapted to their intended task, related to the use cases of the project, for instance general spatial learning or mobility preparation with the help of Orientation and Mobility Instructors, but also to their own perceptual and cognitive abilities [Gir+17a].

Based on the user needs analysis, on previous evaluations of the interactive devices, and on graphic and tactile semiology, the student will focus on the design of a conceptual cognitive model of non-visual interaction with 3D urban maps: this model would be approached as an interface between the mental representation of urban spaces and the concrete representation of this urban space into a 3D map augmented with interaction, in order to drive the automatic 3D map design process.

This objective implies to describe and implement the link between a mental and a tactile representation of urban spaces, at any scales, made by various PVI to perform orientation and mobility tasks. This could rely on the identification and characterization of specific map design processes (generalization, stylization) of the following entities, in order to produce the related main proxies into the 3D maps, which could be augmented by specific interactive modalities:

- possible meaningful and salient real entities and spatial arrangements of the urban spaces: the width, structure and texture of pavements, or the shapes, directions and structure of a crossroad, etc;
- possible main proxies in the real world that could support orientation and distance perception, such as specific noises, wind perception, or urban ambiances;

The cognitive model will be experimented with possible interactions with the tabletop and mobile devices, in order to serve 3D maps in various use contexts, based on the regular feedbacks and recommendations of the users of the projects, i.e. PVIs and orientation and mobility instructors. This research work will rely on experimental methods issued from cognitive psychology [KJ97, Gir+17a], HCI [Bro+15] and Geographic Information Sciences [Ory+15;18] research fields.

Student profile

M2 Cognitive sciences, psychology studies or Geographic Information Sciences.

This internship is granted by the [ANR ActivMap project](#).

Timing

Starting from September 2020.

Location

The PhD thesis will be held at the [IGN - LaSTIG](#) in the [GEOVIS](#) team (73 avenue de Paris 94160 Saint-Mandé, France), with regular travels to the IRIT, [Cherchons pour Voir lab](#), in Toulouse, France.

Contacts

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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.
- [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).