Procedural Petticoats in *Shrek 2*

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1. Abstract

In the CG animated movie *Shrek 2*, the costume design for Fairy Godmother required us to develop a procedural technique to create ruffled petticoats that are visible at the bottom of her garment. Instead of spending weeks simulating layers and layers of petticoats, we decided to create the geometry procedurally as a post process. With this in mind we simulated her outer garment to create an illusion that many layers of ruffles support the garment from underneath. Once these simulated models were generated, the petticoats were created to fit correctly in place.

Fig 1: *Petticoats*

2. Visual and Technical Goals

We had four objectives, which helped us narrow down our procedural modeling solutions: 1) Petticoats will be textured as sheer and slightly transparent surfaces to hide possible stretching. 2) Motion of the petticoats will be driven by the character's legs and the simulated garment. To avoid adding additional noise the petticoats must be as stable as possible from frame to frame. 3) Maintain consistent uv parameterization. 4) Create the perception of a large volume of fabric beneath the garment.

3. Sphere Packing

While coming up with a procedural modeling solution, we explored several techniques. As the garment changes shape from frame to frame we couldn't simply create the new geometry by moving the garment CVs an arbitrary distance along their normal. Each CV needed to know exactly how far to move without colliding with itself, the garment, or the character.

Instead of using ray tracing or offset curve techniques we chose a simpler and more controllable method we call "sphere packing". On each frame the petticoat system finds a sphere for each CV that best fits between the simulated garment and the character.

We use an iterative process of adjusting the sphere radius until it fits correctly within a certain tolerance. With the garment as a starting point, we used each sphere's radius to generate the petticoat layers. See figure 2.

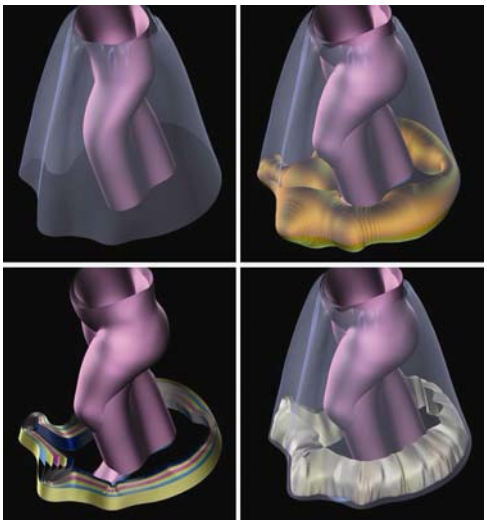

Fig 2: *Petticoat Generation*

If you were to isolate a single horizontal isoparm from the garment, this process would produce results that resemble a contour map. See figure 3. The radius also determines the maximum offset of additional folds/wrinkles that can be added to the petticoat without one layer crossing through another.

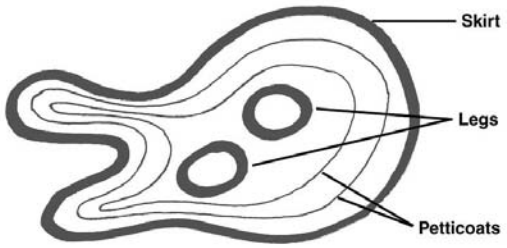

Fig 3: *Concentric Layers of Petticoats*

The interface to this system allows the animator to tune both the look and efficiency of the process in order to meet the specific visual needs of the shot. Some of the shot level controls include: the number of petticoat layers, how far vertically each layer extends, and the accuracy of the sphere packing. Because the petticoats were designed as a post process to the cloth simulation, the time saved was tremendous. The resulting motion generated by this procedural modeling technique gave the illusion that we actually simulated many layers of fabric -- which is one of the most challenging of all clothing simulations.