3차원 교량모델에서의 상태평가정보 가시화를 위한 요구사항 분석

Requirement analysis for visualization of condition assessment in 3D Bridge Model

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Abstract

This paper proposed an approach to integrate bridge condition assessment related information with a 3D bridge model to visualize bridge condition assessment information in the 3D bridge model. In this approach, bridge information model plays a centric role in the data access and realizes the integration of bridge initial design and historical bridge maintenance records. Behind the bridge information model is a rational database. After the system requirements for this approach, several IFC data model extensions are suggested.

Keywords: IFC data model, condition assessment, bridge structure, visualization

1. Introduction

Bridge condition assessment is essential for bridge maintenance management of aging bridges. Technologies such as visual inspection, nondestructive testing (NDT), and structure health monitoring (SHM) can be adopted for condition assessment. Decision on bridge maintenance activities are mainly made based on various types of accumulated historical data, such as design drawings, inspection records, and sensing data. There are systems for storing and maintaining these data electronically in database. However, the data accessing mode of these systems is based on text input on web form, looking through massive volumes of paper-based initial design drawings and maintenance records is labor and time consuming and not intuitive enough for interpreting retrieved information. Meanwhile, bridge information modeling technique is recently emerged along with the rapid development of building information modeling (BIM) and Industry Foundation Classes (IFCs) data model. Bridge information modeling technique is the methodologies and processes for creating bridge information model, which is a data-rich and standard-based model in order to exchange and share information throughout of bridge life cycle phases (Lee and Jeong, 2006). Sturts and

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Griffis (Sturts and Griffis, 2005) claim that some civil engineering design practices have experienced a tenfold increase in productivity since the adoption of CAD, including 3D modeling. A survey (Khemlani, 2004) conducted among users of architectural 3D modeling software showed that, 63% of the 56 respondents reported productivity increases of at least 50% for migration from 2D CAD to 3D modeling in architectural practice.

Bridge information model can be applied to the whole bridge life cycle, i.e. planning, design, construction, and operation and maintenance. However, most of the research efforts about bridge information modeling have been focused on design phase, limited efforts have focused on construction simulation, and little effort has yet gone into bridge maintenance management. This paper proposed an approach to integrate and 3D visualize bridge condition assessment related information with initial design information through bridge information modeling technique. The system requirements for the proposed method are analyzed in the following contents. The main focuses of this paper are visual inspection data and condition ratings of bridges.

2. Proposed Method and its requirement analysis

In this paper, an approach to integrate bridge condition assessment related information with initial design information and to 3D visualize bridge condition assessment is proposed. In the method, bridge information model plays a centric role in the data access and integration of bridge initial design information with historical bridge maintenance records. There are reasons for proposing such an approach. Firstly, historical bridge inspection data and condition ratings for each component (element) can be stored and retrieved in a 3D environment. This makes the inspection data and condition ratings more intuitive for understanding and it helps the Professional Engineers (PEs) for managing the large amount of historical inspection and condition rating data. Secondly, the system can integrate design and construction information with inspection and condition rating information three-dimensionally. PEs need initial design information for making maintenance decisions. In current bridge management system, the bridge inventory includes only layout information, without detail design information. Consequently, maintenance managers need to look through the initial design (2D CAD files). This process is time-consuming and error prone. In the proposed approach, PEs can retrieve the initial design information immediately and correspondingly to any specific component. In this way, PEs can make better and quicker decisions. This feature is extremely important in emergency situation. Thirdly, the system provides automatic quantification function to bridge maintenance manager. Finally, as the condition assessment related information is captured in IFC data model, it can be exchanged and shared throughout of the entire bridge lifecycle.

The major requirements for such a system are: 1) hierarchical representation of bridge structure system and condition assessment related information as all the information is bridge component-based, 2) aggregation functions for aggregating bridge hierarchical condition data, and 3) IFC data model supports for the above hierarchical representation. The following section analysis these requirements in detail.

3. Hierarchical representation of bridge condition assessment in IFC

3.1 IFC extension for representing condition assessment information

Industry Foundation Classes (IFC) is an object oriented file format with a data model developed by buildingSMART to facilitate interoperability in the building industry (Liebich, 2004). There are IfcCondition and IfcConditionCriterion entities in IFC data model to representing condition related information. However, it is insufficient for bridge engineering domain. Additional entities and attriutes are added, as shown in the desh box of Figure 1. Entity IfcConditionEnvironmentFactor is added to representing the surrounds that affect the deterioration of bridge elements. Attributes ConditionWeight is added to Entity IfcCondition to capture the weights of bridge components in condition aggregation. Hotspot Attribute is also added to Entity IfcCondition for representing hotspot information; a hotspot is a place with extraordinary high environment loading and low material resistence or a place where already damage was observed. Type IfcConditionHotspotTypeENUM is also defined.

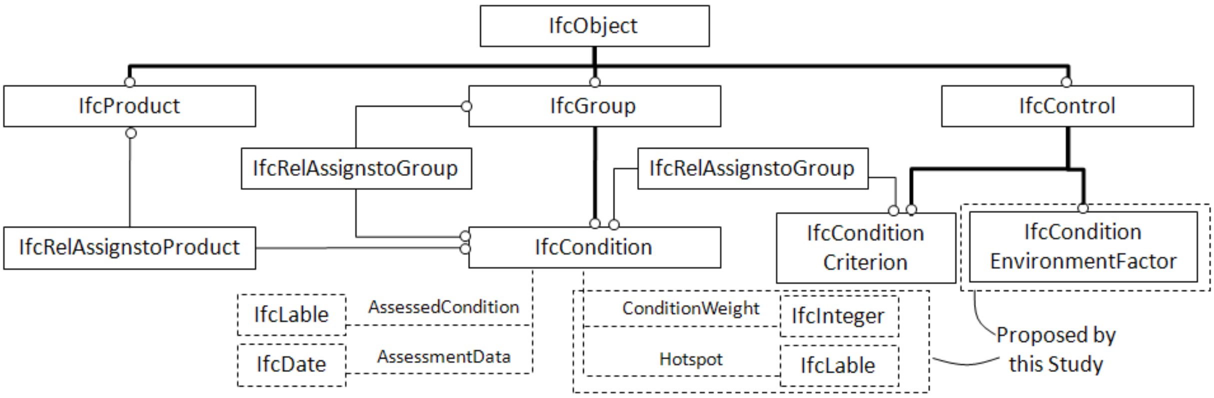

Figure 1 IFC data model extension for representing condition assessment information

3.2 Hierarchical representation of bridge structure and condition data in IFC

IFC-Bridge is an extension of IFC for bridge domain (Arthaud and Lebegue, 2007). Kim proposed an extended IFC-Bridge data model (Kim, 2009). By using the extended IFC-Bridge data model and the IFC extensions proposed in this paper, the hierarchical representation of bridge structure system and condition assessment information is shown in Figure 2, where “C” is corresponding to IfcCondition Entity and “CC” is corresponding to IfcConditionCriterion Entity in IFC data model.

4. Conlusions

This paper proposed an approach to integrate and 3D visualize bridge condition assessment related information with initial design information through bridge information modeling technique. The system requires for hierarchical representation of bridge structure system and condition data using IFC data model. For this purpose, exsiting data models are reviewed and several IFC data model extensions are proposed. Additional report documents of bridge inspection can also be integrated through IFC reference document functions. However, image data producted during bridge field inspection can not be captured

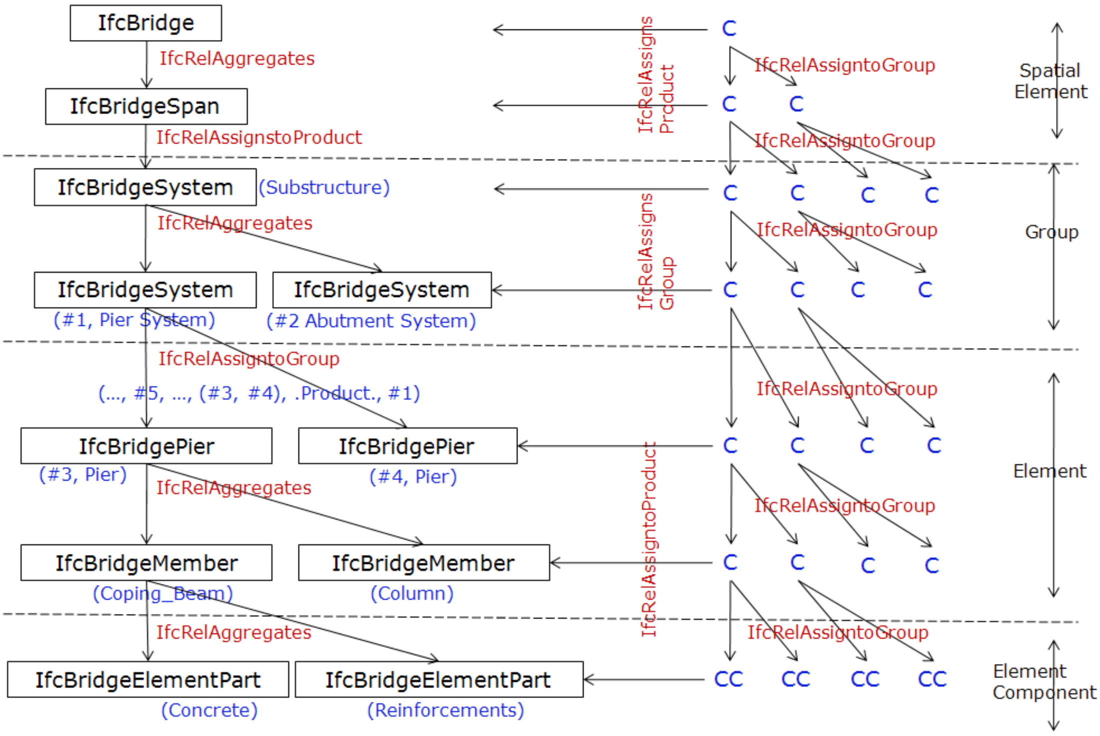

Figure 2 Hierarchical representation of bridge structure and condition data in IFC

and exchanged using IFC data model. To resolve this problem, image files will be stored and shared in the rational database directly. The next step of the research is to developing a pilot application system to verify the proposed method.

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