Frieze Patterns : Generation and Recognition

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Introduction

Frieze patterns are one-dimensional repeating patterns that are based on an equidistant point lattice. They have two-dimensional motifs that repeat symmetrically in one direction, making them periodic. Frieze patterns are part of a class of infinite discrete symmetric groups of patterns on a strip, which are called frieze groups. There are seven possible frieze groups that have infinite repeating symmetry within one dimension. These patterns can be mapped onto themselves by horizontal translation and other transformations.There are 7 frieze patterns :

Hop - Translation Symmetry
**Step** - Translational and glide reflection symmetries
Sidle - Translational and vertical reflection symmetries
Jump - Translation and horizontal reflection symmetries
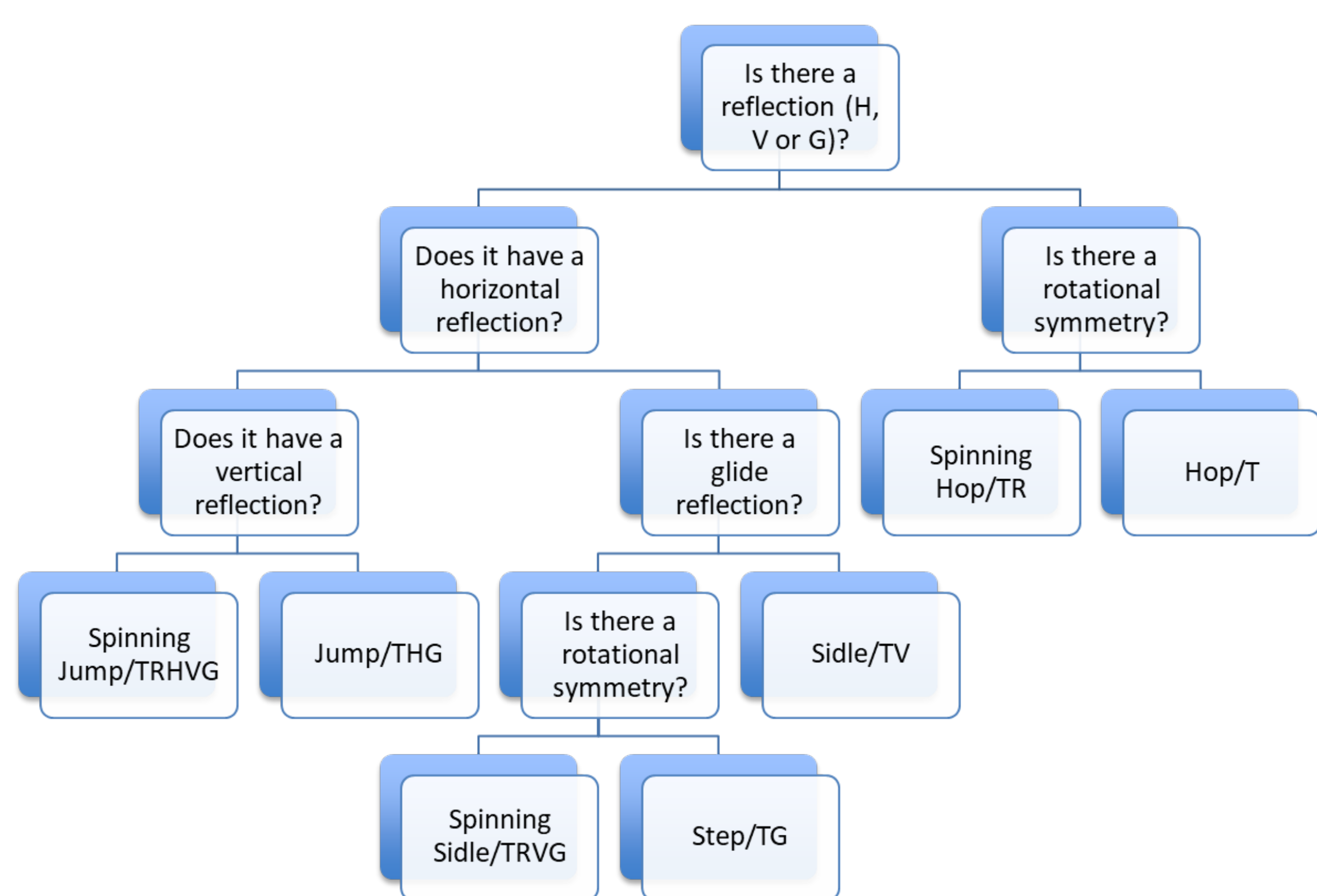**Spinning Hop** - Translation and rotation (by a half-turn) symmetries
Spinning Sidle - translation, glide reflection and rotation (by a half-turn) symmetries
Spinning Hop - all symmetries- translation, horizontal & vertical reflection, and rotation

Glide	Hop	Jump	Sidle

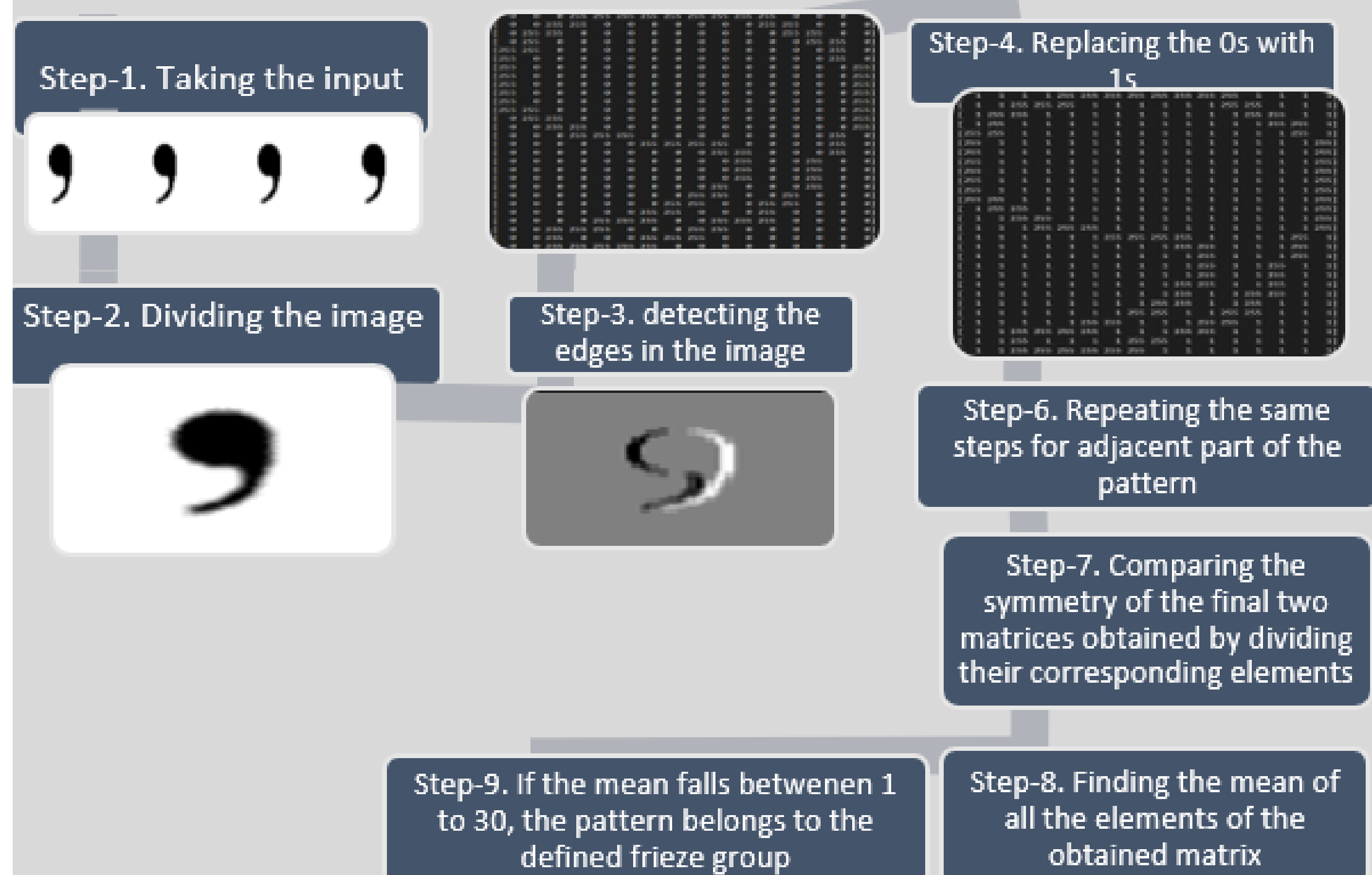| Spinning Hop	Spinning Jump	Spinning Sidle
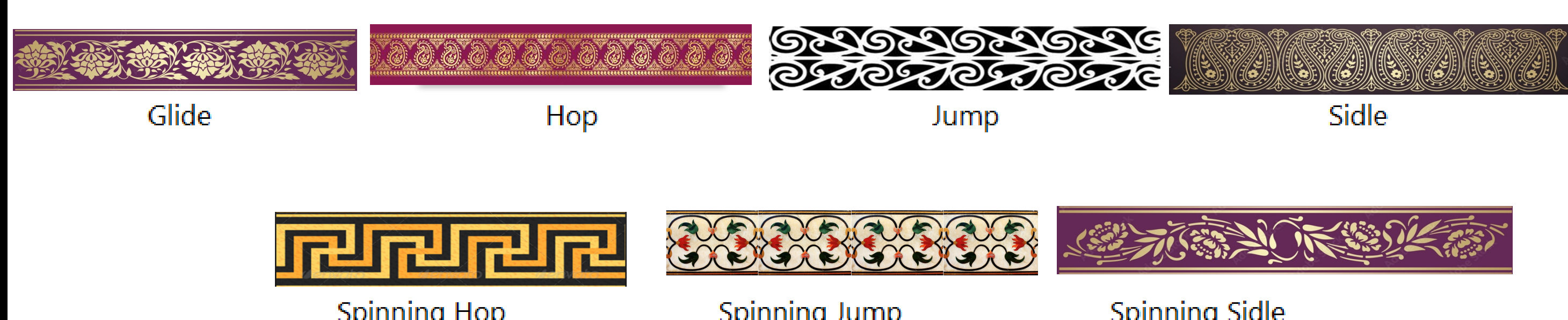
Methodology

1. **Frieze Pattern generation :** For the generation of the required pattern, the selected picture was concatenated on the basis of the following flowchart determining symmetry in the patterns.

- Is there a reflection (H, V or G)?
- Does it have a horizontal reflection?
- Is there a rotational symmetry?
- Does it have a vertical reflection?
- Is there a glide reflection?
- Spinning Hop/TR
- Hop/T
- Spinning Jump/TRHVG
- Jump/THG
- Is there a rotational symmetry?
- Sidle/TV
- Spinning Sidle/TRVG
- Step/TG

Decision Tree for the generation of frieze patterns (Image courtesy : Prof. Shobha Bagai)

2. Frieze Pattern Recogniion :

- Step-1. Taking the input
- Step-2. Dividing the image
- Step-3. detecting the edges in the image
- Step-4. Replacing the 0s with 1s
- Step-6. Repeating the same steps for adjacent part of the pattern
- Step-7. Comparing the symmetry of the final two matrices obtained by dividing their corresponding elements
- Step-8. Finding the mean of all the elements of the obtained matrix
- Step-9. If the mean falls betwenen 1 to 30, the pattern belongs to the defined frieze group

Objective

The aim of this project is to analyse frieze patterns and develop a software to create a strip of any of the 7 patterns of any selected photo and conversely to recognize the pattern if a strip is selected.

Results

Pattern Generation — To Print Pattern
Pattern Detection — To Detect Pattern

What is Frieze Pattern

In mathematics, a frieze or frieze pattern is a two-dimensional design that repeats in one direction. Such patterns occur frequently in architecture and decorative art. Frieze patterns can be classified into seven types according to their symmetries. The set of symmetries of a frieze pattern is called a frieze group.
Frieze groups are two-dimensional line groups, having repetition in only one direction. They are related to the more complex wallpaper groups, which classify patterns that are repetitive in two directions, and crystallographic groups, which classify patterns that are repetitive in three directions.

Choose File

frieze pattern you want to generate

Horizontal | Jump | Sidle

Jump pattern generated

```
import cv2
import numpy as np
path = 'C:\\Users\\Desktop\\Patterns\\SpinningHop\\1.jpg'
img = cv2.imread(path)[:,:,0]
rec_frieze(img)
  0.0s
The predicted pattern :  p2
```
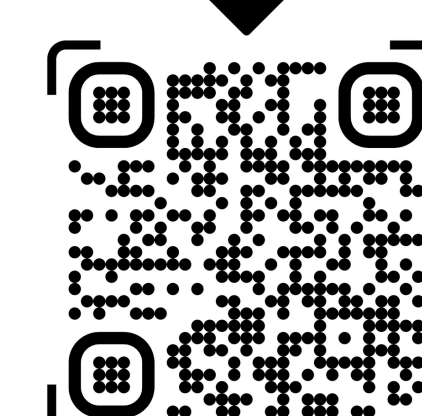
Applications

- The algorithm could be integrated into graphic design software, allowing designers to quickly and easily create complex frieze patterns for use in a wide range of applications, from textiles to wallpaper.

- Patterns can be useful in the medical field to diagnose any unusual pattern in heart rate, pulse rate etc. By analyzing patterns in treatment outcomes, doctors can optimize treatment strategies and improve patient outcomes.

- The algorithm for recognizing frieze patterns could be further developed and help to recognize other types of patterns in images and videos. This could have applications in a wide range of fields, from security to manufacturing, where pattern recognition is important.

Future Work

- The model can be fine tuned to recognize frieze patterns more accurately
- The dataset can be increased by generating more no. of images' patterns
- The UI can be modified and an app can be integrated

References

Appendix