Generalized Approach to Rendering Fabric

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1. Introduction

For *Shrek 2*, a shader was required to render elegant fabrics such as taffeta and silk. Rather than designing a specific shader for each type of fabric, we decided to design one that was both general and extendable to many types of fabric. This shader was used for a multitude of fabric- and fabric-like surfaces in *Shrek 2*.

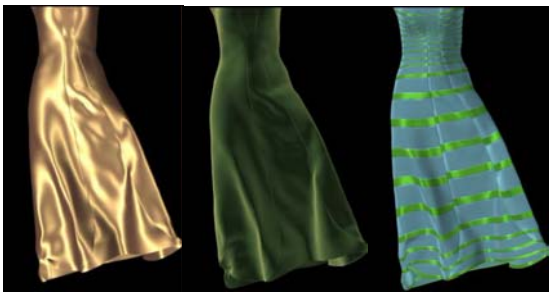

Fig. 1

2. Generalized Approach

The common element to all fabric is thread. A generalized approach requires designing a shader that allows the user to control thread direction and to combine the effects of multiple thread directions. This thread direction can come from some combination of u and v surface derivatives and surface normal directions with mapable perturbations. If it is assumed that these threads are simply cylinders of varying smoothness and not individually visible, then an anisotropic lighting model can be utilized. In this way, threads strictly along the normal produce a velvety result while those along the surface produce a silk-like result. Many combinations of threads and directions are possible.

A key to maintaining extendibility is to use this anisotropic lighting model to scale the effect of an already existing base shader's lighting model. In this way, the fabric shader inherits all of the features of the base shader. This inheritance of the other shader's lighting model and scaling of its intensity can be referred to as *anisotropic damping*. The anisotropic damping can then be balanced with the undamped intensity to give greater control of the overall intensity of the fabric. Although originally intended for clothing, we found that this generalized design allowed us to enhance the look of many other materials, organic and man-made.

3. Clothing

Using the shader for clothing, we were able to simulate many different effects of cloth and blend them together adding a new dimension of realism and detail. For instance, many of the costumes for *Shrek 2* were designed with elaborate patterns and embroidery, some very subtle and others graphic. With the fabric shader we could blend velvet with an ornate pattern of silk, or in a more subtle example, blend very similar fabrics with the only difference being thread direction. One can use a mask or pattern to blend these fabrics or simply blend them together.

Fig. 2

We would often texture map the thread direction to get different effects, like crushed velvet or worn satin.

4. Other Surfaces

We also applied the fabric shader on many other materials. One of the more obvious applications we used it for was brushed metals, which in many ways is similar to silk and satin. Some of the more obscure uses were for materials like skin, glass, fake fur, leather, wood, grass, flowers, glitter, and cookies.

Fig. 3

Anisotropic shading is the result of the surface having thread or grain. In reality, most materials have some form of micro-grain or thread. For example, a blade of grass has small ridges that follow its length, this gives it a satin quality. A cookie is covered in a crumbly dust, which produces a velvet quality on raking angles. Another interesting application of the fabric shader was sparkles and glitter. When blending fabrics of different anisotropic intensities we could get the effect of small cuts in a surface, which would reflect light more intensely. This is great for scratches in metal but could also be used to add sparkles to a dress or glitter in a character's lip gloss and makeup. Applying the fabric shader to an object, even at a very subtle degree, often adds a layer of realism and richness to the shading of a material that was well utilized in *Shrek 2*.

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