iPattern:
A Pattern-Generating Software Using Rule-Based Computational Design

Youmna Bassiouny, German University in Cairo, New Cairo, Egypt
Rimon Elias, German University in Cairo, New Cairo, Egypt
Philipp Paulsen, German University in Cairo, New Cairo, Egypt

ABSTRACT

Computational design takes a computer science view of design, applying both the science and art of computational approaches and methodologies to design problems. This article proposes to convert design methodologies studied by designers into rule-based computational design software and help them by providing suggestions for designs to build upon given a set of primitive shapes and geometrical rules. iPattern is a pattern-making software dedicated to designers to generate innovative design patterns that can be used in a decorative manner. They may be applied on wallpapers, carpets, fabric textiles, three-dimensional lanterns, tableware, etc. The purpose is to create a modern pattern design collection that adds a new essence to the place. In order to generate creative design patterns, primitive shapes and geometrical rules are used. The generated design pattern is constructed based on the grid of the Flower of Life of the sacred geometry or similar grids constructed using primitive shapes (rectangles, squares and triangles) combined in the layout of the Flower of Life.

KEYWORDS

Computational Design, Computer Graphics, Flower of Life, Geometric Patterns, Pattern Generation, Pattern-Generating Software

1. INTRODUCTION

A pattern is a usually repeating artistic or decorative design. As such, the elements of a pattern repeat in a predictable manner. A geometric pattern is a kind of pattern formed of geometric shapes and typically repeating like wallpaper.

In art and architecture, decorations or visual motifs may be combined and repeated to form patterns designed to have a chosen effect on the viewer. In fashion, the pattern is a template used to create any number of similar garments. Since geometrical design patterns are extensively spotted in many areas, rule-based computational design became a major research area.

Computational design refers to the use of computers and mathematical approaches to the generation of geometries, objects and architectural models. It takes a computer science view of design, applying both the science and art of computational methodologies to design problems including presentation, analysis, evaluation, interaction or aesthetic expressions.

Computational design is a methodology in which the output (image, sound, architectural models, animation) is generated by a set of rules or an algorithm, normally by using a computer program. It is a fast method of exploring design possibilities that are used in various design fields such as art, architecture, and product design, etc.

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Computational design is guided by two entities: primitive shapes (e.g. circles, squares, rectangles, triangles, cubes, spheres, etc.) and geometrical rules (e.g. rotation, translation, reflection, repetition, etc.). Applying geometrical rules to primitive shapes by means of computations may create different designs.

The objective is to turn design methodologies studied by designers into rule-based computational design and help them by providing design patterns suggestions to build upon given a set of primitives and rules.

This paper is structured as follows. Section 2 discusses the previous related work. Section 3 discusses the concepts needed for developing the project. Sections 4 and 5 discuss the proposed application to generate design patterns and the methodology used for implementation. Section 6 discusses the experiment design, participants, procedure and questionnaires used. In Section 7, data collection and analysis are done along with a discussion on the results. Finally, Section 8 provides a summary of the study.

2. LITERATURE REVIEW

Since design patterns are invading the interior design market as they are widely applied on wallpapers, carpets, fabric textiles, three-dimensional lanterns and tableware, rule-based computational design became a major research area. It has been explored from many perspectives.

A research by Ulu and S¸ener (2009) used the 10-sided polygon, decagon, tie and bow-tie subshapes in creating geometric patterns in Islamic art. Two design templates were developed to generate Islamic patterns using a shape grammar model. The model should be applied to a software to get easier and faster results.

An Islamic star pattern is an arrangement of lines that forms different shapes. A research by Kaplan (2000) examined the characteristics of Islamic patterns: stars and rosettes.

A research by C¸olakoglu et al. (2008) gave formal descriptions of eight-pointed Islamic star pattern that showed a variety of geometrical structures. “PatGen” software was developed to produce Islamic patterns, which was based on tiling stars and rosettes in a plane. Other patterns are investigated in (Kaplan, 2005) and (Kaplan & Salesin, 2004).

Patil (2002) proposed a geometric model for two-dimensional patterns. Patterns were described using a hierarchical tree model, which defines a pattern in terms of shapes. The model was implemented as a Shape Description Format that allows users to describe shapes in terms of curves.

A software named “pattern” was implemented that reads in a shape description, builds a tree of shapes and renders a pattern. The model does not take into account the space occupied by shapes. If some shapes overlap, the model does not detect the overlap.

Songket is a Malaysian hand woven traditional fabric. Ismail et al. (2013) focused on generating songket patterns from a traditional Malaysian flower songket motif, Bunga Cabit. It consists of three squares connected diagonally at the tip, with the middle one bigger than the other two. Songket designs were generated by recursively applying basic rules on the Bunga Cabit motif. The rules include translation, rotation, scale, mirror and combination of them. The generated designs maintain the traditional songket motif, Bunga Cabit.

A study by Singh et al. (2013) focused on how mathematics and algorithms are applied to produce design patterns in sense of art. Repetition, symmetry, translation and rotation were found in most patterns. Patterns were classified into three categories. In the first category, the motifs were constructed with circles, arcs and lines. In the second category, the motifs were constructed with triangles and hexagons. In the third category, the motifs were constructed with squares.
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