Wrapped Clothing on Disney's Raya and the Last Dragon

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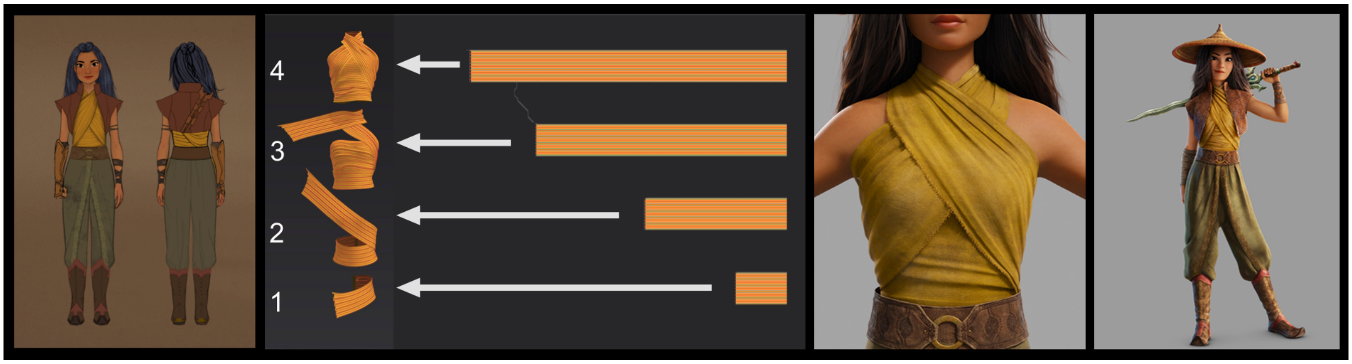

Figure 1: Raya's *bust-wrap* and *dhoti* design (left-right): concept art, bust-wrap construction steps, renders of wrap and full outfit

ABSTRACT

This talk outlines novel techniques used to create the complex wrapped clothing on Walt Disney Animation Studios' "Raya and the Last Dragon". Inspired by traditional Southeast Asian designs, these wrapped garments are formed by deftly folding long panels of cloth, with little to no reliance on seams to hold the structure. This departure from a standard pattern-based pipeline made the construction and performance of these specialized garments in CG a very challenging task. Using the sampot, dhoti, and bust-wrap garments as production examples, we describe their real-world counterpart designs and construction, discuss what makes them challenging to create in CG, and then outline how we extrapolated their designs and realized them for the stylistic needs and performances of the characters on the film.

CCS CONCEPTS

• **Computing methodologies → Physical simulation**; *Mesh geometry models.*

KEYWORDS

wrapped garments, tailoring, cloth simulation

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1 INTRODUCTION

The designs of the garments worn by the characters on the film are inspired by traditional wrapped clothing from the many diverse regions of Southeast Asia. These garments, such as the *dhoti*, *sampot*, and *bust-wrap*, typically consist solely of large pieces of fabric that are wrapped, folded, and tucked into position to produce the structure and style, with little to no seams to hold the form. These garments can have very different appearances depending on the weave and how the hand-crafted folds land upon draping.

In contrast, the types of garments found in our previous films are typically constructed from 2D patterns resulting in fabric pieces that are sewn together to produce the 3D garment (e.g. pants, shirts, skirts). The pattern, seams, stitching, pleats, etc, produce the overall structure. Our existing cloth construction pipeline has evolved over time to emulate the pattern-based workflow used in tailoring. We have found that this approach gives us the most natural results both in look and motion performance. Faced with the challenge of realizing these unique wrapped garments, the insight was once again to look into the real-world counterparts and extrapolate the wrapping technique into a novel approach in CG.

2 RESEARCH AND EXPERIMENTATION

Our first step was to understand how wrapped garments are created and worn. In this effort, we were not able to find any examples of this style of garments in CG , neither in film-making nor in the fashion industry. Thus started a series of research and experimentation, to analyze how these unique garments are wrapped and worn to gain insight into their complex draping behavior. The Asset team did a series of hands-on experiments where we wrapped the garments on a doll, as seen in Figure 2, and also on ourselves and then recorded enacting some of the ranges of motions that the characters needed

Figure 2: (left) Sisu's *sampot* and *bust-wrap* concept art. (right) Result of hands-on experiments creating both of the garments on a doll using two rectangular paper panels.

to undergo. This allowed us to visually comprehend the balance between mobility, flexibility, and appeal in the performance of these garments. All of these tests helped inform and influence the design choices for each character's personality and performance.

This tactile experimentation with the garments helped us lay out the steps needed to translate from the real world into CG. One challenge is that these garments have very few or no seams. Our existing methods are not directly applicable because they depend on analysis of tension wrinkles and adjustment of the surface area and seams to achieve a good fit. From this exploration, we inferred that we should treat the garment holistically, staying as true as possible to the physical mechanics and rely on different wrapping and folding techniques to achieve the desired form.

3 GARMENT ASSET CREATION

For our standard pattern-based workflow, we utilize the Marvelous Designer tailoring package to define the 2D patterns, seams, and stitching features, and to simulate the initial draped pose of the garment on the character. The pattern uvs and draped meshes are then used in our in-house cloth solver to create the cloth rig. We followed a similar overall workflow for the wrapped garments, however the main insight and departure was instead of trying to fit these garments into a standard pattern/seam solution, the garments are composed from large fabric panels which are rolled and/or folded to create the structure and drape.

Our initial CG tailoring efforts informed us that the final drape is dependent on many factors, including use of rolls versus folds, the aspect ratio of the cloth panel, and the order of overlapping layers of cloth. We leveraged various CG capabilities of the tailoring package and solver to emulate pulling and tugging of the cloth to wrap it over a form to produce the desired folds, as shown in Figure 1. This includes dynamically growing the pieces to emulate unrolling, altering gravity, adding helper collision objects and temporary pins, and adjusting the garment edge-flow and resolution.

3.1 Iteration with Simulation

Once the initial tailoring pass was complete, motion tests were essential in finding the best drape for the design and desired performance. This required efficient iteration between tailoring and simulation. We developed an end-to-end approach that allowed us to address art direction at the reference diagram or panel level as well as in the simulation. Adjusting the topology in simulation was key in achieving the very specific folds.

To efficiently absorb tailoring changes in simulation and rendering, all geometry data is stored in a uv panel space that is stable across changes in shape and topology. This reduced the turnaround time and optimized iterations, enabling us to efficiently experiment with various folding and wrapping approaches. We were also able to leverage the uv space to represent rest lengths in the solver to recapture any tension that resulted from the draping of the cloth in the tailoring phase.

Understanding how to practically realize these garments in CG was a learning process that required numerous iterations. Our in-house cloth solver was developed with an emphasis on robust collision handling which allowed us to push the draping and folding complexity. However, due to the number of iterations, as well as the large size of the cloth panels and number of folds, it was key to improve the stability and speed of the overall simulation rig. Performance gains were achieved by strategically reducing collision thicknesses, and removing areas of the fabric that do not contribute to the art-directed look. The combination of the various optimization techniques introduced in the tailoring and simulation phases enabled a tight continuous loop of experimentation and iteration that was key in achieving the final designs.

3.2 Refitting for Garment Reuse

Once the base garments were created for the hero characters, we were able to easily refit these garments to other characters that varied in shape and size. In our typical workflow for pattern-based garments, refitting is done by adjusting the 2D pattern panels. For the wrapped designs, the garment complexity is less on the pattern side and more in the complex draping and folding construction techniques. In order to leverage the construction as well as the base panel design, we developed a new process, which instead of altering the 2D panels to refit, utilizes simulation inside the tailoring package. First, to adjust the overall size of the garment, the simulation is run progressively, interactively scaling the warp and weft uv attributes of the solver as the base body mesh is blend-shaped into the target body shape. Fine tuning of the new garment fit is similarly achieved through further uv adjustments. Since the refit does not alter the shape, size, or topology of the base 2D panels, the resulting 3D cloth drape pose is the only data that is unique to the target. This allows efficient and seamless sharing of all cloth rig data between the base and refit garments. This simulation-based refit process is straightforward and efficient, and scales well to a large number of characters.

4 CONCLUSION

Realizing the wrapped garments in CG was a highly iterative, collaborative, and creative process that relied on a balance of real-word research and development of new CG techniques for faster iteration, stability, and art-directed performance of the simulation. We were able to successfully author and simulate this complex clothing by staying true to the actual mechanics of the construction. The final wrapped garments achieved the highly art-directed design and performance goals for the characters in the film, while staying true to the inspirational essence of their real-world counterparts.