

From Data-Driven to Information-Driven: Measuring & Modeling High-Dimensional Appearance in Computer Graphics

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Abstract

Over the last two decades, the data-driven approach has achieved tremendous success in computer graphics and significantly improved the photorealism in rendering. This approach, however, soon becomes incompetent for many appearance phenomena in nature (even with today's most sophisticated acquisition systems), such as time-varying reflectance, fluids, and dynamic light field, which are inherently complex and high-dimensional.

In this talk, I argue that a better way to tackle high-dimensional appearance is the *information-driven* approach. It has two key distinctions compared to the data-driven approach. First, instead of directly sampling 2D slices of appearance (which is both expensive and redundant), novel imaging systems can be designed to take *coded, information-condensed measurements*, which can later be decoded computationally. In particular, I will describe how we used coded illumination for efficient recovery of time-varying volume densities from a single view and how we designed coded exposure for CMOS image sensors for flexible space-time sampling. Second, instead of directly tabulating and interpolating the measured high-dimensional data, *low-dimensional computational models and associated editing operators* can be developed for controllability in synthesizing or reversing the appearance effect from images. As examples, I will describe how we exploited the space-time coherence for modeling time-varying surface reflectance across a wide range of weathering processes and how we incorporated natural image priors for removing image artifacts due to contaminated camera lenses. I believe the information-driven approach is also able to prompt fundamentally new research on acquisition and representation for other disciplines in imaging science that go beyond computer graphics.

Biography:

Jinwei Gu is currently a PhD student at the Computer Vision Laboratory (CAVE) at Columbia University under the supervision of Professor Shree K. Nayar, Professor Peter N. Belhumeur, and Professor Ravi Ramamoorthi. He defended his PhD thesis on March 5th, 2010, which is focused on measuring, modeling, and synthesizing time-varying appearance of natural phenomena for computer graphics. Prior to this, Jinwei received his bachelor and master degree from Department of Automation in Tsinghua University, China in 2002 and 2005. He had also been an intern student in Microsoft Research Asia from 2003 to 2004 and in Adobe Research (CTL Laboratory) in 2008. His current research interest lies at the intersection between computer vision, computer graphics, and computational photography.