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# Supporting Spatial Learning with the Indoor Sign InteGrated Navigation System

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**Abstract:**

Wayfinding can be challenging in indoor environments, especially in large-scale public buildings such as museums, universities, hospitals, shopping malls, and transportation hubs, due to the segregated nature of indoor spaces (Richter, 2017). To offload cognition and ease indoor wayfinding, external representations of the environment, such as existing navigational aids (signs and floor plans), are designed and placed in almost all public buildings (Arthur & Passini, 1992). With technological development, public service sectors have also begun to offer indoor mobile navigation services. Currently, existing navigational aids and mobile navigation services operate independently.

Studies showed that conventional mobile navigation services negatively influenced spatial learning in short-term spatial knowledge acquisition (Brügger et al., 2019; Gardony et al., 2013; Ishikawa et al., 2008; Münzer et al., 2006; Parush et al., 2007; Ruginski et al., 2019), as well as long-term spatial ability (Dahmani & Bohbot, 2020; Ishikawa, 2019). Outdoors, researchers demonstrated that integrating landmarks in route instructions could support spatial learning (Gramann et al., 2017; Wunderlich & Gramann, 2018; Wunderlich & Gramann, 2021). Indoors, signs are semantic landmarks by their designed nature. Therefore, we hypothesised that integrating signs into indoor navigation systems could support spatial learning.

In this study, we propose a fully automated computational framework named ISIGNS (Indoor Sign InteGrated Navigation System), which integrates signs and their semantics into indoor navigation services. It starts by modeling signs and their semantics into an indoor navigation model. Then, routes considering sign semantics are generated and communicated to navigators as route instructions (Figure 1).

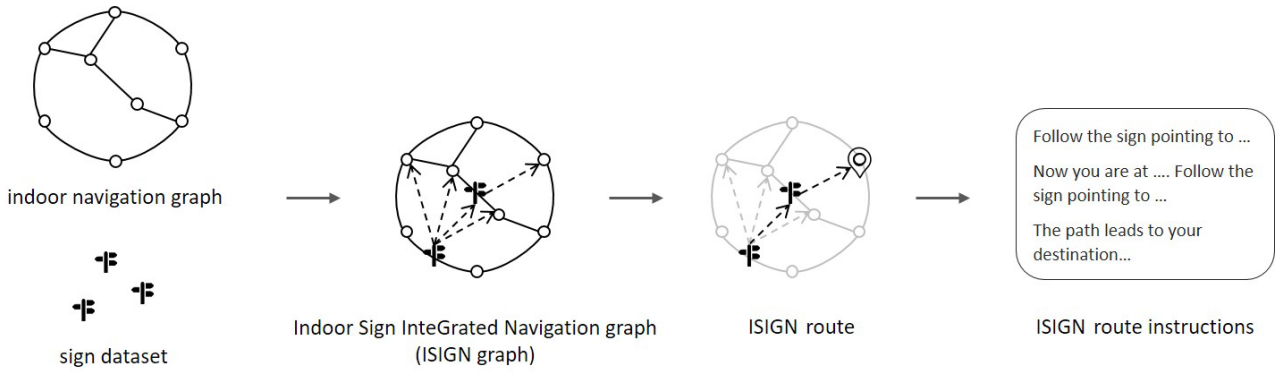


Figure 1. The overall workflow of constructing the ISIGNS.

An in-situ experiment with human participants was conducted, to evaluate the performance of the proposed ISIGNS in the real world, and test whether using ISIGNS prompts spatial learning. As a benchmark, we compared ISIGNS with the conventional navigation system using metric-based turn-by-turn instructions.


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The results revealed a tendency for faster speed and fewer stops using ISIGNS, but the difference was not significant. As expected, assessments for spatial knowledge acquisition, either recognition or recall, concurred to indicate enhanced spatial learning. Regarding user experience, participants felt more confident with and favoured ISIGNS, but not to a significant extent.

Overall, the proposed Indoor Sign InteGrated Navigation System encourages attention allocation to the environment and leverages the semantic nature of signs, leading to improved spatial knowledge acquisition.

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