PhD proposal IMT Atlantique and IPAL Singapore

Can GPS guidance lead to cognitive mapping?

Keywords

Spatial Cognition, Spatial Learning, Human Computer Interaction, Gaming, User-Centered Design, Evaluations.

Context

Studies have shown the negative effect of GPS navigation on spatial skills. The lack of spatial reasoning training leads to a decrease of spatial grid cells, and people losing the abilities to perform mental manipulations within cognitive maps (Ruginski et al. 2019).

One pragmatic evidence comes from the amount of persons claiming they could not come back to a place they have already visited without using the GPS guidance anew, and obviously do not manage positioning by themselves relative to environmental landmarks.

Building efficient cognitive maps requires to link together landmarks (*e.g.* Siegel & White, 1975) and spatial frames of reference (*e.g.* Shelton & Mc Namara 2001). More precisely route knowledge, as ego-centered sequences (*i.e.* first person view features of the environment) need to be mentally assembled to build map knowledge, as allo-centered representation (*i.e.* birds eye view). Then these cognitive maps are powerful enough to support spatial orientation.

Previous research, especially in the partner teams have shown that including spatial navigation information in a scene makes it more easily memorable (*e.g.* Mukawa *et al.* 2017), and can help people with special needs (*e.g.* Katz et al 2012). In addition, virtual navigation can train people to coordinate spatial frames of reference (*e.g.* Simonnet *et al.* 2009).

General Objective of the PhD project

Since artificial intelligence is able to make us reach places as quick as possible taking into account environmental constraints, it should be possible to use it to teach us how to build an environmental map. Referring to previous knowledge, such a system should present spatial information in a way that leads us to encode landmarks and perform mental rotation within the environment. Here the challenge is to keep using the GPS, as an efficient personal guidance system, and also learn environment at the same time.

Aim of the PhD project

- ❖ design a personal guidance system that includes spatial information including cues related to both landmarks, routes and surveys;
- ❖ which leads users to play a game to estimate ego- and allo-centric localisations of landmarks. Hence, users can memorize the current environmental layout during navigation but also, at home, when the journey is over.
- ❖ such an app may also record all the episodic memories during the journeys and serve as a tool to revisit previous experiences.

- evaluate the impact of such personal guidance device on spatial learning and skills

Methods and tools

The work will rely on scientific theories about spatial cognition and learning but on gamification and user experience knowledge too, in order to keep users involved. In other words, how to wayfind and learn at the same time?

Student profile

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

The PhD is granted by IMT and Astar funding schemes that are reserved to excellent student only (among the top ten students in the class).

Timing

3 years starting from September or October 2020

Location

Stays to be defined between :

- IMT, Brest
- IPAL, Singapore

Contact and application

Please send :

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

To :

- Mathieu Simonnet, IMT Atlantique: mathieu.simonnet@imt-atlantique.fr
- Christophe Jouffrais, IPAL: christophe.jouffrais@ipal.cnrs.fr
- Joo Hwee LIM: joohwee@i2r.a-star.edu.sg

References

Katz, B.F.G., Kammoun, S., Parseihian, G., Gutierrez, O., Brilhault, A., Auvray, M., Truillet, P., Denis, M., Thorpe, S. **Jouffrais, C.** NAVIG: Augmented reality guidance system for the visually impaired: Combining object localization, GNSS, and spatial audio. Virtual Reality, Vol. 16 N. 3, p. 17, 2012.

Mukawa, M., Tan, C., **Lim, J. H.**, Xu, Q., & Li, L. (2017). The effect of different types of navigation assistance on indoor scene memorability. Behaviour and Information Technology, 36(9), 897–912.

Ruginski, I. T., Creem-Regehr, S. H., Stefanucci, J. K., & Cashdan, E. (2019). GPS-use negatively affects environmental learning through spatial transformation abilities. Journal of Environmental Psychology, (64), 12–20.

Shelton, A. L., & McNamara, T. P. (2001). Systems of Spatial Reference in Human Memory. Cognitive Psychology, 43(4), 274–310.

Simonnet, M., Jacobson, D., Vieilledent, S., & Tisseau, J. (2009). SeaTouch: a haptic and auditory maritime environment for non visual cognitive mapping of blind sailors. In K. S. Hornsby (Ed.), COSIT 2009, LNCS 5756 (pp. 212–226). Aber Wrac'h, France: Springer-Verlag.