NAV-VIR

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NAV-VIR : an audio-tactile Virtual Environment to assist Visually Impaired People (VIP)

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Context :

Visual Impairment

VIP: 26 350 000
Blind: 2 550 000

- **Most prevalent** sensory deficiency
- Huge impact on the **quality of life**
- Likely to **double** in the next **25 years**

High difficulty with **autonomous navigation** and going into **unknown areas**

Lack of electronic solutions to **get comprehensive information** on an area's **spatial layout** before visiting it

Acknowledgment :

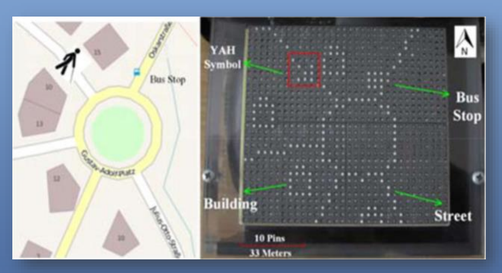
This work was the result of a **French-Polish collaboration**, funded under the **PHC (Polonium)** framework

Current solutions :

Thermoformed maps

- Static (fixed area)
- No info on current position on the map
- No active guidance

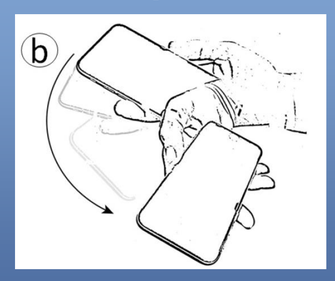
Dynamic pin displays :



Example of tactile map, taken from [1]

- Binary type of display
- Symbol-based
- No active guidance

Audio exploration devices :



VirtualWalk gesture, taken from [2]

- Audio only
- Difficulty to perceive distances correctly
- No active guidance

Our approach :

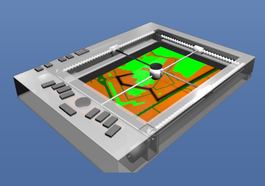
NAV-VIR

Dynamic multimodal Virtual Environment (VE) for **intuitive spatial representation**

Simulated 3D audio soundscape [3]

- Simulated audio environment
- Local and ambient audio cues
- On-demand localization cues (street name, …)

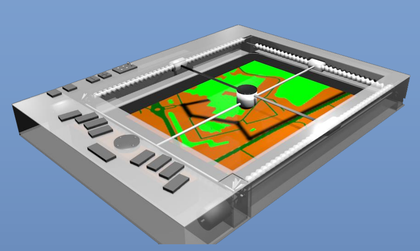
Force-feedback tactile interface (F2T) [4]



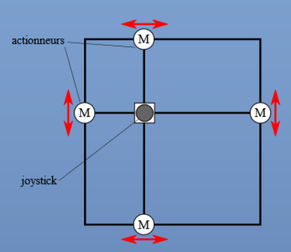
- Simplified haptic representation (*gist*) of the area's topology [5]
- Active guidance or passive exploration
- Points of Interest

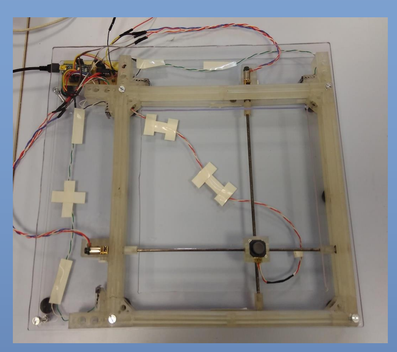
Implementation : NAV-VIR architecture and functionalities

Tactile interface :



F2T Model





F2T 2nd prototype

- Provides information by modulating the resistance to the user's movement

2 modes :

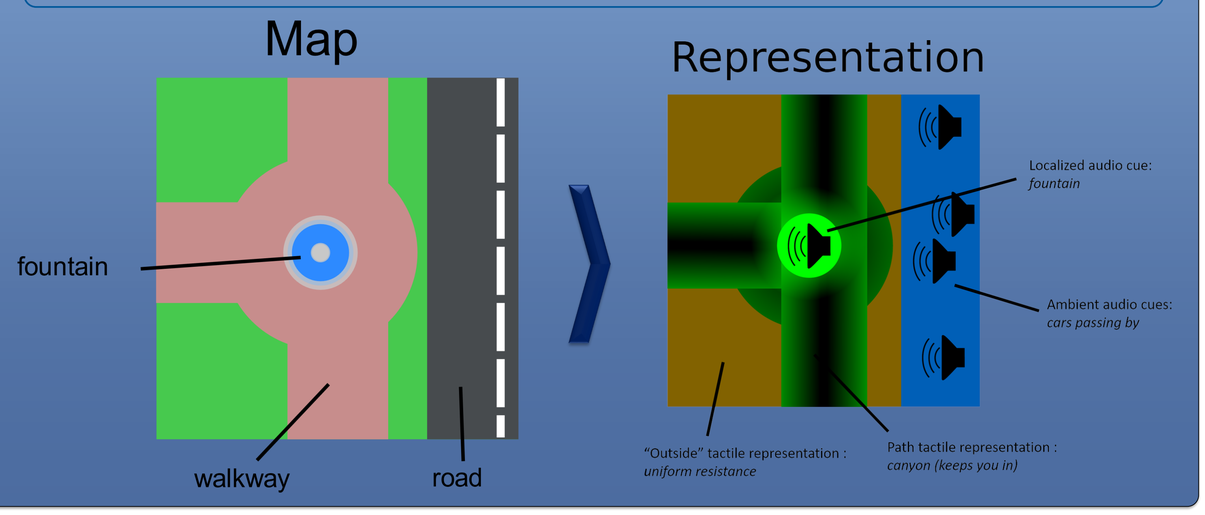
- **Active** : joystick guides users' finger (e.g. along a path, around an object)
- **Passive**: resist or facilitate users' movements

- Benefit from hand's sensory-motor loops → better spatial integration

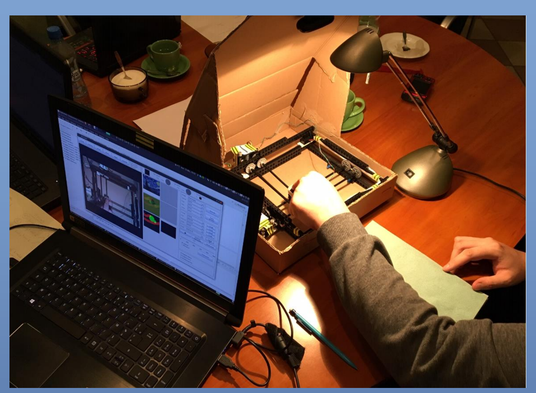
Audio environment :

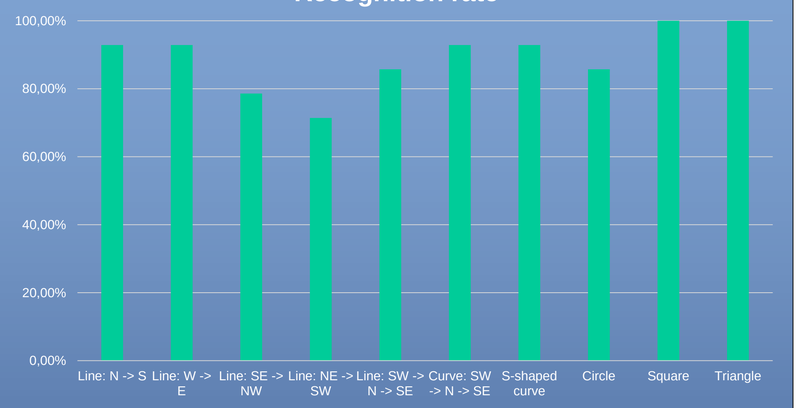
A combined approach to synthesis :

- Binaural recordings of sounds from real environments
- Spatially filtered simulated sound events using resonance audio (Google VR Audio)



Evaluation :





Simple shape recognition :

- N = 14 (8 women, 6 men)
- 7 congenitally blind, 3 late blind, 4 blindfolded

Results :

- Movements : μ = 85,7%; σ = 9%
- Shapes: μ = 94,6%; σ = 6,8%

Discussion :

- We presented a **dynamic audio-tactile VE** for journey preparation, which allows VIP to discover unknown areas beforehand.
- Thanks to NAV-VIR, VIP will be able to train their spatial cognition and **rehabilitate their wayfinding and orientation skills**.
- Further evaluations in more ecological settings are required.

References :

[1] Zeng, L., & Weber, G. (2016). Exploration of Location-Aware You-Are-Here Maps on a Pin-Matrix Display. *IEEE Transactions on Human-Machine Systems, 46*(1), 88–100.

[2] Guerreiro, J., Ahmetovic, D., Kitani, K. M., & Asakawa, C. (2017). Virtual Navigation for Blind People: Building Sequential Representations of the Real-World. In *Proceedings of the 19th International ACM SIGACCESS Conference on Computers and Accessibility - ASSETS '17* (pp. 280–289). Baltimore, Maryland, USA: ACM Press.

[3] Bujacz, M., & Strumiłło, P. (2016). Sonification: Review of Auditory Display Solutions in Electronic Travel Aids for the Blind. *Archives of Acoustics, 41*(3), 1–11.

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[5] Pissaloux, E., Velazquez, R. (2017). Model of cognitive mobility for visually impaired and its experimental validation. In E. Pissaloux, & R. Velazquez (Eds.), *Mobility in Visually Impaired People*. New-York, NY: Springer