Exploring Maps with Touch: an Inclusive Haptic Device (F2T)

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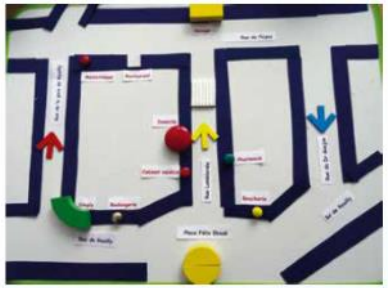
Introduction: 2D data & VIP

- In our digital society, most information is visual.
- Visually Impaired People (VIP) can only access this information through specific supports (relief pictures, maps with magnets, thermoformed surfaces, …)
- However, those solutions are :
  - Expensive (usually),
  - Static (display a fixed portion or scale of the information),
  - Require experts to be created.



Haptic representation of information

- Requires an interface able to display dynamic haptic information based on the exploration intentions of the user (e.g. finger or eye movements).
- Various existing technologies : Taxel matrices, electro-tactile surfaces, wearable vibrators…

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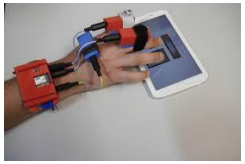

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- However, most are not actively used by VIP due to:
  - Difficulty to recognize and differentiate textures and edges / objects
  - Difficulty to convey complex / real-world data
  - Lack of system assistance to find specific objects / locations

The F2T : an inclusive haptic device

- Novel interface to explore graphical content interactively: Force Feedback Tablet, F2T

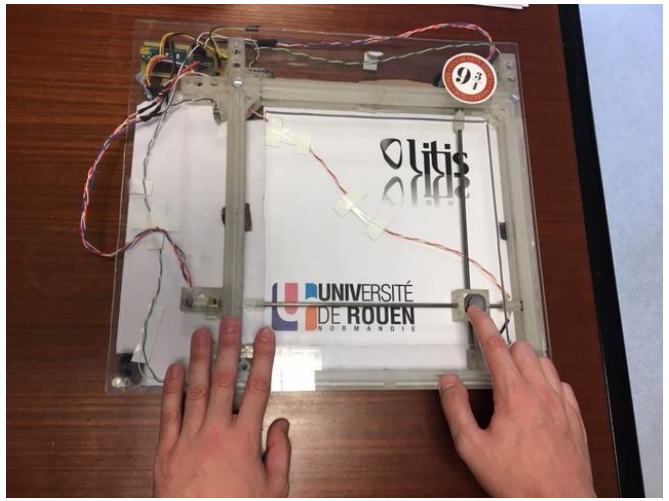
- Haptic effects are generated based on the underlying content of the image.
- Haptic effects assisting the interpretation of graphical primitives such as edges or textures.
- Can adapt the haptic effects to the specific task the device is used for.

Principles of F2T work

- VIP can explore and feel graphical content by moving a small mobile platform (a flat thumbstick) supported by motorized axes over a virtual image.

- Different effects are applied to the mobile platform to modify its speed or direction, simulating friction, bumps, currents, …

- Two working modes :
  - Free exploration (passive feedback)
  - Guided (assisted) exploration



Experimental evaluation

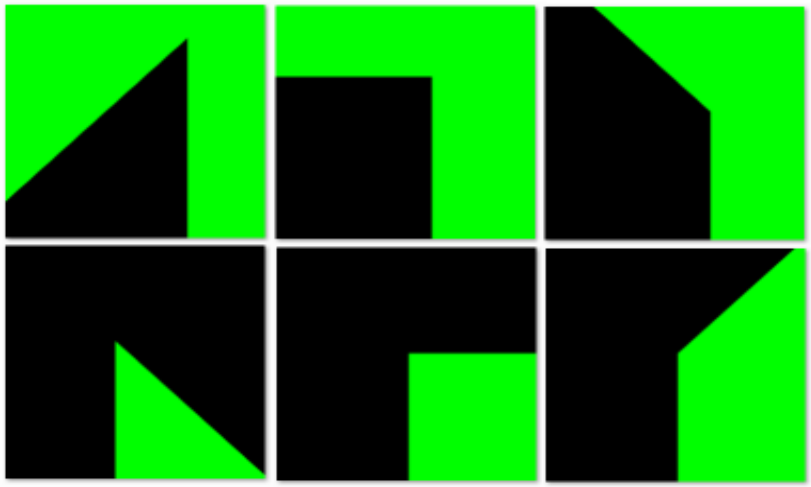
- **High-level goals**:
  - Exploration of map data with haptic stimulations
  - Assist the emergence of a mental representation of a simple indoor map

- **Protocols**:
  - Exp 1 : Identifying the angle between two walls.
  - Exp 2 : Recognizing the layout of a room.

- **Participants**: 12 blindfolded sighted persons

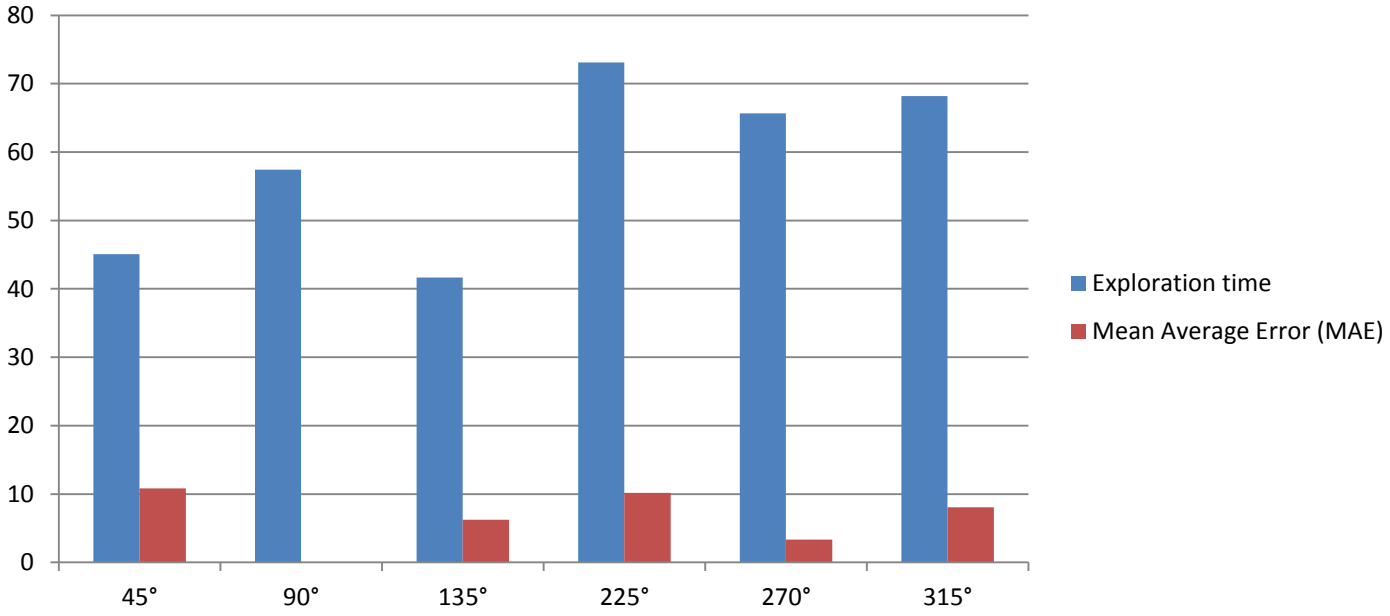
Experiment 1:
Angle perception

- 45°, 90°, 135°, 225°, 270°, and 315° « haptic » angles.
- Randomized order and no preliminary information on the angles.
- **Participants**:12 blindfolded sighted participants.
- **Task**: identify the angle.
- Participants could freely explore the image.



Green areas represent virtual walls,
they can’t be crossed.

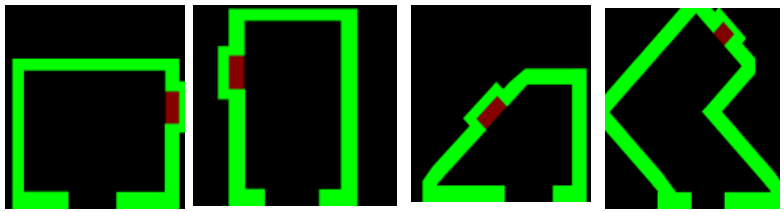
Experiment 1:
results



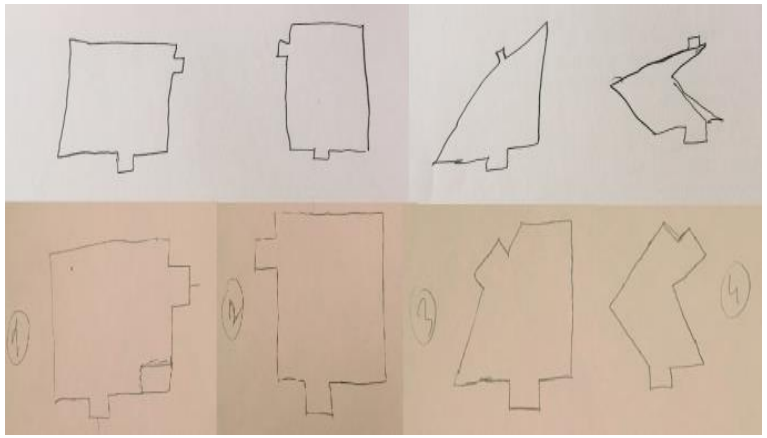
- The average exploration time was 58.5 seconds with a standard deviation of 12.8 seconds.
- Right angles (90° and 270°) were the most easily recognized ones, with a MAE of 0° and 3.33° respectively.
- The highest MAE (of 9.5°) was observed for 45° and 315° angles, while the MAE is around 8.2° for 135° and 225° angles.

Experiment 2:
Layout perception

- Four basic room layouts :
  - An entrance facing the user
  - An exit identified with a specific friction effect
- Participants divided into 2 groups:
  - Free exploration only
  - Guided exploration of the walls & exit, followed by free exploration.
- **Task**: drawing the layout
- Same participants as the previous experiment.

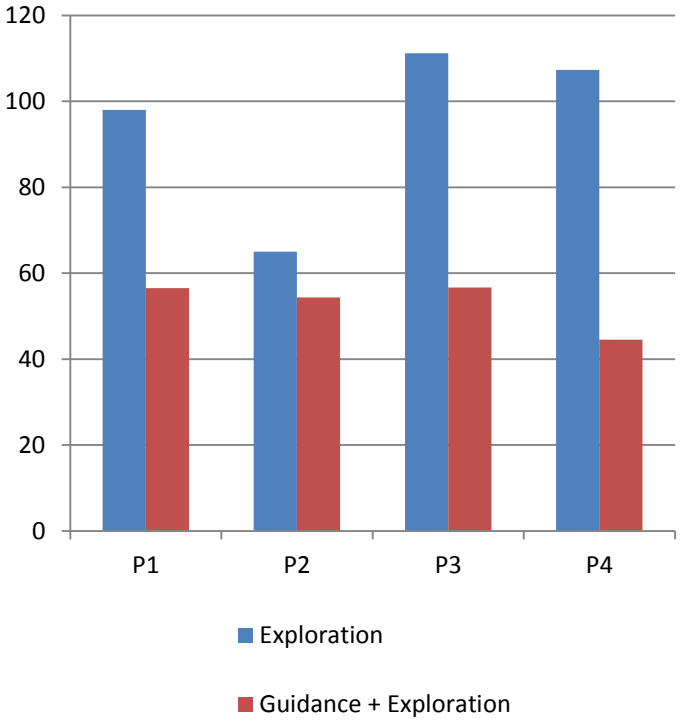


P1 P2 P3 P4



Experiment 2:
results

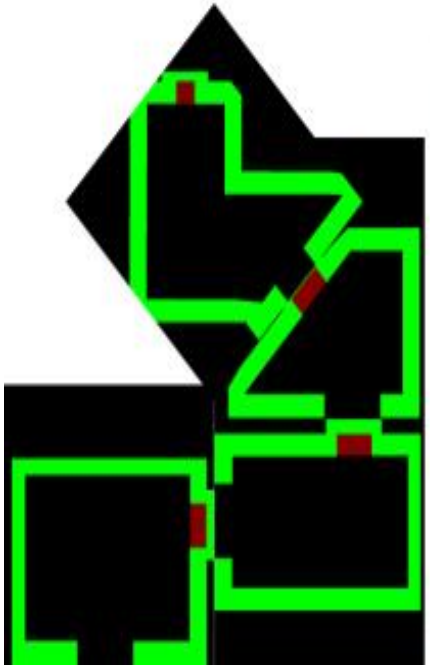
- The average free exploration time :
  - Non-guided condition : μ = 95.4s
  - Guided condition : μ = 53s

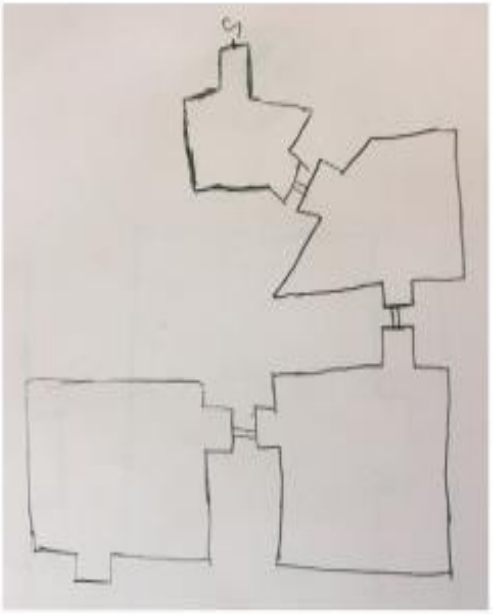


Users can use the guided exploration to mentally represent the structure of the layout, thus reducing the free exploration time required to correctly draw the layout.

Mental representation

- **Task**: draw the whole apartment by linking the four interconnected rooms previously explored.
  - *Requires to mentally rotate some of the rooms to connect the exit to the next entrance*





Conclusion

- Presenting a new haptic device to explore 2D graphical data through a combination of active and passive haptic feedback: the F2T
- It allows VIP to intuitively explore and interpret images by representing scene elements and mobility points of interest (e.g. stairs, elevators, etc.) with specific haptic effects.
- Simple experiments were designed to test the emergence of spatial awareness in blindfolded participants while exploring simplified layouts with the F2T.
- The results are encouraging but will need to be confirmed with more robust protocols and visually impaired participants.
- The contribution of sychronised ad hoc audio information for improved scene recognition should be studied.

Thank you for your attention

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