

氏 名 Andaroodi Elham

学位（専攻分野） 博士（情報学）

学 位 記 番 号 総研大甲第 954 号

学位授与の日付 平成 1 8 年 3 月 2 4 日

学位授与の要件 複合科学研究科 情報学専攻  
学位規則第 6 条第 1 項該当

学 位 論 文 題 目 Architectural Spatial Ontology Model  
On a Corpus of Silk Roads Caravanserais for Advanced  
Classification

|        |     |       |                 |
|--------|-----|-------|-----------------|
| 論文審査委員 | 主 査 | 助教授   | Frederic Andres |
|        |     | 教授    | 神門 典子           |
|        |     | 教授    | 武田 英明           |
|        |     | 助教授   | Nigel Collier   |
|        |     | 特任教授  | 小野 欽司（国立情報学研究所） |
|        |     | 非常勤講師 | 深見 奈緒子（東京大学）    |

## 論文内容の要旨

In this research the design and implementation of knowledge model for management of architectural heritage information attempts to conceptualize the content as well as specify and represent its technical knowledge. Furthermore, the model should cover specification of architectural assets, such as three-dimensional form and spatial organization. As part of Silk Roads study, the research focused on a special corpus of an important subset of architectural relics of Silk Roads, caravanserais. With the wide variety of types of caravanserais the target domain is the Iranian Safavid Qajar on route caravanserais.

This multidisciplinary research is conducted with the support of the architectural engineering background of the author. Its subject is an Architectural-Spatial Ontology Model for Caravansaries of Silk Roads on a corpus for advanced classification. The research processes are as follows:

1- Study of background knowledge on the corpus of caravanserais of the Silk Roads, state of arts of ontology definition, techniques and application; finally, spatial studies and systematic analysis of space in shape grammar in architecture, taxonomic numerical descriptive rules, systems of qualitative representation of space, etc.

2- Design of architectural spatial ontology schema through:

2-1- Design of a lexical model through data acquisition, component-recognition and a multilingual technical term-set for components of caravanserais.

The terminology is completed basically in Persian language as the country of origin of caravanserais. Later it is extended to English language and in a collaborative study (by UNESCO experts) to other important languages of the Silk Roads.

2-2- Design of a thesaurus-based model of lexical data by manual mapping from available ontologies and formalization by the Protégé tool.

This ontology knowledge model covers the lexical attributes of a term such as definition, etymology, quotation, pronunciation and synonym. Some lexical references such as Oxford English dictionary and the General Ontology for Linguistic Descriptions have supported the knowledge for design of the taxonomy and attributes of this lexical ontology.

2-3- Design of a spatial knowledge model by development of two complementary schemas: architectural schema with support of spatial relations and shape rule schema with support of shape grammar knowledge for the specific corpus and formalization of both schema inside the Protégé tool.

The architectural schema is consisting of taxonomy of architectural relationships such as spatial relationships, building construction, environmental and upper level relationships. Each class of the taxonomy has attributes to connect a pair of instances of lexical ontology together with the target relationship. The systems of qualitative representation of space has supported the knowledge for define of spatial relationships; meanwhile, the

domain knowledge of architecture and historical buildings has supported design of the schema.

Due to the ambiguity of architectural schema considering shape, topology and dimensions, the ontology is supported by define of shape grammar for a specific corpus of caravanserais. Accordingly the shape grammar rules are represented either by drawing or by natural language equivalents and the ontology schema for shape grammar is developed.

Finally the architecture of ontology for caravanserais is designed as pairs of entities connecting together by set of lexical, architectural or shape attributes. If the attribute does not have the topology or shape specification, the instances of entities are selected directly from lexical and architectural ontology. In case the attribute has shape or topological restrictions, then the shape grammar ontology schema and lexical schema are providing the instances or entities for a target attribute or relationship.

3- Evaluation and application of the system through tool based exploitation of the ontology, technical consistency checking, and advanced systematic classification of 137 cases of a specific corpus of caravanserais.

The domain application of ontology is advanced classification of the final corpus. The target of classification is for verification of the conceptual design of caravanserais buildings and accordingly the development of an historical hypothesis of their creation. In this process the complete entity verification schema of ontology is exploited in two levels of precision: general classification of six categories of caravanserais and precise classification of subcategories for each class. The ontology has a tool-based application called Image Learning Ontology (under development by engineering team) for advanced semantic access to image data of caravanserais.

The background research of Elham Andaroodi's thesis is related to historical architectural assets information and knowledge management. Architectural relics provide a comprehensive visual or spatial knowledge through composition of components. of architectural assets reflects the main characteristics of a building.

With this specification architectural heritage can be conceptualized with an ontological approach to create a knowledge model. Such model needs to reflect spatial features to manage efficiently visual 3D information and related annotation.

Despite the large numbers of results from the research area related to multimedia documents management, little progress has been made in the personalization aspect of the distribution of shared data. Nowadays, users involved in communities typically arrange their multimedia collections in file systems which provide poor annotating mechanisms and hierarchical directory structures for organization and searching. There are many issues which make the collaborative management of large multimedia collections quite inefficient.

The PhD thesis solved the problem how to reach to a systematic and analytic recognition and advanced classification of a specific corpus of caravanserais by implementing advanced ”.

A knowledge model for a selected corpus of historical architecture. It points out how an innovative knowledge representation approach and technology for representation of spatial knowledge and how the knowledge in the domain, i.e. architectural science supports such ontology model?

related to the lacks of global approaches that consider the knowledge management from the acquisition to the dissemination. In fact, information systems do not enough take advantage of metadata until now, and great opportunities have been missing to improve their knowledge management tasks. Furthermore, this model aims at improving the knowledge representation in order to enhance the delivery of data between communities' members.

Elham Andaroodi's PhD thesis introduces an innovative model.