Florautomata | Faunautomata

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Abstract

Each member of this collection of textile artwork embodies a juxtaposition of time-evolved 1D cellular automata (CA) and biological forms derived from plant and animal sources. The works incorporate digitally printed textiles with CAs embroidered via a computerized longarm quilting machine. Biomorphic forms in the digital prints are quilted using freemotion thread painting techniques. We present the creative process leading to the realization of selected works, including mathematical programming, integration with vector graphics and the longarm machine, and design principles used in thread painting.

Introduction

Florautomata | *Faunautomata* joins a number of other works blending mathematical elements drawn from cellular automata with physical instantiations in the fiber arts (*e.g.*, knitting, weaving, and clothing). [4,6–9, 12] It also extends the artist's own work merging digitally-printed textiles with manual and automated quilting and embroidery processes. The *Florautomata* | *Faunautomata* series of works incorporates juxtaposed 1D time-evolved cellular automata (CA) and biomorphic forms drawn from digital macrophotography. The intent is to evoke, in the viewer's mind, the relationship between simple code-based automata and complex biological systems that share coded structures via their genetic inheritance. Each instance in this series of textile works uses a cellular automata "frame," paired with a central figure based upon a floral or animal subject. The CA material is rendered via computerized embroidery on a longarm quilting machine, and the remainder of the work is quilted using freemotion techniques on the longarm. A Python script, `caemb.py`, performed CA generation using a 3-neighbor computation with rendering to Scalable Vector Graphics format (SVG) via the *svgwrite* Python module [10]. The CA numeration scheme used is from Wolfram [11].

Rationale

A grant provided by Lehigh University for a project entitled *Curved on Straight* funded a project that continues exploration of biomorphic form, abstraction and mathematics. Initiated by plant and insect photography that demonstrates some formal organization, (whether it be evidence of the phyllotactic ratio in leaf or petal arrangement, Fibonacci sequences in spiral patterns and petal count, or golden ratio in venation and wing proportions) the main image is then post-processed with further cropping. The linear element of a stitch itself is analogous to the pixel. Every image must ultimately be rendered into stitches in order to be quilted which is in itself an act of abstracting form. The challenge here will be to harmonize what is generated from the curvilinear biomorphic seed with the cellular automata seed.

Digital quilting fill patterns are widely available from commercial vendors. [5] They lend themselves to traditional quilt styles and don't vary in density to the extent that free motion fill techniques do. The cellular automata are used here as the background fill and they interrupt the contours of the primary subject. The primary subject retains its identity but its edges are permeable much the way that a Dutch Baroque portrait or still life has lost and found (*i.e.*, soft and sharp) edges. Every instance of a cellular automaton is like a fingerprint: the familial lineage encoded in the CA rule is recognizable but the particular instance is unique, based upon initial seed conditions. This approximates the hand of a free motion artist that might otherwise be overly regular in automated quilting.

After aesthetic decision-making, the first requirement is to reduce the number of machine stops and starts and resulting thread cuts and potential misalignments of the machine head on each start. This requires a single line stitch path. Embroidery with a Wolfram cellular automata rule as its seed is rendered with a contrasting but harmonizing embroidery thread in a monochromatic or analogous color scheme. In the quilted and embroidered example, the embroidery color is in the same family of violets and magentas extant in the cropped flower. The key is higher to allow for sufficient contrast to perceive a figure ground relationship between the embroidery and the flower, elevating the importance of negative space in the composition. The three-sided triangles of negative space created in the embroidery patterns by the cellular automata rule are juxtaposed on a five-sided form following the floral arranging tradition. Odd numbers in floral arrangement are considered more aesthetically pleasing and are typically asymmetrically balanced.

Workflow

The original macrophotography files are edited in *Adobe Photoshop* [2] and imported to *Adobe Illustrator* [1]. The output of the caemb.py script is added to the Adobe Illustrator document, and edited to avoid obfuscation of the central subject. Thread color selection is determined based upon the macrophotography file background, but with sufficient contrast to distinguish from the background itself. The modified vector layer is exported as an Illustrator file, and is then processed in *Art and Stitch* [3], which writes an output file compatible with the longarm quilting machine. Figure 1 shows the original CA source image (with a pseudorandomly-generated initial condition) with the realization to embroidered and quilted artwork.

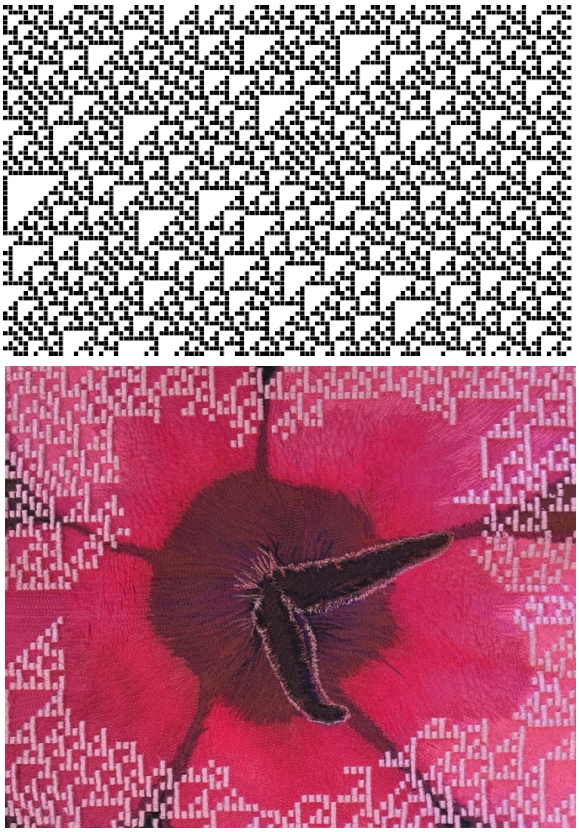

Figure 1: *(top) Cellular Automata, rule 102. SVG exported graphic from Python script. (bottom) Florautomata I (17 x 14 in.). Digital print, embroidered cellular automata and thread painting.*

Continuing Work

Figure 2 depicts digital previsualizations of upcoming series members. The thread color for the butterfly wing on the right is the color of the lemon it was feeding on. The thread color of the moth wing on the left is intrinsic to its abdomen. The finished floral composition in Figure 1 is based on a floret that was ¼ inch in size. The thread color is a higher key value of the outer edge of the cropped petals.

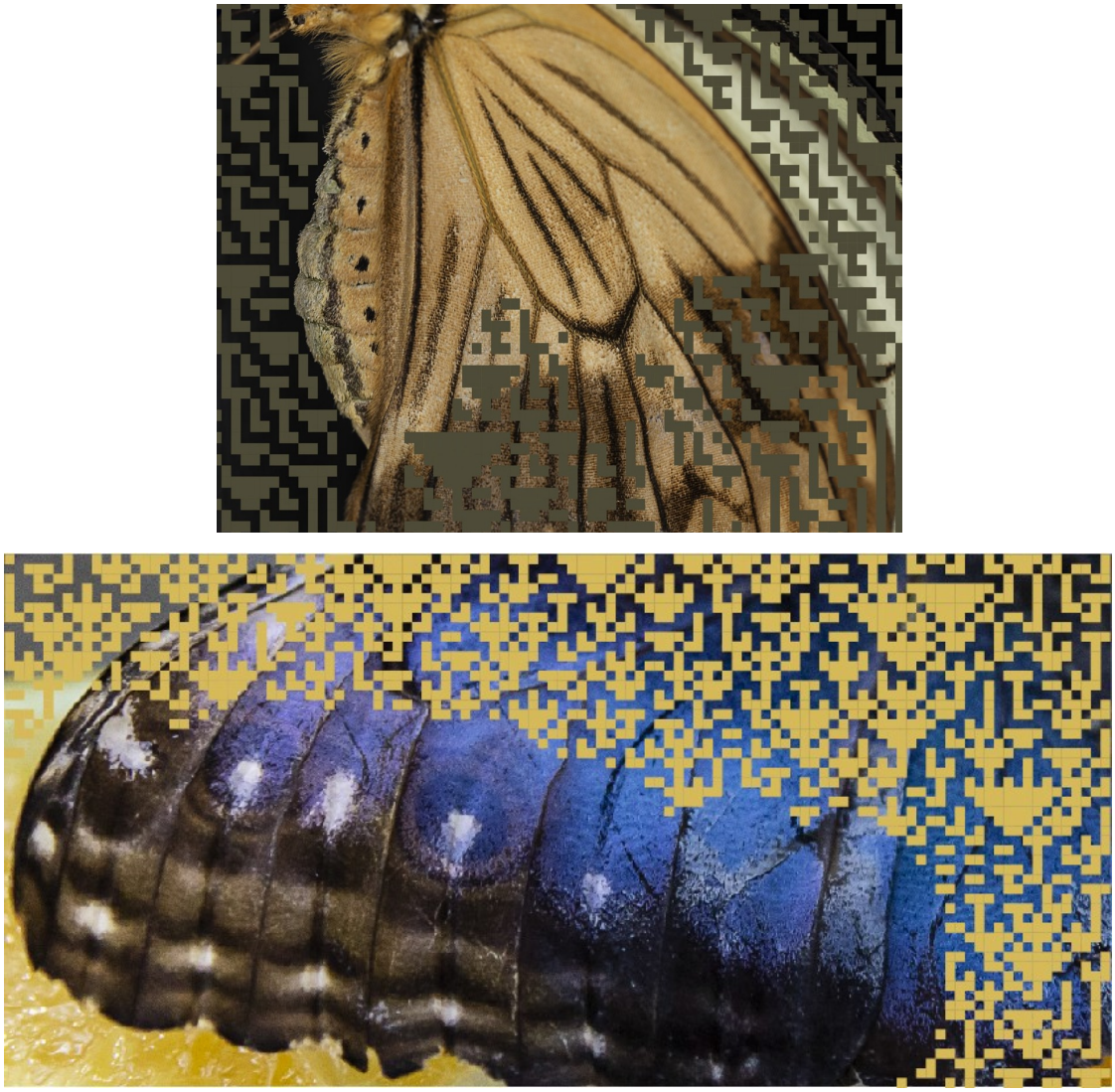

Figure 2: *(top) Faunautomata I. Rule 149 (after Wolfram); (bottom) Faunautomata II. Rule 165 (after Wolfram). Digital print macro photos, embroidered CA and threadpainting.*

Summary and Conclusions

Curvilinear organic forms were captured using 5:1 magnification of floral and insect imagery, which were thread painted with free motion longarm techniques. These curvilinear biomorphic forms are juxtaposed with rectilinear computer-driven embroidery of cellular automaton renderings. Thread painting incorporates optical color mixture.

A technical issue to address in future work is the number of machine starts and stops. In the embroidered piece there were over 1600 squares and the embroidery software thread path is more visible than we like.

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