Introduction

It has been widely recognized that lighting plays a key role in the realism and visual interest of computer graphics renderings. This has led to research and development of image based lighting (IBL) techniques where the illumination conditions in real world scenes are captured as high dynamic range (HDR) image panoramas and used as lighting information during rendering. Traditional IBL where the lighting is captured at a single position in the scene has now become a widely used tool in most production pipelines. In this poster, we give an overview of a system pipeline where we use HDR-video cameras, [1, 2] to extend traditional IBL techniques to capture real world lighting that may include variations in the spatial or temporal domains, [3, 4]. We also describe how the capture systems and algorithms for processing and rendering have been incorporated into a robust systems pipeline for production of highly realistic renderings. High dynamic range video based scene capture thus enables highly realistic renderings where traditional image based lighting, using a single light probe, fail to capture important details.

**HDR-video capture**

The HDR-video sequences used in the experiments described here were captured using two prototype camera setups. The first setup, see Fig. 1 (left) and [1], was implemented using the Ranger C55 camera platform from SICK-IVP. The sensor micro-code was modified to support sequentially HDR-capture with a per-pixel minimal time disparity between the exposures. This camera exhibits a dynamic range of 23 f-stops at 25 fps with a resolution of 960x512 pixels.

![HDR-video camera setup](image1.png)

**Figure 1: HDR-video camera setups**

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**Temporally varying IBL**

To extend IBL to include the temporal domain, we capture panoramic HDR-video sequences along camera paths and switch the lighting environment for each rendered frame, see Fig. 3. The rendered objects will appear as they are following the same path. High frequency changes in the time domain may lead to flickering artifacts since we, for each time step, use only a single angular radiance distribution for the entire virtual scene as in traditional IBL. It is therefore useful to apply filtering to smooth out rapid changes in the temporal domain as shown in Fig. 4. In our pipeline, we normally use a gaussian or triangular filter over 3-5 frames. Fig. 5 shows frames from a sequence using temporal IBL rendering. For efficient sampling of the lighting environment during rendering, we use a sequential Monte-Carlo approach taking into account the coherence between input frames. For real-time rendering, we use a GPU based algorithm for fast spherical harmonics (SH) projections of the captured light probes [3]. Using pre-computed radiance transfer techniques, we compute SH projections of the BRDF and local visibility on the virtual objects. This enables real-time rendering with streaming, high resolution (1700x1700 pixels) input from the HDR-video camera.

![Temporally varying IBL](image2.png)

**Figure 3: HDR-video camera setups for temporal IBL**

**Figure 4: Temporal filtering to avoid flickering artifacts**

**Figure 5: Four frames from an animated temporal IBL sequence**

**Spatially varying IBL**

Assuming that the scene is static during the duration of the capture our pipeline allows for reconstruction of a geometric proxy model of the scene as illustrated in Fig. 6. The scene reconstruction uses HDR-sequences as input and carried out in a semi-automatic fashion. First, we use structure from motion techniques to compute a dense point-cloud representing the geometry of the scene. In a second step, the user refines the proxy geometry and interactively extracts the direct light sources in the scene. The radiance measurements described by each pixel in the input HDR-video sequences are then re-projected onto the recovered proxy geometry and stored at the surfaces. The final scene model with HDR textures can be loaded into most modeling softwares (we use Autodesk Maya) and be directly used for rendering of highly realistic scenes. Fig. 7 shows a comparison between traditional IBL (left) and our approach (right). It is evident that the spatial variations in the illumination plays a key role in the realism and visual richness, for an overview see [4].

![Spatially varying IBL](image3.png)

**Figure 6: Recovered scene model**

**Figure 7: Comparison traditional IBL (left) vs. Spatially varying IBL (right)**

**References**


