Surface appearance reconstruction from image streams

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The technologies for the acquisition of very precise 3D representations of real objects have been improved in a considerable manner in the last few years. While the methodologies for the acquisition of the shape through 3D scanning allow the reconstruction of very accurate geometries in an affordable times, on the other hand the acquisition of the object's surface appearance is more complex and the technology is in a more primitive status.

We propose a new technique for the acquisition of the surface appearance of a real object from temporal coherent image streams, like video sequences, and its projection over a triangular mesh of the same object. The technique is composed by two steps: the registration of the video sequences over the mesh by calibration of the camera; reconstruction of the surface appearance using the advantages of a video sequence, the frame-to-frame temporal coherence and the redundancy of the data.

The goal of the first step is to obtain an accurate alignment of each frame of the video over the mesh to allow the bidirectional data transfer between the 3D model and the video using the perspective projection defined by the camera model. Our solution uses two different approaches: feature-based registration by KLT video tracking, and statistic-based registration by maximizing the Mutual Information between the gradient of the frame and the gradient of the rendering of the 3D model with some illumination related properties, such as surface normals and ambient occlusion. While the first approach allows a fast registration of short sequences with simple camera movements, the MI is used to correct the drift problem that KLT tracker produces over long sequences, due to the incremental tracking and the camera motion.

The goal of the second step is to reconstruct the reflectance behavior of the surface by statistical analysis of the color samples projected in each point from each frame of the video. From this statistical analysis we are able to recover the diffuse and the specular color of the object, along with a rough estimation of the lighting environment conditions that characterized the acquisition of the image stream.