Realistic Modeling Techniques Based On Real-World Sampling Dataset

Abstract

With the rapid development of computer graphics, computer visions, and HCI technologies, virtual reality has been extensively applied to many areas such as virtual prototype designs，entertainment industries, and military trainings. The traditional modeling methods for constructing 3D virtual environments are not capable of meeting the requirements of many applications due to their low efficiencies of modeling and bad fidelities. How to get useful information from real-world environments and assemble it onto a virtual world has been viewed as a hot topic in recent years. This thesis attempts to address such a challenging problem from both an image-based modeling approach and a sample-based modeling approach.

At first, we designed and implemented a prototype system to automatically reconstruct a geometric model and corresponding textured surface of 3D physical object. This system took advantage of stereo vision-based methods to acquire 3D data points through sampling on the surface of physical object. All the resulting geometric models, textures, and texture coordinates were used in a standard rendering pipeline. We discussed a collection of procedures involved in the whole system, including system calibration algorithms, 3D points acquisition algorithms, surface reconstruction algorithms, and texture registration and blending algorithms. An example was used to illustrate the proposed approaches and verify the performance of system.

Second, we developed a synthesis method for an arbitrary surface using a sample bidirectional texture function (BTF). BTF is defined as a 6-dimensional function that describes nature textures arising from both spatially-variant surface reflectance and surface mesostructure. Our approach accomplished a BTF-based synthesis using surface textons, which were extracted from the sample BTF. In order to speed up the process of such a BTF-based synthesis, we proposed a general search strategy, i.e., a k-coherence search algorithm. Our experiments showed that the surface BTF obtained by using the above synthesis approach not only kept the same viewing/illumination properties as the sample BTF but also visually retained similar mesostructures even if we observed it at different viewing and lighting directions.