Generative capacity of kolam patterns using Tile pasting rules

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Abstract: Kolam is the art introduced and developed by south Indian People to entertain themselves during the festival seasons. Even now it is regularly followed by the villagers especially by women every day morning in front of their houses using the rice flower. This paper gives an overview of drawing such patterns using colored petri nets and tile pasting system.

Key Words: Petri nets, Colored Petri Nets, Kolam patterns, Tile pasting

1. Introduction

Kolam is the traditional art that is followed in many places of southern country of India. It gives Psychologically a peaceful and joyful environment for the people during the functions and festival times. In many places even now the women are getting up in the early mornings and clean the entrance (called vassal in Tamil) of their houses and decorate them with the kolam patterns. This habit of drawing such kolam in the entrance of houses has been practiced from long back. One way of drawing these kolam patterns is keeping dots and joining them by drawing a line on them or keeping dots and drawing around them. On the other hand without any dots just a curved lines or a straight lines are also used. These types of kolams are known as rangoli. During the festival seasons rangoli are colored with followers or color powder or even some time dipping the salt in color powder and used. In literature we can see many works on this kolam generation[6, 7, 8] Instead of drawing these kolams continuously we can use a square tiles and tile pasting system to complete these kolam designs. Tile pasting system [5] can be used for pasting these type of tiles.

On the other hand Petri nets are used to model the systems that are concurrent, dynamic, parallel and non-deterministic. Petri nets are first introduced by Carl Adam petri in the year 1962 [1, 2]. Later it has been developed by adding a property that the tokens carry a data value which is called a colored Petri nets [3, 4]. Petri nets have been used for array generation [9, 10, 11], password generation[12] and tile pasting……..

Many methods are existing to generate these kolam patterns in literature. Motivated by this we have introduced a new concept for kolam generation by Petri nets using tile pasting.

2.1 Basic Definitions and pasting rules

Petri Nets: We can see the basic definition for Petri Nets and colored Petri Nets in literature.

Petri net is a bipartite directed graph which has places and transitions. The main difference for
Petri nets and colored Petri nets is: In Petri nets tokens are considered as black dot. In colored petri nets tokens carry a data value. This provides more control on firings.

**Tile pasting:** There exist many examples and definition for triangular tile pasting, extended triangular tile pasting and tessellation. Two tiles can be pasted together if length of their sides is equal. In this type of tile pasting triangular tiles are used. In this paper we have used square, rhombus tiles with and without pattern in it.

**Catenation rule:** We use the following catenation rule:

**Pasting rule:** Two tiles can be joined or pasted together with the edges $e_1$ and $e_2$ using the rule $(e_1, e_2)$ provided that the edges or sides have the same length.

### 2.2. Tiles used for Kolam generation:

![Tiles](image1.png)

Fig.1. Tiles used in Kolam Generation

**2.3. Kolam Tile Array Token Petri Nets:** Kolam generated by kolam tile array token Petri net structure is defined as tuple $\text{KTATPN} = \{ C, T_A, T_R, F \}$ Where $C$ is the basic Petri net structure having places, transitions, arcs that run from place to transitions and from transition to places. $T_A$ is the finite non-empty set of tiles used for creating kolam patterns. $T_R$ is the set of rules applied for kolam generation and $F$ is the final set where the kolam patterns generated by the net are collected. Its explained in the following example.

**2.3.1. Example:** Let $\text{KTATPNs} = \{ P, T, I, O, T_A, T_R, M, F \}$ where $P = \{ p_1, p_2, p_3, p_4 \}$, $T = \{ t_1, t_2 \}$ and the input and the output functions can be noticed in the net in figure (2). $T_A = \{ (c) \}$ taken from figure(1). $T_R = \{ t_1(10, 11), t_2(9, 12) \}$ , $M = \{ (c) \}$ is the initial marking in the place $p_1$, $F= \{ p_3 \}$ is the final set.

![Petri net](image2.png)

Fig.2. Petri net Generating the Kolam in Fig.3

The tile ‘c’ again using the firing rule $(10, 11)$. That is the side 10 of ‘c’ is pasted with the side 11 of ‘c’. This condition is continued till all the sides of ‘c’ with lable 10 is...
joined with the side 11 and the resulting tile is moved to the places p2 and p3. As soon as the tile reaches the place p2, transition t2 is enabled for firing. When t2 fire, it removes the tile from p2 and joins the sides 9 with 12 ans it deposits the resulting array to p1. The kolam patterns that are produced by using the rules assigned for the transition are collected in the place P3, the final place and it is shown in figure (3).

**2.3.2. Example:** Let KTATPNs = \{P, T, I, O, T_{A}, T_{R}, M, F\} where P = \{p_1, p_2, p_3, p_4, p_5, p_6, p_7\}, T = \{t_1, t_2, t_3, t_4, t_5, t_6\} and the input and the output functions can be noticed in the net in figure (4). T_{A} = \{(a), (b)\} taken from figure (1). T_{R} = \{t_1(1, 7), t_2(2, 8), t_3(3, 5), t_4(4, 6), t_5(5, 3), t_6(7, 1)\}, M = \{(a), (b)\} is the initial marking in the place p1, F= \{ p_7 \} is the final set.

In the initial place p1 we have two tiles a and b. The transition rules are defined in example 2. On firing t1 the tiles a and b are removed from place p1 and joined with the sides 1 and 7 and posteted in the place p2. As soon as the tile reaches the place p2 transition t2 will be ready for firing and on firing t2 sides having label 2 are joined with sides having label 8. The tile coming out is shown in figure (5). The corresponding transitions are also fired and the rules are applied one by one and the kolam produced is collected in the place p7 as shown in figure (5).
Conclusion: A new model for generating the Kolam patterns have been discussed in this paper. Tile pasting and kolam generation has been explained in literature separately. Kolam generation using petri nets and pasting rules together results in decorating a large area with beautiful kolam pattern. Kolam generation using tile pasting and colored petri nets will be considered in the future work.

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