# Anisotropic Reflectance Modeling of Woven Fabrics based on Multi-view and Multi-illuminated Image Analysis

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Recent advances in 3D visualization from research on computer graphics (CG) and computer vision (CV) have stimulated vigorous research on the digital modeling and rendering of cultural assets and heritage for preservation, archiving and content production. The materials and cultural assets preserved in museums include precious cloth objects such as Noh costumes made of specially woven silk fabrics with such gold/silver-plated strings. Therefore, the automatic modeling of such reflectance properties of woven fabrics from observed image data for photorealistic rendering has been the one of the main problems in CG and CV.

The reflectance of fabric surface is commonly represented by a 4D bidirectional reflectance distribution function (BRDF). To generate the BRDF from measured data by a gonioreflectometer with 2 degrees of freedom of the light source and 2 degrees of freedom of the observing direction, it requires an enormous amount of measurements. In this thesis, an efficient image-based method for rendering the anisotropic BRDF of woven fabrics is proposed, based on the micro facet surface geometry determined by the cross-sectional shape of fibers, twist of yarns, and type of weave. At first, the relationship between the reflectance properties and the micro facet surface geometry of a type of woven fabric such as silk-like synthesized fabric are examined. Next, an image-based method for generating the BRDF of woven fabrics from measurement of the reflectance is developed. The simulation results on arbitrarily colored dresses show the performance of the proposed approach.

Next, the reflectance of such fabric surface of Noh costume is commonly represented by a large-scale of bidirectional texture function (BTF) which requires an enormous amount of measurements. In this thesis, an efficient image-based method for acquiring, modeling and rendering of multi-resolution BTF of such woven fabrics is proposed. At first, images of the woven fabrics are segmented into regions according to their colors. Next, the relationship between the reflectance properties and micro facet surface geometry of a type of such woven silk fabrics is examined. Then an image-based method for generating the multi-resolution BTF for each segmented regions is developed using EM algorithm. The simulation results on rendering an arbitrary colored Noh Costume at arbitrary distance without aliasing show the performance of the proposed approach.