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Stress analysis in acquired artistic works using the Scan-and-Solve approach

M. Freytag, V. Shapiro, I.Tsukanov

Summary

With the availability of low-cost high-speed acquisition techniques, real-world geometry is being captured at an increasing rate. This acquired data is primarily used only for visualization purposes, as more complex analyses like physical field simulation require extensive manual conversions and processing, or rely on representations producing results with questionable accuracy. The fields of medicine, engineering, and architecture, among others, could all benefit from the ability to transparently compute accurate physical analyses from these data.

We demonstrate the Scan-and-Solve approach by performing stress analysis in Michelangelo's David statue from the original 3D acquired data using our Scan-and-Solve approach. Our approach, dubbed Scan-and-Solve, enables an engineering analysis performed directly on acquired geometry, bypassing tedious, error-prone, and artificial reconstruction methods. It is based on the recognition that any shape is represented unambiguously by an associated distance field that can be rapidly sampled, approximated, smoothed, differentiated, and integrated using modern computational techniques. These distance fields can also be used to solve most engineering analysis problems using the meshfree technology developed by the authors over the last ten years. Scan-and-Solve approach combines these capabilities that transform engineering analysis into an attractive technique that can be applied directly to shapes acquired from a variety of sources.