ETH zürich

Institute of Cartography and Geoinformation

Cartographic Visualization for Indoor Semantic Wayfinding

Master Thesis, Spring Semester 2018
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1 Introduction

Main aim of the current thesis was to investigate the feasibility of the Indoor Landmark Navigation Model (ILNM) (Fellner et al., 2017), a method for generating landmark-based routing instructions, by combining it with indoor route maps and conducting a wayfinding experiment with human participants. In this context, three different cartographic visualization scenarios were designed and evaluated.

2 Concept implementation

The core of the concept implementation was the design, implementation and execution of a wayfinding experiment with human participants. Below, in figure 1, the overview of this process is presented, while in figure 2, the two design approaches selected for visualizing the extracted landmarks are illustrated.

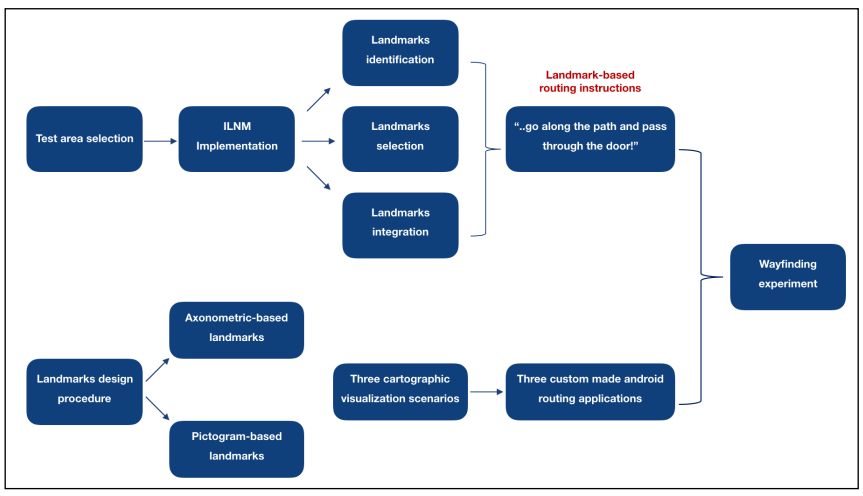

Figure 1. Overview of concept implementation procedure

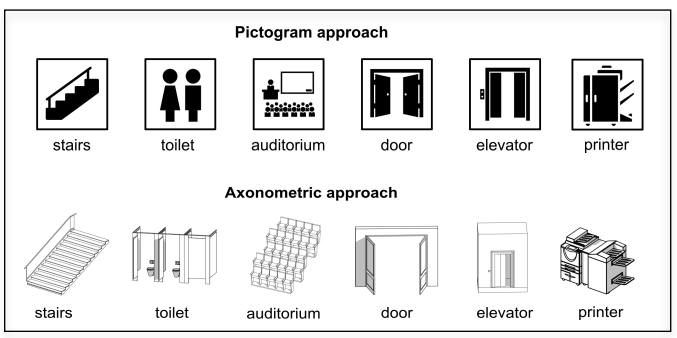

Figure 2. Landmarks visualized based on two design approaches

The outcome of the concept implementation process was the development of three custom-made android routing applications (based on Google maps) (Figure 3). Two of these applications were based on the ILNM implementation, while the third one was based on the benchmark approach for indoor navigation assistance (metric-based routing information).

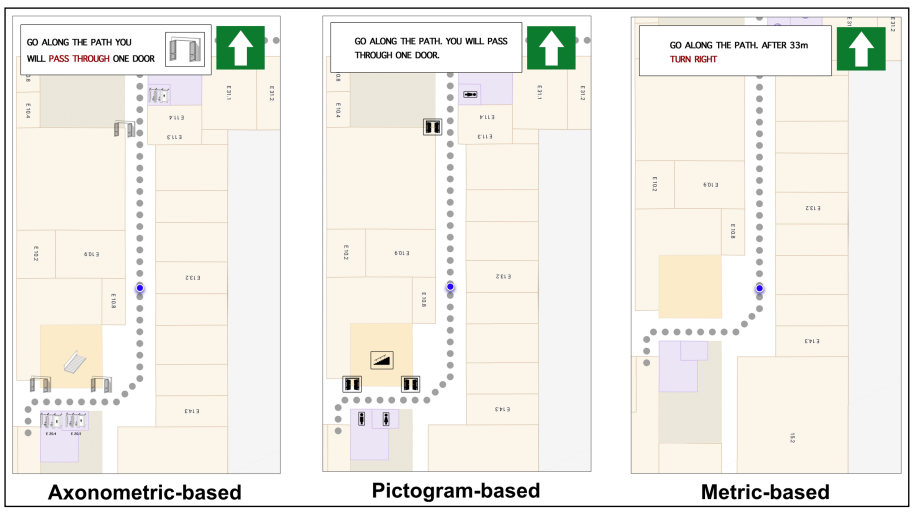

Figure 3. Three custom-made android routing

3 Experiment

In a wayfinding experiment with 30 participants (10 for every scenario), the two landmark-based approaches were evaluated and compared to the benchmark approach for indoor navigation assistance (metric-based routing information). Participants' task was to navigate along the same route within the HIL Building at ETH Hönggerberg Campus. After they had arrived to their destination, the experimenter asked participants to fill in some questionnaires for the assessment of their user experience, their perceived cognitive workload as well as their landmarks visualization preferences.

4 Results

Navigation Performance

	Completion Time	Number of Errors
Mann-Whitney U (**Pictogram vs Axonometric**)	41.50	47.00
p-value	0.520	0.765
Mann-Whitney U (**Axonometric vs Metric**)	47.00	27.00
p-value	0.820	0.055
Mann-Whitney U (**Metric vs Pictogram**)	34.00	20.50
p-value	0.369	**0.028**

Table 1. Mann-Whitney U Test results between all pairs of conditions

	Pictogram		Axonometric		Metric	
	Time of Completion	Number of errors	Time of Completion	Number of errors	Time of Completion	Number of errors
Mann-Whitney U	8.50	9.00	5.00	8.50	0.000	4.000
Z	-0.457	-0.423	-1.257	-0.655	-2.558	-1.783
p-value	0.648	0.673	0.209	0.513	**0.011**	0.075

Table 2. Mann-Whitney U Test results between experienced and non-experienced in navigating within HIL Building, participants.

User experience

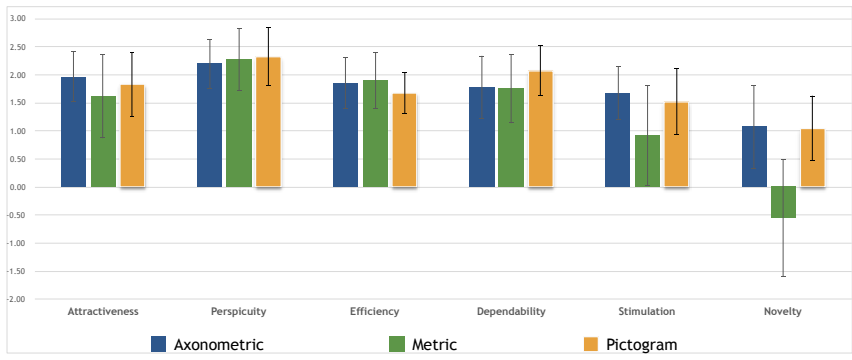

Table 3. User Experience results for each UX category and condition. The black error bars indicate the confidence level

Cognitive workload

	Mental Demand	Physical Demand	Temporal Demand	Performance	Effort	Frustration	Total Workload
Mann-Whitney U (**Pictogram vs Axonometric**)	48.00	38.5	36.00	49.50	46.00	41.5	43.50
p-value	0.875	0.344	0.269	0.965	0.753	0.461	0.621
Mann-Whitney U (**Pictogram vs Metric**)	28.50	31.00	46.00	41.50	47.50	40.50	41.00
p-value	0.083	0.112	0.749	0.476	0.844	0.413	0.490
Mann-Whitney U (**Axonometric vs Metric**)	25.00	43.00	39.50	43.00	49.50	47.00	47.00
p-value	**0.045**	0.547	0.401	0.558	0.967	0.804	0.815

Table 4. Mann-Whitney U Test results, between all pairs of conditions (Pictogram vs Axonometric, Pictogram vs Metric, Axonometric vs Metric)

5 Conclusions

- Landmark-based approaches are more efficient in terms of navigation performance, compared to the benchmark approach
- Statistically significant differences among the three approaches observed in the UX category of **'Novelty'**
- Statistically significant differences observed only in the **'Mental demand'** cognitive workload category (Axonometric vs Metric)
- Pictogram design approach was the most popular choice for landmarks visualization

6 References

Fellner, I., Huang, H. and Gartner, G., 2017. "Turn Left after the WC, and Use the Lift to Go to the 2nd Floor"—Generation of Landmark-Based Route Instructions for Indoor Navigation. *ISPRS International Journal of Geo-Information*, *6*(6), p.183.