GAN Generated Knitted Pattern Punch Card Designs

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Abstract

Textiles and computation have a lot in common. Early computing was developed, using punch cards from the Jacquard loom (Hollings 2018). This paper explores the use of computational Artificial Intelligence for the design of new knitting punch card patterns using Generative Adversarial Networks (GAN). These designs were ultimately tested on a domestic Brother Kh 836E knitting machine producing physical tactile patterns.

Introduction

Domestic knitting machine punch cards consist of 24 dots wide and varied lengths. These dot patterns act as a binary code. This research uses an AI GAN combine and interoperates a data set of punch card images into new pattern designs, revealing an underlying structure across the sample set of designs.

Historical Context

Knitting is a more recent development than weaving. Originally done by hand with knitting needles, knitting machines developed in the 19th century utilizes a bed of needles, punch cards, and a cartridge to carry the yarns across the rows.

Fair Isle Patterns

Fair Isle knitting patterns use only two colours in a row, and consist of small repetitive decorative patterns. While one colour is active the other floats in the back of the fabric. For successful Fair Isle patterns, floats should be less than five stitches long. Patterns consist of geometric, organic, and object based designs.

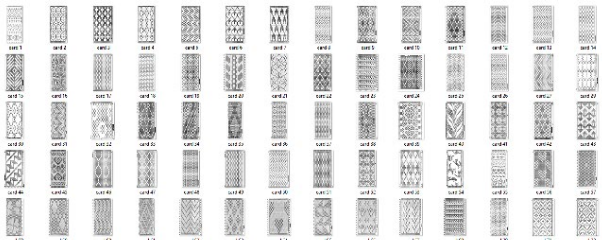

Fig. 1. *Sample Portion of the Data Set*, 2020, Virginia Melnyk.

Computation

Neural Networks (NN) act similar to how human brains learn. Layers of neurons or nodes categorize pattern information. GANs use both a generator and a decimator network to test the validity of a produced image.

The Data Set

The data set for this exploration was scraped from google images; resulting in 121 quality pattern images (See Figure 1). To create a broader data set, the images were cropped into multiple square images and some were mirrored. This resulted in total of about 1200 images.

AI Knits

In this research, Neural Style Transfer (NST) and StyleGAN2 were used within Runway ML software.

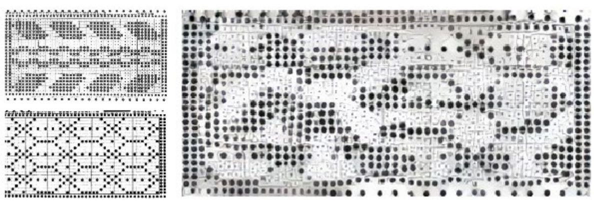

Fig. 2. *NST Punch Card,* 2020, Virginia Melnyk.

Neural Style Transfer

NST uses two images, a style image and a structure image. The results were successful, as you could see the underlying structure and the style pattern working together in the resulting punch card pattern image (See Figure 2).

StyleGAN2

For StyleGAN2 the larger data set of cropped images was used to train. Several tests were run at different epochs. The 1500 epoch run produced the best results for clear unique punch cards. The resulting square images were combined to create a longer punch card proportioned pattern (See Fig. 3).

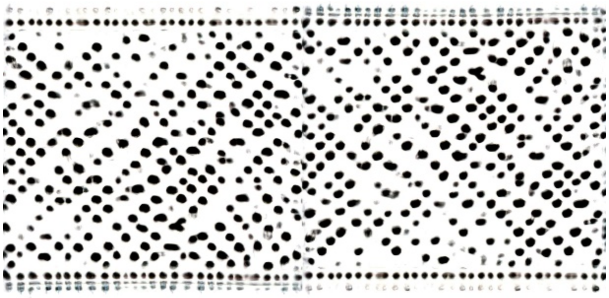

Fig. 3. *StyleGAN2 Punch Card,* 2020, Virginia Melnyk.

The Results

The punch card images generated were then used to knit physical tests in different materials and colors, to explore the robustness and tactility of the designs.

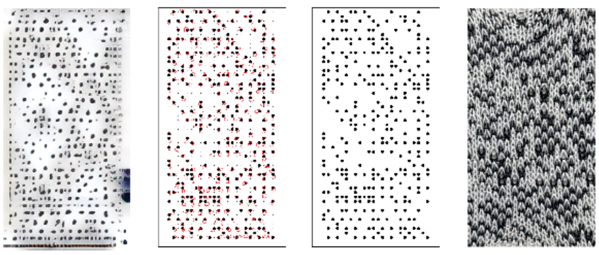

Fig. 4. *Punch Card Process,* 2020, Virginia Melnyk.

Creating the Punch Cards

The resulting punch card, images were not precise dot matrixes to be able to directly use as punch cards. Parametric software, Grasshopper for Rhino, was used to refine the circles and restructure them onto the ordered grids (See Fig. 4). These were then laser cut out of thick Mylarfilm.

Resulting Knits

The physical results generated patterns were successful Fair Isle designs. They used two colors and had floats lasting no more than 5 stitches. The patterns appear stochastic at first glance but upon longer inspection they had underlying repetition such as diagonals, checks, and vertical stripes (See Figure 5). The use of different yarns produced varying textures.

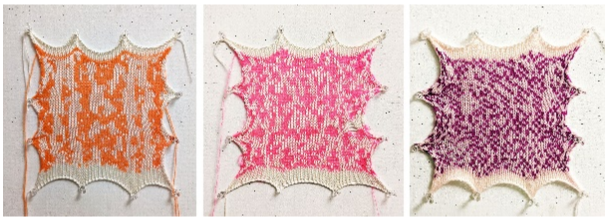

Fig. 5. *Knitted patterns,* 2020, Virginia Melnyk.

Conclusion

The exploration of knit pattern design does successfully produce new patterns that follow the underlying structure of Fair Isle knits. These new patterns reconfigure and recombine the many styles and cultures of the patterns from the data set. Throughout the process of production, human and machine collaboration is utilized as a back and forth relationship. Perhaps these textiles generate a new AI aesthetic reflecting the mixing pot of contemporary digital culture.

References

Hollings, C., Martin, U., & Rice, A.C. (2018). *ADA Lovelace: The Making of a Computer Scientist*. Oxford: The Bodleian Library.

Biography

Viginia Melnyk is currently a PhD student at Tongji University's DigitalFUTURES International PhD program. She explores temporary, textile, and transformative structures, focussing on knitted textiles as an intelligent material and designing within the pattern and material structure. She has exhibited work from Beijing to Toronto, Boston, Cincinnati, and Buffalo. She currently is also a lecturer at Clemson University.