

## Advanced Topics in Computational Photography

### Abstract

Computational photography combines plentiful computing, digital sensors, modern optics, many varieties of actuators, probes and smart lights to escape the limitations of traditional film cameras and enables novel imaging applications. Unbounded dynamic range, variable focus, resolution, and depth of field, hints about shape, reflectance, and lighting, and new interactive forms of photos that are partly snapshots and partly videos, performance capture and interchangeably relighting real and virtual characters are just some of the new applications emerging in Computational Photography. The computational techniques encompass methods from modification of imaging parameters during capture to sophisticated reconstructions from indirect measurements.

For the first time, we will bypass basic and introductory material presented in earlier versions of this course (Computational Photography 2005,6,7) and expand coverage of more recent topics. Emphasizing more recent work in computational photography and related fields (2006 or later) this course will give more attention to advanced topics only briefly touched before, including tomography, heterodyning and Fourier Slice applications, inverse problems, gradient illumination, and novel optics. With this deeper coverage, the course offers a diverse but practical guide to topics in image capture and manipulation methods for generating compelling pictures for computer graphics and for extracting scene properties for computer vision, with several examples.

A larger problem is that a multi-disciplinary field that combines ideas from computational methods and modern digital photography involves a steep learning curve. While basic techniques are becoming well-known, many advanced ideas in computational photography are still relatively new to digital artists and programmers and there is no up-to-date reference text. For example, photographers are not always familiar with advanced algorithms now emerging. These topics, however, can be easily learned without extensive background. The goal of this presentation is to present both aspects in a compact form.

We introduce benefits of higher dimensional representation of light-fields and reflectance fields, clarify concepts such as ray-transfer matrix and explain wavefront coding and non-linear optics. We discuss applications of sensors for depth, thermal and millimeter waves. This is the first time an advanced course is being proposed. A subset of speakers presented a course in Computational Photography 2005-2007, where the emphasis was on learning about Siggraph/Computer Vision literature. In the proposed advanced course, our emphasis is on ideas and methods from outside the computer graphics and computer vision community.

The participants learn about topics in image capture and manipulation methods for generating compelling pictures for computer graphics and for extracting scene properties for computer vision, with several examples. We hope the course will better satisfy the technical specialist without intimidating the curious graphics researcher and any SIGGRAPH attendee interested in recent advances in photography. The intended audience is photographers, digital artists, image processing programmers and vision researchers using or building applications for digital cameras or images. They will learn about camera fundamentals and powerful computational tools, along with many real world examples.