

Creating Novel Islamic Geometric Ornaments by Using Parametric Design

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Abstract

Islamic Art was characterized by various motifs such as (floral and geometric motifs and Arabic calligraphy), but it was distinguished by the Islamic geometric ornament, which relies on geometric networks and mathematical relationships, Which helps in producing many complex geometric formations. Parametric design appeared in the last century and spread its fame and use at the beginning of this century, It is one of the most important digital technologies that spread in many contemporary architectural designs.

. Parametric techniques used to develop solutions to design problems by by using digital models with variable parameters, which produce a design that could be modified during the work and after work, by changing the parameters of the structural equations. It is also characterized by the concept of reproduction and generating networks, which we focus on in this paper. Artists and scholars were interested in Islamic motifs which were such an inspiration to them. Thus, upon the emergence of parametric design, many artists and designers found a deep connection between between the parametric techniques and the mathematical structure of the Islamic ornaments in a very complex way, without the difficulty of the traditional mathematical work. They also help them to examine new experimentations because of those variables.

the research aims to explore new contemporary design solutions for Islamic geometric motifs using parametric design, with a saving of time and effort. The researcher has experimented with making engineering designs on one of the parametric softwares (Grasshopper), and she created the structure of the basic grids in the geometric ornaments (triangular grid - hexagonal grid - square grid). She also did two experiments, the first with one variable, and the second with several parametric variations on different grids. This resulted an infinite number of new and, highly complex designs in less time and effort, by using a modern digital technical means, that can also be printed with two-dimensional printers. Thus, we can achieve civilized communication between our heritage and modern technology.

Keywords

Islamic Geometric Decoration, Parametric Design.

The research problem

- 1- Can parametric design affect the construction of new shapes for Islamic geometric motifs?
- 2- Is it possible to access an infinite number of designs that carry in their structural approach the identity of the Islamic style through visual algorithms that are easy to apply?

The research Importance

- 1- Study the foundations and criteria for the structures of Islamic geometric motifs of geometric shapes, using parametric design.
- 2- Evolution of the structural relationships of the decorative geometric shape by using parametric algorithms in terms of construction and implementation.
- 3- Enriching the design field with contemporary Islamic engineering designs.
- 4- Producing designs characterized by complexity in design, ease of construction and implementation.

The research aims

- 1- Producing an innovative design structure for Islamic geometric decoration through parametric design algorithms.
- 2- Producing several different designs of the same shape according to the variables entered in the program used for the design (Grasshopper).

Research Methodology

The research follows the descriptive and analytical method for introducing some terms and analyzing the compositions of some geometric motifs

The research limits

- Temporal boundaries: through the study of some Islamic geometric motifs in the brightest periods.
- Spatial boundaries: By producing some geometric decorative experiments for the two-dimensional plane design using parametric algorithms using Grasshopper program.

The research assumes

The study of the structural compositions of Islamic geometric ornaments was able to create many designs using parametric design.

Geometric decorative lattices:

At the beginning of his work on the surface to be decorated, the Muslim artist creates a methodology based on an engineering basis that he can follow through which errors can be avoided. Elements are distributed in parallel between shapes, spaces and spaces, and the artist's method is that he divides the surface into equal parts, but on a grid Define it at the beginning (Triangle - Square - Hexagonal).

Parametric design

Parametric design is used in recent times in the field of design widely, and parametric design works through variables and uses the parametric modeling system, not software based on geometric shapes. Hence the research point where the traditional methods of using networks for Islamic decoration are clarified, and how parametric design and technology can be used. In creating geometric ornaments, by means of this type of design, the geometric shape or a specific

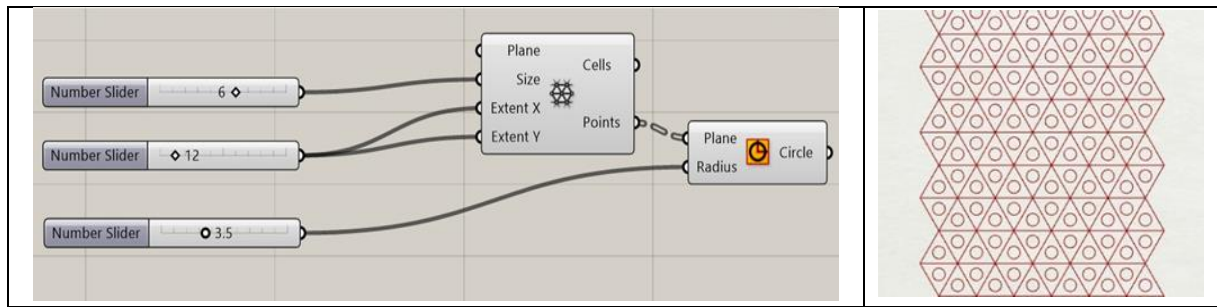
part of it can be modified in a way that does not affect the final shape and without re-drawing it again, and this is done by changing the parameters, which are the variable properties and are determined according to the shape. This design allows for an infinite number of designs to be produced. The researcher's experiment is based on the use of parametric design in an experimental way to reveal the extent of the influence of variables in the geometric decoration system.

The researcher will make several designs for the geometric Islamic decoration by means of parametric design. The experiment is divided into designs resulting from one variable and designs resulting from several variables. The researcher used the Islamic Grids that the Muslim artist was using in his work, so she made designs on the triple, hexagonal and square grid.

First: Different designs resulting from **one variable**

1- the **triangular** grid

The circle will be drawn in the middle of the triangle and then the primary variable will be the diameter of the circle

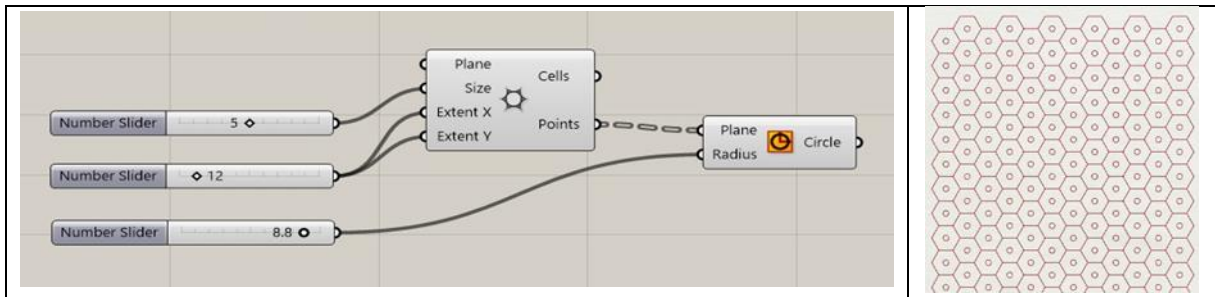


Design number	1	2	3	4
The design				
Circle radius	2.5	3.1	3.6	9.5

Table ()

2- The hexagonal Grid

-The circle will be drawn in the middle of the hexagon, and then the primary variable will be the diameter of the circle,



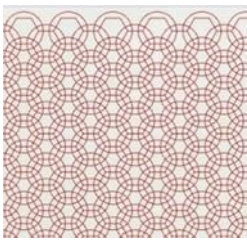
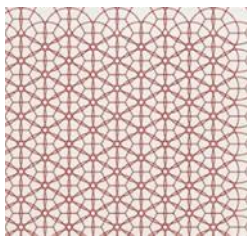
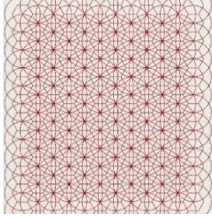
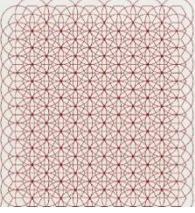
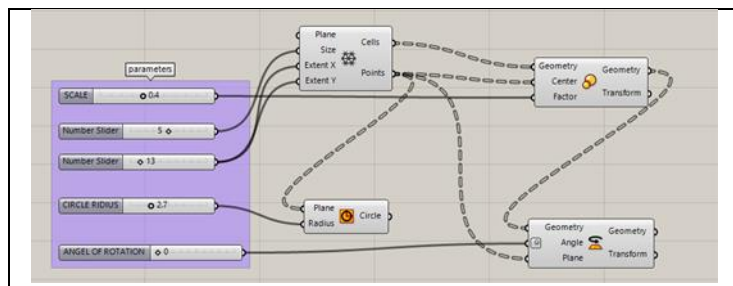
Design number	1	2	3	4
The design				
Circle radius	6.5	7.9	8.6	8.8

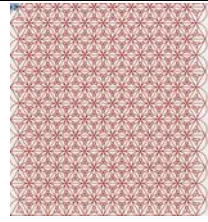
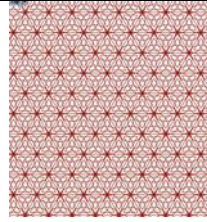
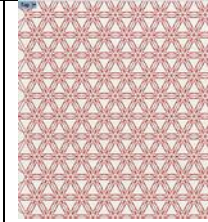
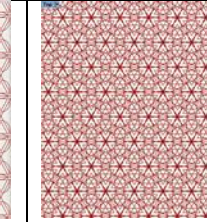
Table ()

Second: Different designs resulting from **several variables**

1- the **triangular** grid : The circle was placed in the middle of the triangle, and two other variables were created (Scale and Rotate). The researcher explained all the parameters as follows:

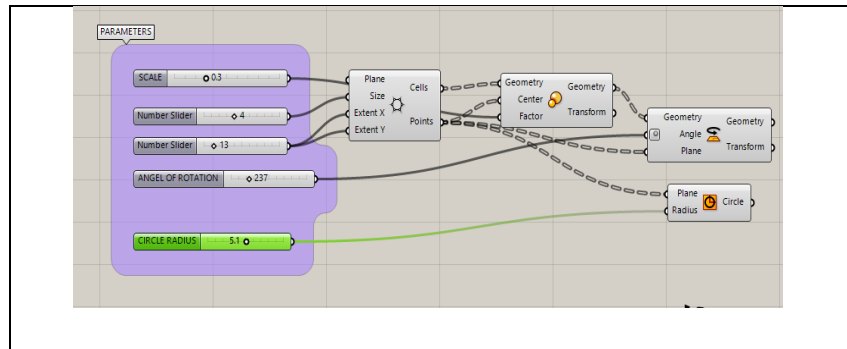
- Scale variable.
- Circle Radius variable.
- The Angel of Rotation variable.

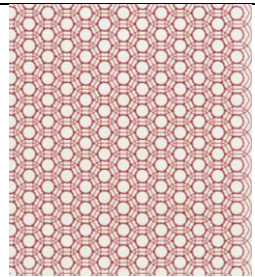
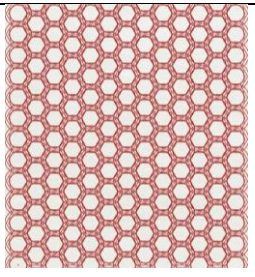
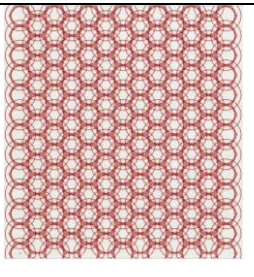
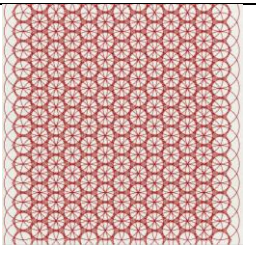


Design number	1	2	3	4
The design				
Table ()				

2- The hexagonal grid: The circle was placed in the middle of the hexagon, and two other variables were created (Scale and Rotate). The researcher explained all the parameters as follows:

- Scale variable.
- Circle Radius variable.
- The Angel Of Rotation variable.



Design number	1	2	3	4
The design				
Table ()				

The Results

- 1- Benefiting from parametric design in developing contemporary design thinking.
- 2- The possibility of utilizing optical algorithms in parametric design to arrive at complex structures easy to create.
- 3- The possibility of accessing the multiplicity of forms from the same structure.
- 4- Wide open the horizon for experimentation.

- 5- Benefiting from our heritage and employing it in line with modern technological developments to achieve civilized communication.
- 6- Parametric design results in an infinite number of innovative design ideas that can be adapted into many design ideas, whether two-dimensional or three-dimensional designs.

Recommendations

- 1- Disseminating the study of parametric design due to its importance in many areas of design, especially in the applied aspect.
- 2- Introducing parametric design programs such as Grasshopper into educational curricula.
- 3- Study methods of 3D printing that can be used directly from these programs.
- 4- Searching for sustainable environmental materials that are compatible with complex designs.

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