Constraints for different locomotion types and their role in subspacing of indoor environments for indoor navigation

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ABSTRACT

Most frameworks for indoor navigation focus on one single type of locomotion, i.e. either walking, driving, or flying. This decision often is crucial with respect to the way indoor environments are represented, and these representations typically cannot be used for other types of locomotion. For example, a graph-based abstraction of indoor spaces for pedestrian navigation is not suitable or sufficient for e.g. autonomously driving robots or flying UAVs.

In our paper we address the problem of supporting different types of locomotion in indoor navigation by the examination of the requirements of the three types of locomotion walking, driving, and flying. The definition and formalization of these requirements lead to the determination of individual constraints for each locomotion type. These constraints are essential in the determination of navigable or non-navigable indoor space cells for the specific locomotion type, leading effectively to different 3D subspacings of indoor space. An example use case illustrates the concepts and is used to compare the requirements with related data models for indoor navigation as proposed by other groups.

We further show how the different subspacings can be embedded in the formerly presented framework of the Multi-Layered Space-Event Model (MLSEM) as proposed by Becker, Nagel, and Kolbe in 2008 and 2009. The MLSEM provides a comprehensive and mathematically sound framework for the integration of the 3D representation of the building geometry and topology and the graph based abstractions incl. their 3D embeddings. Above, it is shown in the paper how the subspacing algorithm makes use of spatial and semantic information included in a 3D building model which may be provided by CityGML or IFC in order to derive the corresponding navigable subspaces.

KEYWORDS: locomotion types, navigation requirements, navigation constraints, subspacing, Multi-Layered Space-Event Model (MLSEM)