Computer-aided Design of Art Patterns

Human artists often do the design of art patterns manually. The designer first imagines the art patterns in his mind, and then draws them on paper or canvas. This process is repeated until the desirable art patterns are created. It is time consuming and the novelty of the resulting art patterns is limited to the human’s imagination, which is difficult to meet the requirements for a huge amount of art patterns in a manufacturing industry such as textile. This chapter will mainly discuss how to let the computer assist in the generation of the art patterns, including:

(1) *Art pattern creation by fractals*. It is based on the principles of fractal geometry, and performs the numerical calculation by the iterative function system. The output of the numerical data are colored to generate the resultant art patterns.

(2) *Art pattern creation by shape grammars*. Shape grammars specify a mechanism for selecting and performing recursive rules for shape computations. The computer handles the representation and computation of shapes, rules, and the presentation of correct design alternatives. This frees the designer to specify, explore, develop design languages in terms of the shape grammar, and select alternatives for the desirable art patterns.

(3) *Layout-based creation of art patterns*. Three basic layout-based art pattern design methods are presented: (a) How to convert the graphical layout into the resulting art patterns in terms of the specified structure of craftwork. (b) How to create an aesthetic layout of an art pattern by the regular layout. (c) How to automatically/semi-automatically place the user specified graphical entities by a specific artistic style.

(4) *Knowledge-based creation of art patterns*. The artificial intelligence techniques are employed to represent the design knowledge and aesthetic conventions of art patterns, and then generate the resultant art patterns by reasoning on them.
3.1 The Overview of Art Pattern Design

From the point of view of artwork, the art pattern design is a creative modeling activity that aims at the generation of planar decoration and ornamentation. There are four major components in the art patterns: graphical entities, layouts, colors, and textures [Lu et al., 1997].

The graphical entity is composed of a set of geometric primitives such as points, lines, and faces. The graphical entity is defined relatively to the entire art pattern, and itself could be considered a kind of sub-art-pattern that is generated by the transformations, translation, scale, rotation, skew, etc., applied on the geometric primitives (see Fig. 3.1).

![Fig. 3.1 A graphical entity generated from a rhombus primitive by composite transformations [Lu et al., 1997]. Courtesy of Weilin Lu et al.](image URL)

When multiple graphical entities are integrated into a novel art pattern, the spatial relationships among the graphical entities are called the “layout” of the art pattern. The typical layouts involved in the art pattern can be summarized as follows:

1. **Planar layout.** All of the graphical entities are placed on the same plane, ignoring their depths to the viewpoint, and there is no overlapping among the graphical entities.
2. **Perspective layout.** All of the graphical entities are presented to the viewer in terms of the perspective projection principles.
3. **Scattered layout.** The silhouettes of the graphical entities are generated first. The desirable art pattern is generated by randomly scattering the relevant graphical entities onto the canvas in terms of the predefined density model.
4. **Radial layout.** There is a central graphical entity in the art pattern. The other graphical entities can be centripetally orientated towards the central graphical entity, or centrifugally, or spirally placed from the central graphical entity.