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A Biologically-Inspired Appearance Model for Snake Skin

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MOTIVATION

Photo-realistic rendering of biological tissues and structures, like feathers, fur or reptile skin, is still an open problem. The structural complexity at multiple scales of these biological elements result into complex light matter interactions, manifested as intriguing appearances at macroscopic scale (see Fig. 1). One of the most remarkable and studied examples of biological tissues are the **reptile scales**, which present a combination of photonic structures and pigmentation. Unfortunately, current appearance models in computer graphics mostly ignore the complex anatomic structure of scales and its coloration mechanisms.

Fig. 1. Real photograph of a white lipped python with smooth and iridescent scales [1].

OUR APPROACH

We present a practical and an efficient **multi-layered appearance model for snake skin** based on its anatomy [2] (see Fig. 2 for an overview). In contrast to previous work on diffraction from biological nanostructures [3], our model simplifies the photonic behaviour of the skin with an easy-to-parametrize thin layer, which is easy to author and practical in render time. Their approach requires a complex capture procedure using an atomic force microscope and expensive precomputation, making it difficult to generalize. We model the scales of the snake skin as a mesogeometry, using a tileable bump mapping technique. In this example, we manually create the **bump map texture of the Xenopeltis unicolor's scales**, which roughly follow an uniform hexagonal grid pattern similar to a Voronoi/Worley/celullar noise pattern.

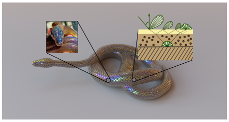

Fig.2. A rendering of a snake 3D model using our practical reptile skin reflectance model roughly matching the general appearance of the Xenopeltis unicolor (see the iridescent scales on the inset).

MULTILAYERED MODEL

We model the appearance of snakes skin using a multilayered BSDF that represents the outermost *oberhäutchen layer* [4] (see Fig. 3). The outer layer is fundamental for the appearance, as it contains different types of chromatophores.

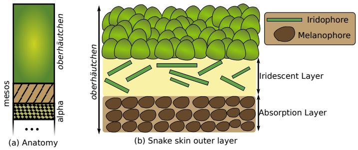

Fig. 3: Illustration of the multilayered model for snake skin based on its anatomy.

Our multilayered material is composed of a thin-film layer responsible of the iridescent effects (similar to [5]) and a diffuse substrate surrounded by an absorbing media mimicking the appearance of the melanophores' layer (see Fig. 4).

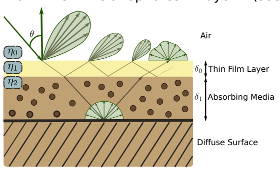

Fig. 4: Our practical multilayered material representation.

RESULTS AND DISCUSSION

We first demonstrate our model expressivity by exploring the range of appearances it is able to generate. As we can see in Fig. 5, the overall appearance changes drastically with both parameters.

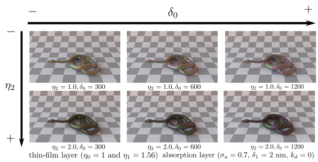

Fig. 5. Appearance range study of our thin film layer.

In Fig. 6 we highlight the importance of the mesoscopic bump map details, the iridescent layer, and the bottom absorbing layer. This ablation study shows that each component of our appearance model is indeed important for the final object appearance. The render time of our multi-layer material is only 1.5 times slower than the render time of a traditional diffuse material.

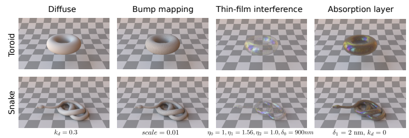

Fig. 6. Ablation studies of our multilayared BSDF model.

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