DECODING PASSURA’

Representing the Indigenous Visual Messages Underlying Traditional Icons with Descriptive Grammar

Rizal MUSLIMIN
Massachusetts Institute of Technology, Cambridge, MA, United States
rizal@mit.edu

Abstract. For the Toraja people in South Sulawesi, Indonesia, the engraved ornament (Passura’) means more than a simple decorative element. More importantly, Passura’ also serves as a symbolic icon to convey spiritual messages. However, only few people actually understand the underlying meaning behind the ornament. Consequently, those without this knowledge can only appreciate the aesthetic dimension of Passura’. Our computational design research focuses on understanding the visual–linguistic aspect of Passura’ using Descriptive Grammar method to investigate how meanings are embedded on the ornaments. The design rules and their description are synthesized into a shape-to-text grammar that can read the ornament as a text, and into a text-to-shape grammar that can write a text into an ornamental design. Preliminary results of this grammar demonstrate how Passura’ works as an active indigenous communication device, rather than simply being a passive decorative element.

Keywords. Passura; ornament; shape grammar; Toraja.

1. Introduction

This paper investigates the association of Passura’s design with its symbolic description using computational design method. In particular, we analyze the emergent quality of Passura’ design using Shape Grammar (Stiny and Gips, 1972) to analyze and synthesize the generative aspect of the design. We also analyze the relationship between shape and its description using Descriptive Grammar (Stiny, 1981), a generative description method to associate a description of design with its design rule. Passura’ designs mostly take inspirations from animals, plants, folklores, household tools, and other natural/man-made objects that are considered
important for the Toraja people (Figure 1). There are about seventy design-types that remain to be widely used in today’s traditional ceremonies, crafts and traditional house. Although Passura’ can be considered as pictograms or ideograms, the pictorial messages in Passura’ are not always as obvious as in other glyph. The shapes are not to be read phonetically as a letter like Chinese characters or Hieroglyph, or as a number like in some Mayan glyph. It is this subtlety that makes Passura’ unique, where the relationship between shape and its description could be one-to-many, many-to-one, or one-to-one.

In order to reason and represent this subtlety, first we will approach it from the visual to the textual by analyzing the design rules with shape grammar, and then map the pertaining symbolic description with descriptive grammar. Second, we will move from the textual to the visual by synthesizing the rules into a shape-to-text grammar that can read the ornament as a text, and into a text-to-shape grammar that can translate a text into an ornamental design.

2. Passura’ Grammar

The available literatures of Passura’s design (Kadang 1960; Pakan 1973; and Sande, 1989) are mostly served as an iconographic catalogue to describe the symbolic meanings of the ornament. However, there is very little explanation about
how their shapes are generated. Based on our observation and interview with several local engravers in Toraja, we found that there are certain procedures to generate the ornament.

To start with, Passura’ designs are mostly developed on top of two overlapping 90° and 45° rectilinear grids (Figure 2).

We represent this grid as an assemblage of a square module that has eight orders of symmetry, i.e. eight different ways of transforming the square back into its original shape using four rotation angles and four reflection planes. With this symmetry, there are eight different basic designs that can be generated from one spatial-relationship. Figure 2 shows an example of one basic design computation with rule $x \rightarrow x + t(x)$. Based on this grid rule, we then develop design rules in two stages: first is to define a rule that produce a modular shape ($L_g$), and second is to define rules that generate various design compositions using this modular shape to finally create new ornaments ($L_G$).

2.1. MODULAR RULES

Here, we limit our study to analysing only one ornament shown in Figure 2. Using a rectangle as an initial shape, rule $g$ generates the spiral in the ornament by adding a scaled and rotated shape and then subtracting part of the initial shape ($g: x \rightarrow t(x) + pt(x)$). The shape has three parameters where $a_1 = \text{Scale Factor}$ (float), $a_2 = \text{Degree of Curvature}$ (integer), and $a_3 = \text{Rule Steps}$ (integer). With these properties, the proportion of a new shape can be defined. For instance, to create an Archimedes Spiral, $a_1$ would be 0.618 (Figure 3).
As seen in Figure 3-table A, the above rule can generate shapes that symbolize particular objects in Toraja as the shape parameter is varied, e.g. 'hook': <0.75, 1, 1> or 'stem': <0.618, 2, 1>. This shape-description association can be registered with a function $g_i \rightarrow d_i$, where $d_i$ is the description of the shape and $g_i$ is a rule that generates the shape. The two shall be encoded in a list $\{d_i; g_i\}$ for future use. The shapes shown in Figure 3-table B are examples of various shapes that can be computed sequentially from the leftmost shapes in table A. In this example, the shapes 'hook' and 'stem' serve as initial shape to generate new designs with rule $x \rightarrow x + t(x)$, where each of the newly-constructed shape is made to overlap with
the initial shape. This rule has an extra two parameters: \( a_4 = \text{Rotation Angle (Float)} \) and \( a_5 = \text{Rule Steps (integer)} \).

While some shapes \( L_g \) can be considered as one ornament, others can also serve as a sub-shape for the composition rule described in section 2.2.

2.2. COMPOSITIONAL RULES

To generate a certain ornament, a modular shape from the previous stage (‘stem’) is placed within the grid module as a carrier, and defines the basic spatial relationship. The modular shape follows the carrier’s order of symmetry and results in eight different rules. Figure 4 shows a number of different strategies.

![Figure 4. Different types of Compositional Rules generate ornament from modular shape.](image-url)
in generating the ornament by defining the rule sequence, and by using the shape that emerges from the computation (see Knight (1999) for more different types of rules, and Knight (2003) for more computing with emergent shape):

**Rule Sequences:** A rule can be used deterministically, where only one rule is applied to the new shape at each step, for instance, R1-R1-R1-R1. A rule can also be used in a non-deterministic way, where two or more rules ordered in particular sequence are applied to the new shape or any other previous shapes, e.g. R1-R2-R1-R2. Different types of rule sequence would extend the number of possible basic design from \( m^n \) deterministic basic designs to \( mn \) non-deterministic basic designs (\( m = \) order of symmetry, \( n = \) number of iteration).

**Emergent Shape:** In order to capture the use of emergent shapes, we show a set of examples involving several schemas: \( g[g(x)] \), \( g[\text{part}(g(x)] \), and \( x \rightarrow \text{prt}(x) + y \). Schema \( g[g(x)] \) will repeat rule \( x \rightarrow x + t(x) \) on the very shape that it generates. As an example, a design from rule R6 is used as an initial shape to generate two new designs with the same rule R6. In the other two examples, only part of the \( g(x) \) design is used as an initial shape, hence \( g[\text{part}(g(x))]. \) Furthermore, schema \( x \rightarrow \text{prt}(x) + y \) will retrieve part of \( x \) and then add a new shape \( (y) \), allowing us to embed a new emergent shape that intuitively resembles a particular object. Based on the Passura catalogue (Sande, 1989), we associate four different descriptions for the new emergent shapes, i.e.: ‘rice’, ‘buffalo’, ‘creese’ and ‘banyan leaf’, with a function \( \text{LG} \rightarrow d \).

Based on this strategy, we define six properties for this grammar \( <a1, a2, a3, a4, a5, a6> \) : \( a1 = \) Initial Shape Parameter (list), \( a2 = \) Spatial Relationship (string), \( a3 = \) Rule Sequence (string), \( a4 = \) Rule Steps (integer), \( a5 = \) Embedding (string, integer) and \( a6 = \) Part Embedding (integer).

2.3. ENCODING PASSURA' AMBIGUITY

As can be seen from the previous analysis, Passura’ design and its description may have an ambiguous relationship: one-to-many, many-to-one, or one-to-one, as illustrated in Figure 5.

When the design is being generated, most Passura’ have one-to-many relationships with the source object. The basic initial shape can be used to generate many different kind of shapes in set \( L_g \) using the parametric-rule shown in Figure 3. Furthermore, the compositional rule strategy (i.e. rule-sequencing and embedding) could further generate enormous number of possible new designs in the set \( L_G \). At the shape and description mapping stage, the emergent design in set \( L_g \) is encoded to the pertaining descriptions in a one-to-one relation. However, the description function \( g \rightarrow d \) can be used recursively to recognize objects (d) from other branch of the design (G). For instance, there could be other shapes in set \( L_g \) that looks
like a ‘buffalo’. At the description domain, the relationship between the concrete noun and the abstract noun may vary. Two different nouns, e.g. ‘buffalo’ and ‘creese’, could be mapped into one abstract noun, i.e. ‘wealth’ as they are both considered a luxury and prestigious object in Toraja. In contrast, the concrete noun ‘a branch’ may also have two different meanings ‘kinship’ and ‘honesty’. There are also some cases where one noun has exactly one meaning (e.g. bended paddy → modesty).

This ambiguous relationship can be encoded with the function \( \{ G_i : D_j \mid 1 < j < N \} \) for an ambiguous shape, or \( \{ D_i : G_j \mid 1 < j < N \} \) for an ambiguous description, where \( N \) is the number of possible translation. Thus the list \( \{ D_0 : G_1, G_2 \} \), for instance, means that there are two possible designs for the description \( D_0 \). This encoding system can also be used to express other ambiguous relationships. For example, the list \( \{ D_i : d_j \mid 1 < j < N \} \), where capital \( D \) refers to Abstract Noun, and small \( D \) refers to its concrete noun, can associate one Abstract Noun (\( D \)) to \( N \) number of concrete noun (\( d \)).

3. Passura’: Text-Shape Interpreter

The relationship diagram shown in Figure 5 has a two-way direction, which means that one can use either shape or description as the starting point. After generating Passura’ designs from shape to description in the previous section, in this section we will reverse the process. Using the design rules and the descriptive function, 

![Figure 5. Text-to-Shape and Shape-to-Text Relationship diagram.](image-url)
we generate the ornament with some text as an input. Suppose that a person wish his/her descendant to be endowed with some wealth: a ‘wealthy descendant’ as described in Figure 6. A collective noun ‘wealthy descendant’ consists of two abstract nouns: ‘wealth’ and ‘descendant’. We derive these abstract nouns into two possible corresponding concrete nouns: ‘wealth’ with ‘buffalo’ and ‘creese’, and ‘descendant’ with ‘child’ and ‘stem’. To define the modular shape, we use the function $L_d \rightarrow L_g$ to call the modular and compositional rules ($g_n$) that match the concrete nouns ($d_n$) as follows:

- $\{D_0: d_0\}$ → ‘child’ : <0.75, 1, 5>
- $\{D_0: d_1\}$ → ‘stem’ : <<0.618, 1, 1>, 1, 180>
- $\{D_1: d_0\}$ → ‘buffalo’ : <‘stem’, ‘R5’, ‘R5’, prt-1>
This descriptive function generates modular shapes in the set \( L_g \). Note that the shape 'stem' has more properties than the shape 'child' since it is essentially the first derivation of the shape 'child' with different curvature and less rotation. The last two arguments (1 and 180) transform the shape by copy-rotating it 180 degrees once. Also notice that the shape 'buffalo' and 'creese' have more properties because they are the second derivation of the shape 'stem' (i.e. the 'stem' properties are nested in their first argument). Their properties are also similar because they both use the same emergent shape, but with different parts (i.e., prt-1 and prt-2).

With these shapes, we use the grammar from compositional rules to generate design that could express 'descendant' and 'wealth'. The design \( (L_G) \) and the description are then encoded with the descriptive function \( L_G \rightarrow L_D \) in the list \( \{D_0 : G_j | 1 < j < N\} \) as described below:

- 'descendant' #1 : <'child', 'R4', 3> \( \rightarrow \) \( \{D_0: G_1\} \)
- 'descendant' #2 : <'stem', 'R3', 3> \( \rightarrow \) \( \{D_0: G_2\} \)
- 'wealth' # 1 : <'buffalo', 'R3', 3> \( \rightarrow \) \( \{D_1: G_1\} \)
- 'wealth' #2 : <'creese', 'R5', 1> \( \rightarrow \) \( \{D_1: G_2\} \)

Later, this encoded list allows us to create an ornament directly from an abstract noun (LD). The ornament can be perceived as a final design (G) or as a modular shape (g) that is ready to be used for generating a new ornament using different rule-sequence or schemas with grammar (G).

4. Discussion

This paper demonstrates how Passura', as a tacit product, can be explicitly represented, analyzed, and synthesized from a text to design and from a design back to text using descriptive grammar. Examples used in this paper are hypothetical as the goal of this study is less about proving the actual design process of Passura' engraver or deciphering Passura' code, but more about representing the promising logic in Passura' design to promote its potential aspect for further semantic computational design research. This study highlights two interesting issues in exploring cultural objects using computational design methods:

- **The Explicit Aspect of Ambiguity.** Despite the ambiguity in reading Passura' design, as not all of them can be discretized into countable shapes, the descriptive grammar could help designers to encode semantic polarizations of Passura design in a more tangible manner.

- **The Nonlinear Association of Shape and Description.** The symbolization of the Passura' design does not occur in linear fashion since the description (e.g. meaning) can be assigned into the shape at any level of the computational design process, either in the case of text-to-shape or shape-to-text.
References