PhysLight: An End-to-End Pipeline for Scene-Referred Lighting

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Figure 1: PhysLight enables artists to match accurately the characteristics of the cinema camera and lights, such as in this image of a fully digital Will Smith lit by a measured LED source from *Gemini Man*.

ABSTRACT

We present a visual effects production workflow for using spectral sensitivity data of DSLR and digital cinema cameras to reconstruct the spectral energy distribution of a given live-action scene and perform rendering in physical units. We can then create images that respect the real-world settings of the cinema camera, properly accounting for white balance, exposure, and the characteristics of the sensor.

CCS CONCEPTS

• **Computing methodologies → Rendering**.

KEYWORDS

rendering, image based lighting, HDRI, spectral rendering, lighting, path tracing

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1 INTRODUCTION

Despite the physical quantities involved in light transport being well understood, most production renderers use dimensionless units for lighting input, and artists typically rely on manual reference-matching to define the mapping between the renderer's working space and the "scene-referred" space of the physical world. Variance between shots caused by different camera settings used to capture the plates is either handled by grading the plates to match across a sequence (commonly termed 'neutral grading'), or by adjusting the lighting to account for differences in camera settings. Both are ad-hoc, error-prone processes.

In use in production since 2015, *PhysLight* builds on Weta Digital's spectral renderer, *Manuka* [Fascione et al. 2018], to perform rendering entirely in physically correct photometric units. We can use the camera data from each shot directly, and the virtual camera in the renderer—the *PhysCam*—correctly responds to settings

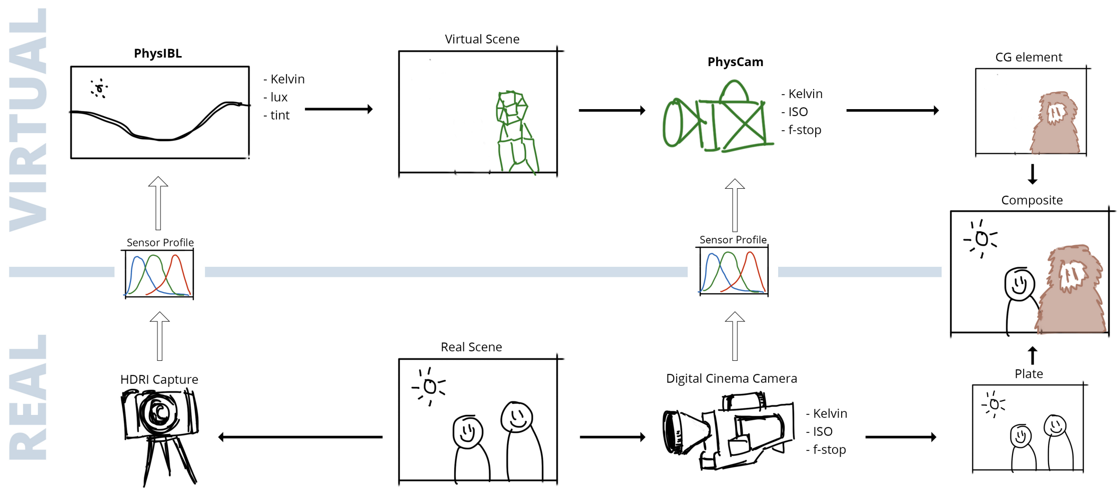

Figure 2: Diagram showing the *PhysLight* process.

such as colour temperature, ISO and f-stop to generate an image matching the original scan from the cinema camera. This separation and accurate representation of lighting and the camera in the final image lead to easier setup and more consistent results.

2 WORKFLOW

We use profiled sensor data for the DSLR and digital cinema cameras used for HDRI capture and plate capture, respectively. The former allows us to reconstruct spectral energy distributions from an HDRI to use as input to the render, while the latter allows us to render an image of the digital scene that matches the way a particular cinema camera would capture its real-world equivalent. HDRI are parameterized by (normalized) illuminance specified in lux. Artists are able to extract finite area lights to place lightsources in 3D space and adjust their parameters for creative lighting purposes. Area lights are parameterized in lumens, and the user can apply a tint function simulating a gel to adjust the colour of the source.

More recently, starting with *Gemini Man*, we have begun using a spectrometer to measure practical light sources on set. This enables us to achieve accurate colour reproduction for all lights, especially those with non-smooth spectra such as LEDs and fluorescents.

The *PhysCam* controls the exposure and colour of the final rendered image according to the profiled digital camera sensor function, and parameters such as Kelvin colour temperature, f-stop, ISO, frame rate and shutter angle. *PhysCam*s are created automatically for each shot from the camera metadata in scan EXRs.

The combination of accurate light and camera reproduction allows artists to quickly set up the lighting for each shot, and to use the same rig for many shots in a sequence with the *PhysCam* accounting for camera differences without resorting to per-shot tweaks or grading. We have experienced significant savings in lighting setup time.

Figure 3: By calibrating against a profiled sensor, we can take a light source from one environment (torch, top-left), and use it to light shots with dramatically different lighting and camera settings.

3 CONCLUSIONS AND FUTURE WORK

Aside from fast, accurate lighting, we have seen many other benefits for VFX production. *PhysLight* takes the guesswork out of lighting for all-digital shots or complete greenscreen replacements as proper exposure of the environment is handled by the virtual camera. Light sources from existing photography can be matched and used in new shots, essentially using the cinema camera as a calibration device. For instance on *War for the Planet of the Apes* we used torches captured in the HDRI to calibrate the temperature of fire simulations which were then used to light subsequent shots with different camera settings (Fig. 3).

We still need to correctly account for many variables in the reconstruction. For example, we need to profile commonly used neutral density filters to be able to represent their chromatic effects. Improved sensor profiling is also an ongoing area of research.

REFERENCES

Luca Fascione, Johannes Hanika, Mark Leone, Marc Droske, Jorge Schwarzhaupt, Tomáš Davidovič, Andrea Weidlich, and Johannes Meng. 2018. Manuka: A batch-shading architecture for spectral path tracing in movie production. *ACM Trans. Graph.* 37, 2 (March 2018), 18. https://doi.org/10.1145/3182161