BIM-Based Model for the Automatic Generation of Construction Sequences

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Abstract. With the rapid increase in complexity in the building industry, project managers are facing more and more complex decision environments and problems. Therefore, it would be beneficial to aid project managers in making sound decisions regarding the intelligent knowledgeable selection of the optimal construction methodology while making use of Building Information Modelling (BIM). BIM models' usage fused with modelling, and simulation tools allow efficiently prototyping a building and examining its construction activities before breaking the ground. For this purpose, an intelligent framework with advanced computational tools and algorithms is designed and created to achieve a higher degree of design-construction integration and spatial integration of individual building elements in order to achieve an optimized sequencing of building elements (in terms of time and cost).

This paper presents a model that extracts building elements, along with their topological relationships and geometrical properties, from an existing fully designed Building Information Model (BIM Model) to be mapped into a directed acyclic Elemental Graph Data Model (EGDM). Using graph search algorithms, Depth First Search (DFS) and topological sortings, possible construction sequences are generated. The model incorporates BIM-based search algorithms for automatic deduction of geometrical data and topological relationships for each building element type. It is implemented in a C# platform and verified with the aid of test cases.

Keywords: Building Information Modelling (BIM), Elemental Graph Data Model (EGDM), Geometric and topological data models, Graph theory, Depth-first Search, and Topological Sorting.

1. Introduction

Over the past 100 years, the building industry has changed dramatically. Buildings have become much more complex with many interconnected and integrated systems. Project managers are faced with complex decision environments and problems in the construction of the majority of the projects. For project managers to take sound decisions, they just rely on human value and judgment systems which contribute to the project problems as well. Accordingly, it is worthy to aid project managers to wisely select the optimal construction methodology. Consequently, professionals in the A/E/C industry began searching for better ways to model facilities/buildings and coordinate all this information together between all the involved parties throughout the project's life cycle (Krygiel, et al., 2008). These efforts were harmonized with research in the field of computer-supported building design, and, consequently, led to the continuous advancement in the development of building data models.

1.1 Building Data Model

Building data model describes the physical characteristics of building elements by means of their three-dimensional (3D) geometry and topology. Geometric data represents the building element's dimensions and location, whereas topological information represents spatial relationships among the building elements comprising connection, adjacency, containment, separation, and intersection (Nguyen, et al., 2005). Project participants/stakeholders consider topological information essential to perform various analyses during design and construction. For such complex tasks to be performed with the aid of building data models, advanced ways of extracting and presenting geometric and topological information should be adopted.