

# Making Beautiful Embroidery for “Frozen 2”

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Figure 1: Embroidery examples from Disney’s “Frozen 2”

## ABSTRACT

In Walt Disney Animation Studios’ “Frozen 2”, costumes play an important part in the character design and story. Intricate embroidery on the costumes captures integral components of the characters’ personalities, symbolized by the different shapes and patterns. One of the challenges for the character team was the realization of the intricate embroidery work that is essential to the character design. We present a new curve-based approach to procedurally generate complex embroidery that can take 2D visual designs represented by line strokes and produce renderable curves. The curves deform along with the costumes while staying flattened on their surfaces. The method is straightforward and intuitive. Authoring and visualization are fast and easy, allowing quick iterations without a large amount of manual work from artists when a design changes. The method supports free-form stitches with threads of various widths, colors and opacities, enabling a wide range of embroidery styles.

## CCS CONCEPTS

• Computing methodologies → Modeling methodologies.

## KEYWORDS

embroidery, proceduralism, curve generation

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## 1 INTRODUCTION

Believable and appealing characters are always a cornerstone of Walt Disney Animation films, and costume is an essential part of characters. In “Frozen 2”, the visual costume design is characterized by different shapes and symbols embroidered on the clothing. The embroidery is not just an accessory, but an integral component of the characters and story. The creation, motion and rendering of the intricate embroidery was a key challenge for the character team.

Previously in Disney’s “Frozen”, embroidery was achieved using a map-based approach (see Figure 2). Multiple layers of texture maps were created, including thread and bezel displacement maps to mimic the embossed look of the embroidery stitches, orientation maps to control the stitch placement, and color maps to control the thread colors. All of these maps were then combined together to create the final embroidery look. With this approach, the artist had to repaint all the layers of the maps when there were any changes to the design. This was very labor intensive and inefficient.



Figure 2: Map-based embroidery examples from “Frozen”

The volume and complexity of embroidery required on “Frozen 2” challenged us to look beyond the map-based approach. We needed a more efficient and artist-friendly approach to achieve the organic and realistic embroidery for a variety of design patterns. Drawing inspiration from how we make embroidery in real life, we have implemented a new curve-based embroidery generation method.

## 2 APPROACH

### 2.1 Input

Embroidery patterns in the real world are comprised of individual stitches that can be represented with lines or curves. The input to our embroidery generation process is a collection of line strokes that represents the stitches of any embroidery patterns. We support line strokes from Adobe Illustrator and Disney’s Meander, our in-house vector drawing tool. The input can also be NURBS curves directly authored in Maya.

### 2.2 Embroidery Prep Tool

The Embroidery Prep Tool is used to process the input data and convert the line strokes or NURBS curves to Disney’s multiCurve shape. multiCurve is our in-house aggregated curve node that can represent a large number of curves. It is significantly more efficient to load and visualize in Maya than NURBS curves, thus making iterations easier and faster.

The Prep Tool then binds curves to the costumes based on the embroidery locations. The color and transparency properties for each stitch can also be specified using this tool.

### 2.3 Embroidery Generator

The multiCurve defining the design patterns is passed to Disney’s XGen to generate final renderable embroidery stitches on the costume. Disney’s XGen is our in-house instancing tool used to procedurally populate geometry surfaces with a large number of arbitrarily shaped objects. It is a very versatile tool and mostly used for hair grooming and environment authoring. For “Frozen 2”, we have augmented it to deal with embroidery by implementing a new embroidery generator. Artists can also take advantage of Disney’s XGen’s many existing functionalities to create more organic and realistic looking embroidery.

Noise effects can be added to generate less-than-perfect stitches for a more organic, hand-made look with jagged edges. This also helps break up the specular response more organically and achieves a more consistent lighting effect than with the map-based approach.

To control the behavior of the stitches, a Flatten effect module is added to prevent the stitches from intersecting or floating over the fabric surface. It makes sure the stitches to stay flattened on the costume, to fold, wrinkle and stretch in accordance with costume movements.

Curve displacement is used to achieve the embossed look of the embroidery stitches. Through Disney’s XGen, it is also possible to define the thickness of each thread, and pass the colors and transparency levels to the shader for rendering.

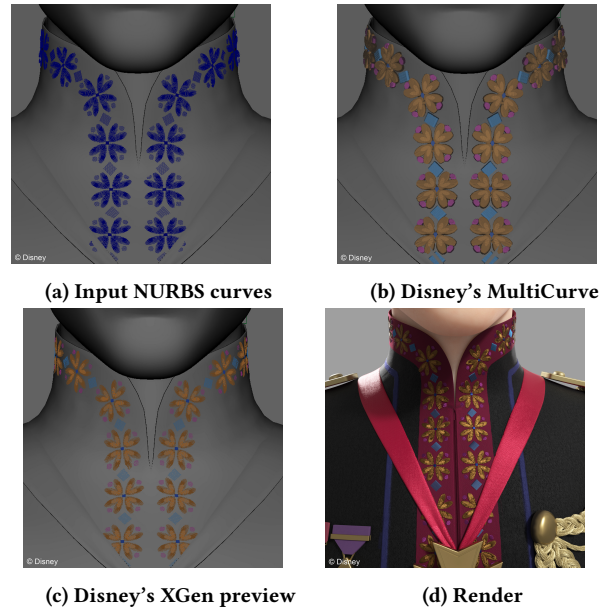


Figure 3: Different stages in making embroidery

## 3 RESULTS AND CONCLUSIONS

The new curve-based embroidery workflow provided an intuitive means for artists to author complex embroidery patterns. It is very easy for artists to make changes to design patterns and placements. Repeating patterns can be created easily from copy and paste. Figure 3 illustrates the results at each step of the process. Figure 4(a) shows the detailed embossed look. Additionally, in the embroidery world, there are also cases where one stitch is made of multiple threads instead of a single one, we have a Curve Bundle effect module in Disney’s XGen to achieve such looks, as shown in Figure 4(b). Due to the use of multiCurve and XGen’s proceduralism, the method is very light weight since no heavy data needs to be carried down the pipeline. The new embroidery toolset made it possible to achieve the various embroidery works as manifested by the beautiful and intricate costumes in “Frozen 2”.

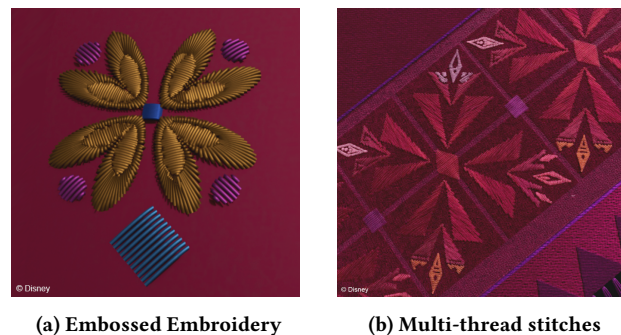


Figure 4: Close-up embroidery examples