論 文 の 内 容 の 要 旨

論文題目　Adaptive Improvement of Raw-Scanned 3D Models by using Domain Specific Knowledge
（ドメイン知識を利用した
３次元スキャンモデルの適応的改善）

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Three-dimensional scanning has increased in popularity to generate 3D models in computer graphics. This technology was originally used by professionals to digitize expensive real-world objects using highly expensive devices, such as a laser scanner. However, recent advances in 3D scanning technology enable a casual user to scan models in our daily lives using a commodity camera. Nonetheless, despite its potential, the scanning method is not widely used in various contexts due to low quality and controllability.

There are three representative problems in a raw-scanned 3D model, from the perspective of quality and controllability. First, geometry artifacts appear in a scanned 3D model such as environmental ground, internal and external noise. In addition, originally separated but adjacent parts become fused. This fused limb parts also hinder from flexible pose changing. Since there is no semantic information in 3D scanning, these artifacts are difficult to be removed automatically. Second, sharp features on the surface become overly smoothed. From the incompleteness of observation and limitation of reconstruction algorithm, a raw-scanned 3D model usually has lower spatial resolution than the source images. Third, additional geometry features such as micro fur strands are also missing. There are several data representations such as a parametric model but conventional 3D scanning methods only cover 3D mesh representation as the final goal. For these reasons, it is quite limited to use a raw-scanned 3D model to other applications such as 3D printing, computer animation, and virtual reality.

In this dissertation, we introduce methods for improving raw-scanned 3D models

by leveraging domain knowledge on target applications. The first approach is the skeleton-based shape refinement method for 3D character animation, which fixes the topological issues in the raw-scanned 3D model by leveraging the user-specified skeleton information as the domain knowledge for shape enhancement. Combined with automatic rigging method, it also provides flexibility of pose changing. The second approach is the transfer-based detail enhancement method for the 3D printed human face replica, which is based on the geometric ridges and valleys of human face components. We detect and parameterize faces from a full-body scanned model, and then transfer the geometric features created by experts. The third approach is utilizing the expert's knowledge on reproducing the parametric fur workflow. We find the conceptual similarity between the expert workflow and perceptual feature-based texture synthesis methods, so we establish an optimization framework that utilizes features from the deep convolutional network.

We show the feasibility and effectiveness of each approach, as well as its limitations. We believe our approaches in this dissertation will serve as a foundation for further raw-scanned 3D model improvement.