Facilitating automatic requirement checking for digital building models

The building industry is a requirement-oriented domain. Every building project should comply with a set of requirements including various standards, design regulations and client-specific requirements. Traditionally, design documents of building projects are manually assessed against these requirements in order to find out issues, which need to be fixed in later stages. As building projects in modern times become increasingly complex, this process can hardly provide required precision and timeliness. Researcher Chi Zhang has implemented software prototypes that are capable to automatically check digital building models against a wide range of requirements.

Automatic requirement checking for digital building models is a domain that has been long investigated. The current dominant approach for realizing an automatic requirement checking system is to hardcode checking logics within programming codes. With such a method, however, developed systems are difficult to be extended and are costly to be maintained when requirements change. As a result, existing requirement checking systems all provide one-of-a-kind solutions, which are expensive to be afforded and cannot fulfil the requirements of increasing use cases in this industry. Therefore, there is a pressing need in research and industry communities for an automatic requirement checking system that can support a wide range of use cases.

In the ideal case, the relationship between requirements and a requirement checking system should be similar with that between CDs and a CD-player: CD collections are not hardwired in the CD player, and they can be reused, changed and extended without changes of the player. My research has explored two methods to approach this goal and has provided in-depth evaluation for both of them. In both methods, I designed requirement checking systems and implemented software prototypes.

The second method I studied, which is based on Semantic Web technologies, shows to be the most promising. It provides a more modular and extensible environment regarding further development. The developed software prototype can check against a wide range of requirements. It can be used to automatically check whether building models miss related information in regards of downstream work. Besides that, it can be used to check geometry related features such as clash detection between building elements or check fire separation distance of external façades according to building codes. More importantly, the system can be easily extended to support use cases which need to check building models along with datasets from other domains. For example, it can integrate sensor data and building models to monitor building performance for facility management.

To evaluate the developed prototype system, I performed diverse case studies. The case studies prove that my system is scalable and can support a wide range of use cases. With proper optimization for the performance, it can be used in practice and many applications can be developed based on it.

Title of PhD-thesis: Requirement Checking in the Building Industry: Enabling Modularized and Extensible Requirement Checking Systems Based on Semantic Web Technologies

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