DSC412 Project Proposal & Plan: Image to Knot Pattern Conversion

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***Abstract*— The art of weaving and pattern-making are intertwined, and yet the process to convert a design into a pattern is arduous and if a pattern is lost, often so is the design. The objective of this project is to translate an object or design from an image into a macrame pattern, that can be used to hand weave textiles.**

I. Proposal

A. Problem

Woven textiles are a staple across different cultures and time. And from Iranian rugs to Brazilian lace-making, patterns are a defining piece of the weaving process. For the scope of this project, the focus will be on macrame patterns, specifically hand-woven knotted textiles generally made in the form of bracelets, lanyards, belts and other long thin forms factors. Colloquially (in the US) this kind of textile is referred to a friendship bracelet, but the knotting techniques and general use cases extend far beyond bracelets.

Typically patterns are made by the craftsperson, taking inspiration from a design, natural entity or object they see around them. However, when the craftsperson begins drafting the pattern, typically represented by a series of pixels/boxes (knots), as shown in figure 1 [1], they are making a series of educated guesses based off their experience and it is very difficult bringing together their intended design with their intended size and thread count.

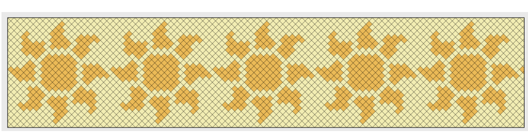

Fig. 1. Example of grid pattern

The primary problem being approached is the lack of baseline pattern for a particular intended design, especially if that design falls outside of very standard designs dating back thousands of years. Craftspeople can see a design or object, but the transfer to a usable pattern is an arduous process. This presents a barrier of entry to newcomers. Furthermore, even if an experienced craftsperson loses their pattern for a particular design, they begin all over again. Pattern loss is actually a relevant problem for lace weaving as well, as the difficulty to enter the industry and sustain a career means that less and less traditional lace weavers are working every year. Combined with the practice of destroying lace patterns, often patterns are lost to time without the ability to recreate them [2].

The objective is not to take the art from the artist, but rather to aid them in developing the baseline pattern which they can then tweak, adjust the size of or expand upon. Pattern loss and barrier of entry to pattern creation are two sides of the same issue, or at the very least two issues that can be approached with a similar method of solving.

B. Method

The proposed solution to the problem is to create an application (may or may not have a GUI) in which the user inputs a photo and the output is a macrame pattern. There is an step between photo and the "final" pattern which is a gridded design. The model will take the photo, identify the primary object in the photo and generate the gridded design. From the gridded design, the "final" pattern can be obtained without machine learning techniques, and this last step may or may not be included in the project.

The object identification will be done using image segmentation, although candidly more research needs to be done on whether semantic or instance segmentation would be more appropriate here. The second step will be auto-filling the rest of the pattern potentially using LaMa (Large Mask Inpainting), although again, more research will be done to affirm that this is the most efficient method [3]. Having worked with LaMa in the past, it is effective but can take up time. Now having identified the primary image *and* filled in the pattern to have a complete design, some form of supervised neural net will be used to overlay the grid. The data includs both gridded pattern and pictures of the resultant bracelet which will be used for comparison. There is also the possibility of contrasting a design on fabric, walls or other two-dimensional designs with a resultant pattern, but the data collection would be extensive. Some collected data will be used, and is described in II-B.

The tricky part will be implementing a GAN (Generative Adversarial Network) or combination of networks to output the gridded pattern image. That will be the final step in pattern creation.

C. Stakeholders

My roommate and other weavers are the potential stakeholders for this project, making them also an excellent resource for inquires into what would be a useful outcome and what would not be. After completing the project, more stakeholders across textiles may become apparent, but for the time being, the weaving and macrame community are the primary stakeholders.

D. Potential Obstacles

The first challenge will be adequately identifying what the object is in the photo that the grid must be generated for. However the larger challenge will likely be auto-filling and generating new images. The model will undergo multiple rounds of trial and error (hopefully educated) to understand what inputs work best with the GAN.

E. Novelty

Multiple papers have been published attempting to use machine learning or AI techniques in regards to textiles, as seen in II-G. The majority of the research has been in analyzing and differentiating textiles, especially in areas like knitting or machine-woven fabric. More intricate, often hand-woven techniques, like macrame, have yet to be studied in such a manner. The primary novelty of the project lies in its ability to generate rudimentary patterns from images for macrame, which has not been successfully done yet or has yet to be published.

II. Plan

A. Data Set Acquisition

BraceletBook [4] and FriendshipBracelets.net [5] are two large vaults of friendship bracelet-style macrame patterns. Both show a gridded pattern of the bracelet and a final pattern. However, only BraceletBook has a filtered version that shows both the image of the bracelet, the gridded pattern *and* the final pattern. The image of the bracelet will be one part of the data, while the gridded pattern will be the second part as further explained in II-C.

B. Data creation

My roommate has generously agreed to loan her creations and their patterns. Images will be collected of both and added to either training or validation data sets.

C. Data Organization

The data will be organized into two categories, images of objects/designs and their respective grid patterns. This will then be subdivided into training and validation data. The distinction of grid pattern and final pattern seems like it would be significant, but the grid *is* a pattern in its own right, which means if time permits, the grid will be converted to a final pattern, but that process is already understood and does not require machine learning.

D. Data Analysis

The first half of the data (the images) will be assessed for patterns that can be identified, but also not so straightforward that the model is essentially trained to only recognize bracelets laid perfectly against the table. If this proves extremely unfeasible, the images collected will be adjusted to make it easier for the model to detect the object/design.

The second half of the data will be analyzed for similarity to the first set of images. Essentially the pattern needs to have shapes or colors that the model will be able to identify as corresponding to the images.

E. Model Type

An image segmentation model, a LaMA model [3] and a GAN (or multiple) will be used in conjunction with one another for this project.

F. Accuracy Determination

Because there are no set patterns (outside of those used for validation data) to compare the resultant patterns to, the best way to determine accuracy at this time is to format the application in an easy-to-use way (possibly with a GUI) and have people compare the output. The best method may be to appeal to forums that weavers use and or speak further with the other weavers in the area. BraceletBook [4] actually has a forum, although how well-used is unknown at this time.

G. Previous Models

Machine learning modelling has not been applied to macrame, but has been applied to machine knitting [6] and pattern-making for lace [2]. Machine learning has also been applied in the textiles industry to help with woven pattern recognition [7].

References

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