A STUDY OF THE CHARACTERISTICS OF TRADITIONAL ROW HOUSES' FACADE IN THE ALLEY IN KARAHORI, OSAKA, JAPAN APPLYING INDUCTIVE LOGIC PROGRAMMING

Yuna Tanaka[1], Shigeyuki Okazaki [1], Noritoshi Sugiura[1]

[1] *Mukogawa Women's University, Japan*

Keywords: alley, traditional row house, Inductive Logic Programing, 3-D model

Introduction

In this study, the characteristics of row house facades in the alley in Karahori, Osaka, Japan are analyzed using Inductive Logic Programming (ILP) [1], machine learning system that executes inductive reasoning. Traditional row houses, built during the Taisho period (1912 - 1926), populate this area (Fig. 1). The area is notable for its individual townscape of various "expression objects," such as plantings and furniture that are placed along the alleys and used in the everyday lives of the inhabitants. It has been reported that the 2-D configuration rules of the elements in the traditional building facades were described [2], but very few attempts have been made at finding rules of 3-D composition of them. In this study, we define the facade as a 3-D model to include the concept of depth and extract the 3-D composition rules of facade.

Methods

Fig. 1: View from the point of V

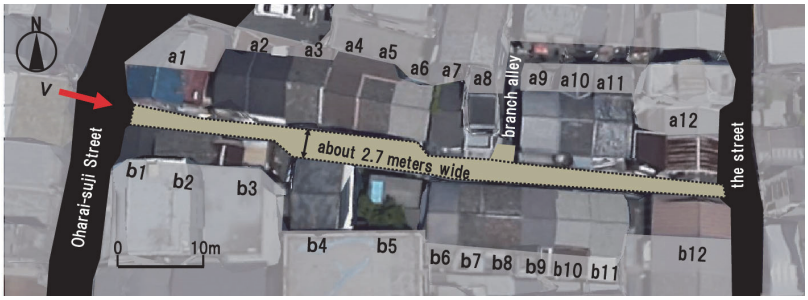

Fig. 2: Satellite image of the site in analysis Satellite image [3]

We focused on the alley that had the greatest number of expression objects, as determined during a field survey. This alley is connected to Oharai-suji Street, which contains many traditional row houses. We analyzed 24 of the houses facing this alley (Fig. 2) and the breakdown of 24 houses is as follows: 3 detached houses (a8, b4, and b5), one middle class apartment (b3), and 20 traditional row houses (a1 - a7, a9 - a12, b1, b2, and b6 - b12).

Our analysis consisted of the following steps: [STEP1] We created elevations of the houses and extracted the building and expression elements that constitute their facades (Fig. 3). We further defined two types of relations: relations on the vertical plane and relations in the depth direction (Fig. 4). [STEP2] Using this data, we assembled 3-D models with computer-aided design (CAD) (Vectorworks 2010). [STEP3] The 3-D models' data were converted into Prolog descriptions (Figs. 5 and 6) by an extension program for Vectorworks that we designed to recognize the relations between elements. [STEP4] These descriptions were input to Progol (ALEPH ver.5) [4], an ILP system, to induct the rules that express

peculiar characteristics of the facade. Input data to Progol consists of positive examples, negative examples, and background knowledge. Each element is regarded as an example to be used for inductive reasoning. Each element type and relation between elements is inputted as background knowledge, constituting an “is-a hierarchy” based on the inclusion relation (Figs. 3 - 6). The elements of one side of two adjacent houses were set as positive examples and the elements of the other house were set as negative examples. Progol constructed the rules that are true on the positive examples and false on the negative examples from these data. [STEP5] The rules were inducted by converting the positive and negative examples (Fig. 7). [STEP6] The above steps (STEP1 - 5) were applied to each house. We call the rules found by comparing to an adjacent house “primary rules.”

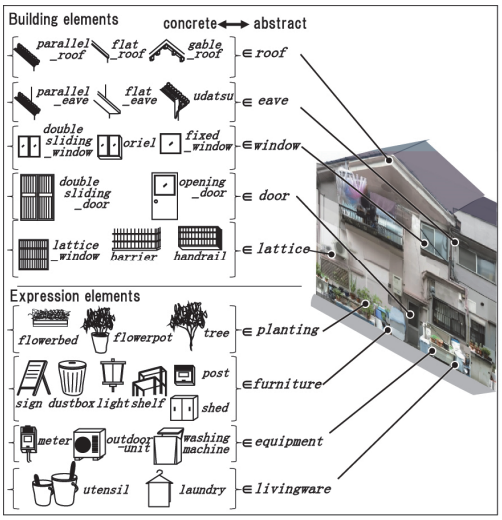

Fig. 3: Types of elements of facade

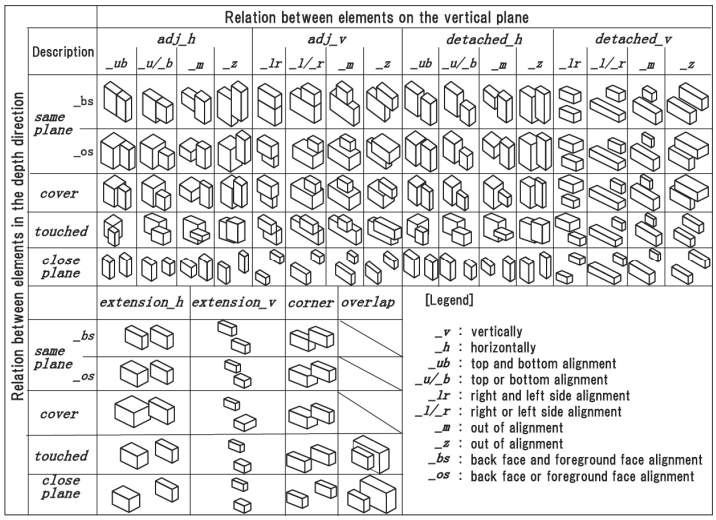

Fig. 4: Types of relations between elements

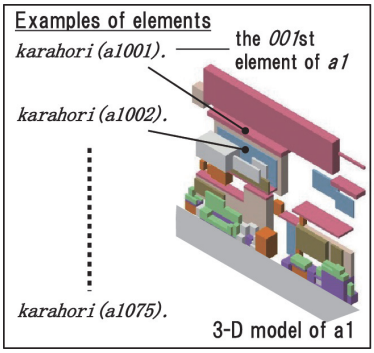

Fig. 5: Descriptions of examples

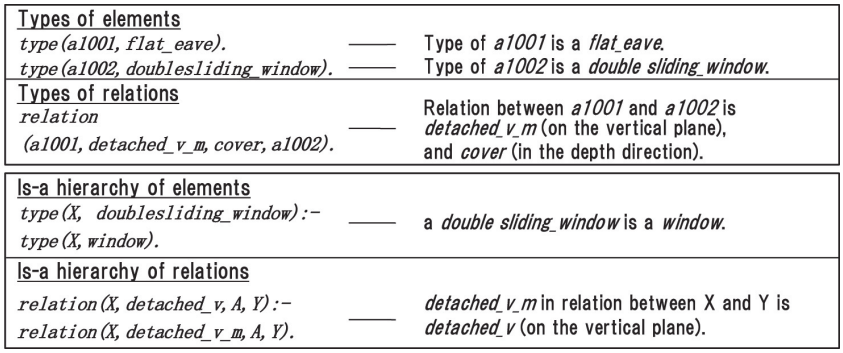

Fig. 6: Descriptions of background knowledge

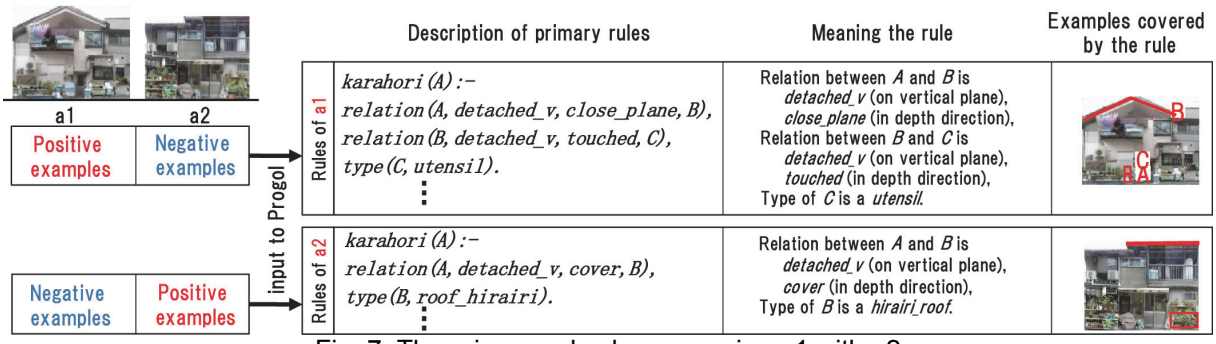

Fig. 7: The primary rules by comparing a1 with a2

Results and Discussion

The results of our analyses are shown in Fig. 8. The primary rules extracted from each house were arranged in order of high coverage. Coverage is defined as the ratio of positive examples covered by the rules to the total number of positive examples [1]. In comparison with the left side and comparison with the right side, we found some of the exact same the rules. We call these “individual rules” that strongly express the individuality of the house.

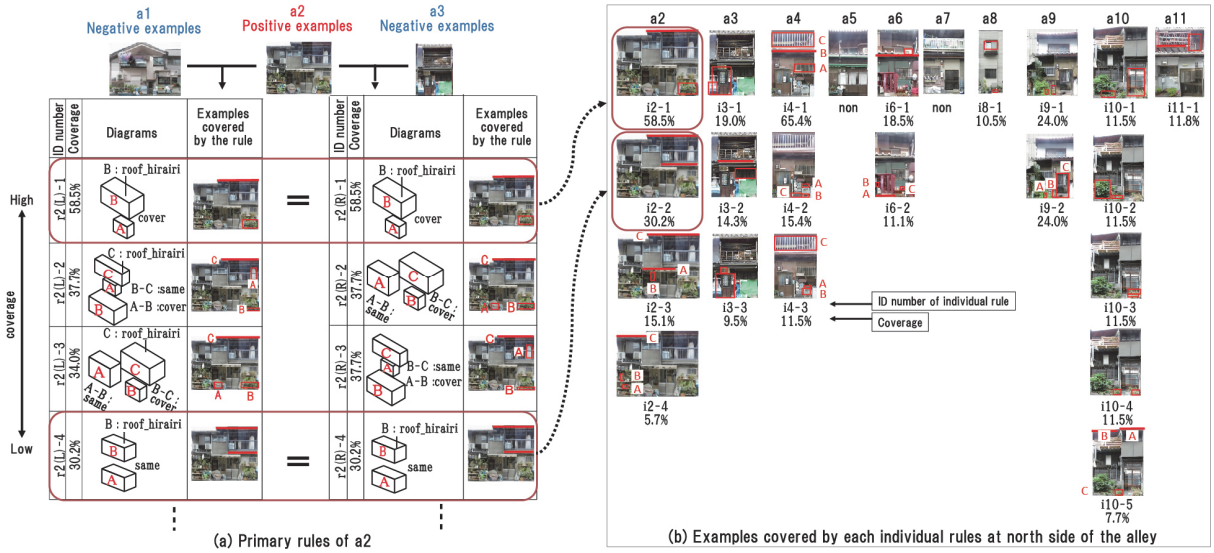

Fig. 8: Results of the analyses using Progol

The primary rules with the highest coverage in the houses that are on both ends of the alley are regarded as individual rules exceptionally. In this paper, we focus on the individual rules with the highest coverage and try to interpret them. Figure 9 shows our interpretation summery.

(1) Comparison of the total number of individual rules
The traditional row houses (a2 - a4, a9, b2, b7, b9, and b11) and the detached house (b4) have over three individual rules. The detached house (b4) has many individual rules because it has many expression elements. We can conclude, therefore, that most traditional row houses have many individual rules.

(2) Trend in relations in the depth direction between elements
Most of the houses (a8, a9, a11, a12, b1-b3, b7, b9, b11, and b12) refer to the relation in edge alignment between elements. In contrast, four traditional row houses (a1 - a4) located close to Oharai-suji Street have different types of relations that are out of alignment between elements. We therefore conclude that the rules of the traditional row houses refer to different types of relations in the depth direction between adjacent houses.

(3) Trend in relations on the vertical plane between elements
The rules of houses a1, a2, a4, a6, a8, b1, b2, b3, b4, and b7 refer to the relations in the vertical direction, such as “detached_v.” In contrast, the rules of houses a9 - a12, b9, b11, and b12 refer to relations in the horizontal direction, such as “detached_h.” Thus, conclude that the two groups divided by a branch alley have different types of regularity; that is, the west and east side groups have rules regarding the relations in the vertical and horizontal direction, respectively.

(4) Characteristic area of the alley

Four traditional row houses (a2 - a4 and b2) located near Oharai-suji Street have many individual rules. Furthermore, one of the individual rules marks the highest coverage in each case. This area is therefore the most characteristic part of this alley.

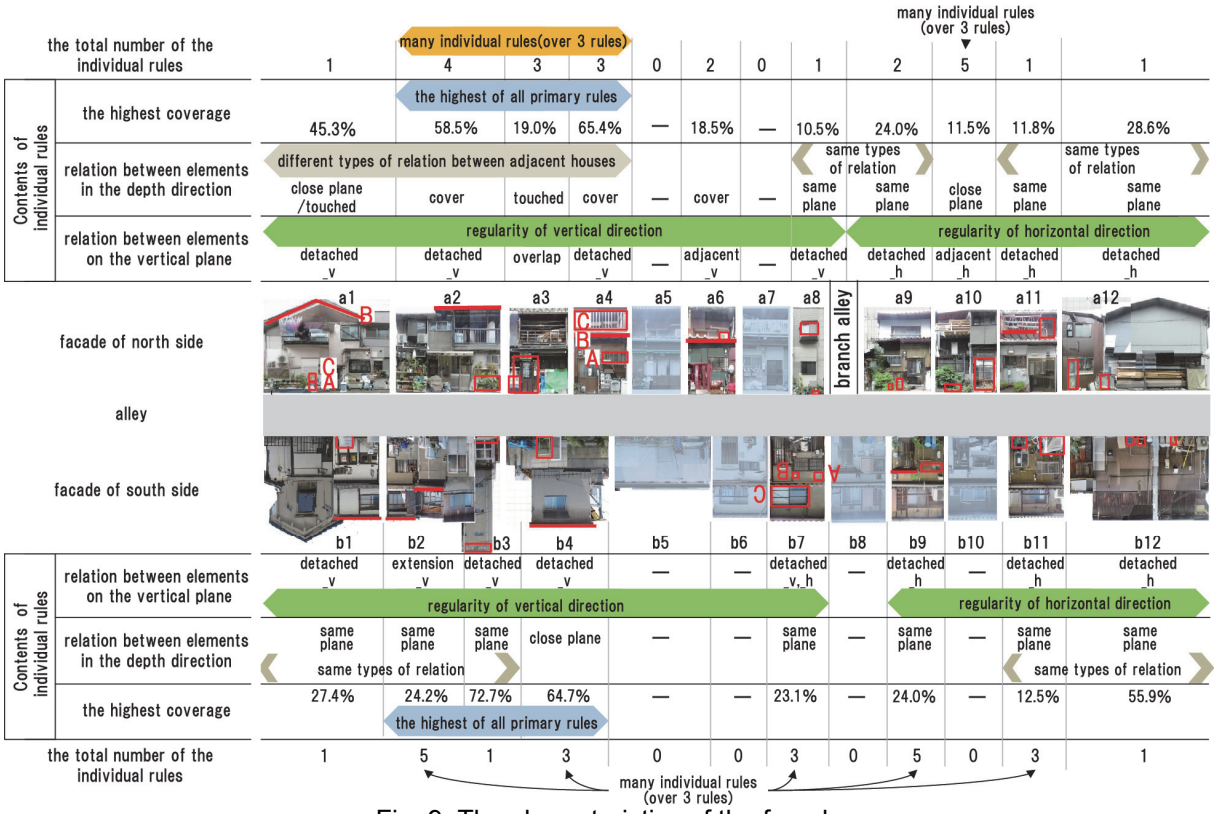

Fig. 9: The characteristics of the facade

Conclusion

In this study, we found the characteristics of peculiar rules of the building and expression elements of traditional row houses in the alley in Karahori, Osaka using ILP. We made the following findings: (1) most traditional row houses have many individual rules; (2) traditional row houses (a1 - a4) have rules that refer to 3-D composition in relation to the depth direction; (3) the two groups divided by a branch alley have different types of regularity in relation on the vertical plane; and (4) traditional row houses (a2-a4 and b2), which are located close to Oharai-suji Street, are the most characteristic of the alley.

References

[1] Hurukawa, K., Ozaki, T., & Ueno, K. *Inductive Logic Programming.* Kyouritsu Syuppan, 2002. (In Japanese)

[2] Saito, K., Matsushita, D., & Munemoto, J. Archit. Plann., AIJ, No.583, pp. 187-193, Sep., 2004 (In Japanese)

[3] Google Earth. https://www.google.com/earth/ (27/02/2016)

[4] S.H. Muggleton and L. De Raedt (1994): *ALEPH User Manual*, Posted at the Oxford University, Machine Learning at the Computing Laboratory, 2007 http://www.cs.ox.ac.uk/activities/machlearn/Aleph/aleph.html#SEC2 (27/02/2016)