Abstract

Construction projects must comply with various regulations. The manual process of checking the compliance with regulations is costly, time consuming, and error prone. With the advancement in computing technology, there have been many research efforts in automating the compliance checking process, and many software development efforts led by industry bodies/associations, software companies, and/or government organizations to develop automated compliance checking (ACC) systems. However, two main gaps in the existing ACC efforts are: (1) manual effort is needed for extracting requirements from regulatory documents and encoding these requirements in a computer-processable rule format; and (2) there is a lack of a semantic representation for supporting automated compliance reasoning that is non-proprietary, non-hidden, and user-understandable and testable.

To address these gaps, this thesis proposes a new ACC method that: (1) utilizes semantic natural language processing (NLP) techniques to automatically extract regulatory information from building codes and design information from building information models (BIMs); and (2) utilizes a semantic logic-based representation to represent and reason about the extracted regulatory information and design information for compliance checking. The proposed method is composed of four main models/algorithms that are combined in one computational framework: (1) semantic, rule-based algorithms that leverage NLP techniques to automatically extract regulatory information from building codes and represent the extracted information into semantic tuples, (2) semantic, rule-based algorithms that leverage NLP techniques to automatically transform the extracted regulatory information into logic rules to prepare for automated reasoning, (3) semantic, rule-based information extraction and information transformation algorithms to automatically extract design information from BIMs and transform the extracted information into logic facts to prepare for automated reasoning, and (4) a logic-based information representation and compliance reasoning schema to represent regulatory and design information for enabling the automated compliance reasoning process. To test the proposed method, a building information model test case was developed based on the Duplex Apartment Project from buildingSMARTalliance of the National Institute of Building Sciences. The test case was checked for compliance with a randomly selected chapter, Chapter 19, of the International Building Code 2009. Comparing to a manually developed gold standard, 87.6% precision and 98.7% recall in noncompliance detection were achieved, on the testing data.