The Algorithm of generating alternative models from the heritage Houses' Gates in old Mosul city

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Abstract

Old Mosul city is rich in architectural details and style and is considered one of the multi-culture cities. Each culture added its details to the original architectural style. Traditional houses in old Mosul city are known for the solid facades, which include a f ew architectural elements, such as gates and windows. Therefore, traditional houses are known by their gate details, which are varied in materials and formation system. The study conducted to deal with the deformation problems during the renovation and reconstruction of the heritage houses, especially in the details of the gates because of technology effects and m igration of labour professionals and c raftsmen. The study aims to determine the algorithmic process of generating new alternative models of Mosulian gates that can be used in new buildings or in the renovation process. Geometric analysis and artificial intelligent methodology are used to analyse the original samples and regenerate new models artificially depending on the results of the analysis. The results show that the effects of materials and colours have a limited impact on the matching with the original, while the formation system is the main element of generating and matching with theorigin.

1. Introduction

The Old Mosul City is one of the heritage sites that faced war disaster and unplanned reconstruction and renovating process. Going through the allies of the city is a discovery process of the heritage architectural buildings and their elements (Thannon, 2007). The Mosulian allies included few façades element, such as openings details, which characterized by the variety in the details and unity in the syntax of these elements (UNESCO, 2022). The research problem observed by the impressive deformation of the reconstructed houses by the owners and some national and international organizations, whos assist the owners to rebuild their houses to reuse them as residential or other functions after the distortion of the war in 2017. The study focuses on the gates' design of

traditional houses (figure 1), which considered the important facades element.

Figure 1. Samples of traditional gates details. (source: captured by researchers).

Few studies conducted to analysis and discussed the architectural elements of traditional facades in old Mosul city. Old Mosul city located in the north of Iraq, which is the biggest and m ain city in Nineveh Governorate. The literatures highlighted the important types of Gates design that included in the famous traditional houses in old Mosul city, such as the house of 'Amin Bak Al-jalily', 'Mostafa Al-Tutunchi', 'Numan Al-Dabagh', 'Hamu Al-Qado', 'Ziadah', and 'Abdoni', which included various gates design. Mahmood (2015) mentioned that 'Amin Bak Al-jalily' gate are 2.6m x 2.3m opening size with pointy vault by 4 centers bounded by vertical and horizontal ornaments using traditional stone material, while the second gate is totally destroyed and closed by new construction materials. The using of new materials and designs affected the originality and heritage value. Therefore, reconstructed gates should follow the main elements of the gate, which are three elements (vertical elements, horizontal elements, and vault). Moreover, the ornaments should follow the original style and used in the same elements of the gate (Mahmood, 2015).

Entrance is the important functional element in the traditional houses located on the middle or side of the house wall faced the allay(Qadir, 2020). The entrance consists of three parts. The first part is the walk way to the house, which planed in (S) or (L) shape for privacy factor. The second elements is the frame of the entrance, which considered the gate of the house because the including of the vertical and hor izontal elements, which usually made of Mosulian marble by hand (Al-Maadhedi, 2002). The vertical elements are work as columns designed by two or three parts decorated by geometric or floral elements (Mahmood & Alchalabi, 2022). The horizontal part work as beam, which designed as arches or vault with various types. The last part of the entrance is the door, which usually made of wooden material with simple ornaments. Most of the gates contained an extra elements over the vault or arches, which decorated by complex ornament linked to the vaults and arches (Mahmood, 2015).

Ismaeel (2014) classified the entrances according to the details and el ements. The gates of traditional house in Mosul included (8) parts as shown in (figure 2). This classification identified (2) groups of gates according to the richness of the gate with details and ornaments. The first group are simple design of the frame with simple ornaments (figure 3). The second group are the improvement of the first group by adding more details and frames around the gates, which usually used in the houses of the rich owners (Ismaeel, 2014)

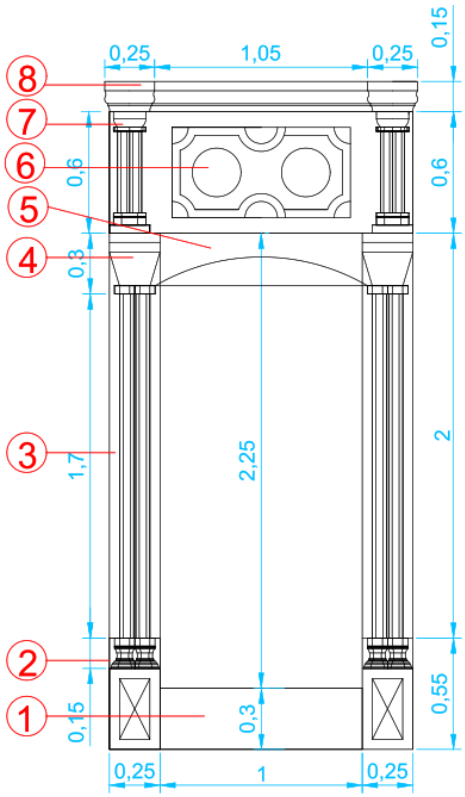

Figure 2. Sample of traditional gate showing the (8) elements identified by Ismaeel (2014)

1- *Entrance steps*
2- *Column base*
3- *Shaft*
4- *Capital*
5- *Arches or beam*
6- *Ornaments above the gate*
7- *Additional ornaments & elements round the gate*
8- *The frieze and Cornice*

(Source: adopted by the researchers from (Abdullah, 2021).

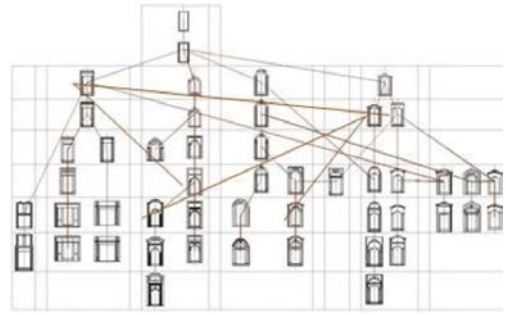

Figure 3. the two groups of gates formation (Ismaeel, 2014,p78).

The design of the traditional gates follows the principles of reflection on the vertical axis of the gate, which provided perfect symmetrical overall shape. The elements of the gates included additional principles according to the gate style, which are mostly reputation, reflection, hierarchy, proportion, scale, and transformation (Ismaeel, 2014; Mahmood, 2015; Mahmood & Alchalabi, 2022).

2. Methodology

The study applied the qualitative and experimental approach using visual analysis and observation to discover the main rule of generating the gate form. Check list observation sheet design to collect the data by observing the formation system (table 1). Generating new models from the original elements and shape relation by applying the rule of formative system with modifying the elements and exchange some with others from another gate.

The visual analysis included two steps. The first level categories the gates with in groups depending on the classification provided by literature (Ismaeel, 2014). The second step is analysis the formative system in two levels. The first level related to overall gate form. The second

level related to the formative system of the gate elements.

Table 1. Analysis checklist to discover the elements and principles of formative system.

Sample No.		Image	
Group type	Simple		Complicated
Elements	type		
Steps			
Column base			
Shaft			
Capital			
Arches			
ornaments			
Additional elements			
frieze & Cornice			
Principles	overall	element	
Reflection			
Transformation			
Repetition			
symmetry			
Hierarchy			
Scaling			
Proportion			
Shape relations	overall	element	
Tangency			
Overlap			
Adjacency			
Physical characteristics of overall form			
Width			
Height			
depth			

(source: The Authors)

In the current study, the color, material, and focus variables were neutralized on the formative system. Therefore, algorithmic steps of generating models from the original gates used in programing auto generating software with variables determined form the results of visual analysis. Auto lisp language within AutoCAD software to produce alternative models from the original gates in 2D drawing. The 3D modeling will follow the physical characteristics of the gate details using extrude command after selecting the proper models produced from Auto lisp application.

3. Results and Discussion

The visual analysis results show the important of three elements of the gate as a minimum element can be used to format a gate, which are column shaft, beam or arch, and additional elements over the beam (figure 4).

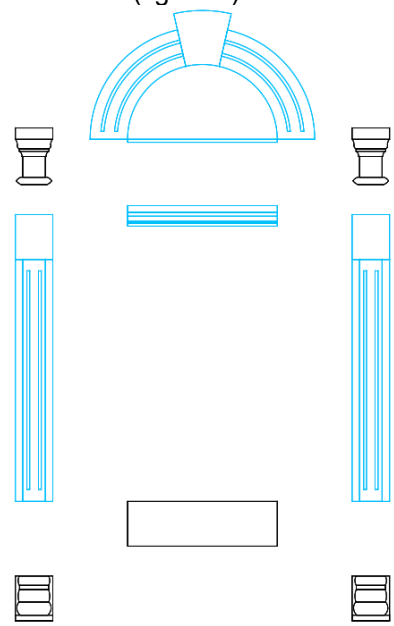

Figure 4. Sample No. 3 the 8 gate elements and the main 3 elements to generate alternative models (Source: The researchers).

The main three elements of the gate are used for framing the entrance, therefore these three elements are the basic elements to generate new designs related to the gates of traditional houses in old Mosul city.

The physical characteristic of the gate follows the proportion of 1D + (between

2.5D to 3D) x 2D with 0.5D as shown in (figure 5). This proportion reflect the size of the gate in addition to create a focal point in the allay wall of the house, which is type of emphasis the owner within the social class in the city.

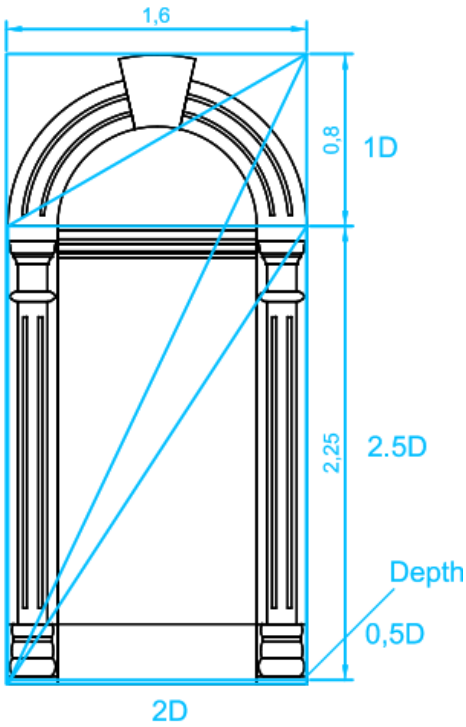

Figure 5. The physical characteristics of overall gate form for Smaple No.3 (Source: the researchers).

The results of the principles and relationship matched to the finding of the literatures, which confirms the importance of balance using reflection and perfect symmetry in overall and elements levels. Most of the ornaments in the gates are existed in the shaft of the column, which are mostly geometrical type. While the floral ornaments are existed in the additional elements over the cornice rounded by arch or frame with geometric ornaments.

The relationships between the gate elements are adjacency with 1D space between the symmetrical columns, base, and capital. While the relationships between the elements of column and beam and additional elements are tangency relations as shown in (figure 6)

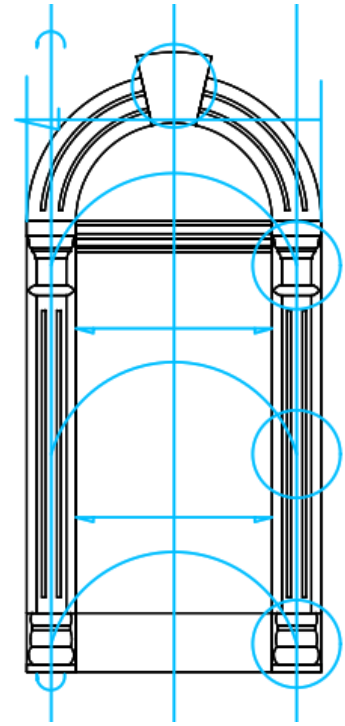

Figure 6. The axis of the balance and relationships between the gate elements (Source: The researchers).

The algorithmic process of generating alternative models of gates derived from original gates transferred to rules used in designing Auto lisp programing, which includes three main steps:

- Selecting the proportion of the gate.
- Selecting the number of elements included in the gate.
- Selecting three different gates that the designer plan to produce alternative models from them (figure 7).
- Selecting the rule and pr inciples for overall and elements level.
- Selecting the number of alternative models (figure 8).

- Selecting one alternative model to transform it to 3D models (figure 9).

The steps appear in the comment par in AutoCAD software or as windows using visual C+ depending on the programing language used to apply the algorithmic.

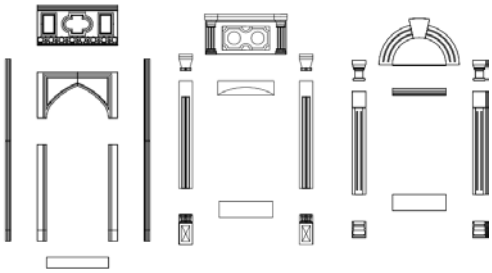

Figure 7. The step of selecting elements from three different gates (Source: The Researchers).

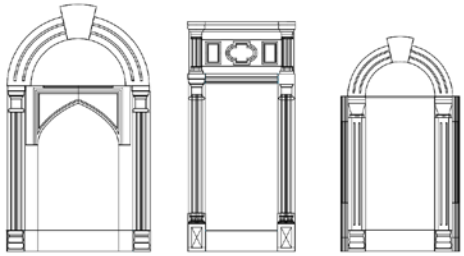

Figure 8. New models derived from three different gates with modifying in proportion and scale of overall and some elements (Source: The Researchers).

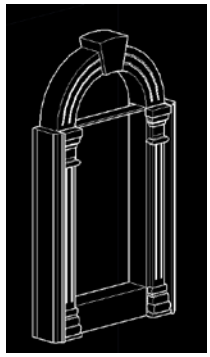

Figure 9. 3D model peroduced by using elements, rules, and relationsips from original gates of traditionl houses in old Mosul city (Source: The Researchers).

The final results of the producing alternative models show the semi-matching with original gates although the changing and exchanging in the elements, rules, and relationships. However, some models matched with rate 50% with original gates, which reflect the non-harmonized elements with unusual proportion.

4. Conclusions

The gate is the part of the entrance of traditional houses in old Mosul city, which is considered an effective element on the façade formation. The formative system of these gates follows the principles and characteristics of traditional architecture in old Mosul city, which is originally a mixture of various architectural styles. The formation system included two levels (overall – elements). Each level included a set of rules to generate it by balance, symmetry, and r epetition, especially for elements level. S even steps are the algorithmic process of generating alternative models of the gate. Each step of formations depends of the selected elements, rules, and relationships, which designer is free to select from the data set that provided previously by a documentation of original gates.

Using programing language to produce an impact alternative models is not related to the language itself, but related to data set that provided by the researchers or designers to feed the software.

5. Acknowledgment

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