Fig. 5. Primitive patterns of the P System Kolam.

$$z\ z\ z\ z\ u\ x\ x\ x\ v\ z\ z\ z\ z$$
$$u\ s\ s\ s\ s\ s\ x\ x\ x\ s\ s\ s\ s\ s\ v$$
$$y\ y\ y\ y\ y\ u\ x\ x\ x\ v\ y\ y\ y\ y\ y$$
$$u\ s\ s\ s\ s\ s\ x\ x\ x\ s\ s\ s\ s\ s\ v$$
$$y\ y\ y\ y\ y\ u\ x\ x\ x\ v\ y\ y\ y\ y\ y$$
$$u\ s\ s\ s\ s\ s\ x\ x\ x\ s\ s\ s\ s\ s\ v$$
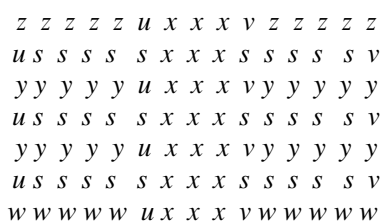$$w\ w\ w\ w\ w\ u\ x\ x\ x\ v\ w\ w\ w\ w\ w$$

Fig. 6. Array representation of kolam in Fig. 3.

The primitive patterns corresponding to the symbols (0 for arc line and 1 for linear line) in the array in Fig. 5 are as follows in the notation by NAGATA and ROBINSON (2006):

a, b, c, d: saddle 0011, 0110, 1001, 1100
x, y: pupil 0101, 1010
u, v: fan 1011, 1110
s: diamond 1111
z, w: drop 0010, 1000

The set of such kolam patterns can be generated by a Sequential/parallel rectangular array P system similar to the P system Π_2 in the proof of Theorem 2, with slight modifications but cannot be generated by any CF 2D matrix grammar as the "middle part" and the "left/right parts" have equal number of columns in the kolam.

5. Conclusion

We have introduced here a new type of array P system called S/P rectangular array P system based on 2D matrix grammars. We have exhibited the suitability of these systems for Kolam pattern generation. One of the problems that needs further study is the minimum number of membranes needed for generation of kolam patterns discussed here.