Light Harmonisation for Virtual Production

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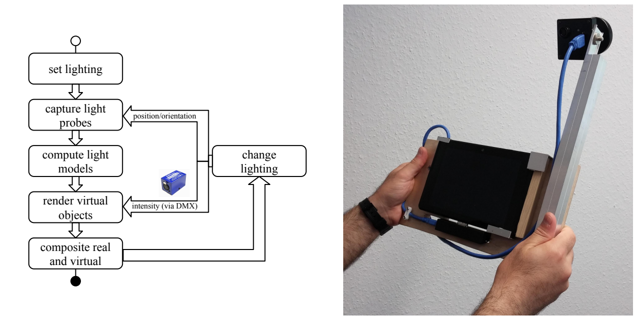

Figure 1: Production steps of a mixed-reality scene with respect to lighting (left) and the prototype light capture rig (right)

Figure 2: Droid at different locations illuminated with the estimated discrete spot lights (top row) versus single HDRI lighting (bottom row)

Harmonising the lighting in virtual and real scenes is required in the production of visual effects (VFX) involving the integration of Computer Generated Imagery (CGI) into real camera images. In order to produce a convincing integration, the virtual (CGI) objects need to be lit with the same lighting as the real scene. Currently this harmonisation between the real and the virtual scene is mainly done by manually setting the lights in 3D rendering tools to match the real lighting as good as possible and achieve the desired look and feel.

An automated approach to capture and use real lighting is through High Dynamic Range (HDR) light probes [1]. It is fast to capture a light probe with suitable equipment and the results are appealing for large extent scenes. However, for studio shots where the direct lighting can change significantly within small areas and there exist moving virtual assets, a *single* light probe cannot model the lighting situation efficiently. Another important limiting factor is to capture the required dynamic range and avoid lens flare, *etc.* where bright lamps and dark corner spots of the scene are both visible in the light probe image. Here suitable importance sampling methods of light probe images are needed in the supporting renderers.

Another approach which is recently getting attention is to improvise the lighting on-set (live production) [4]. Hybrid interfaces like motion capture systems, gesture recognition, touch panels, *etc.* are designed and developed to help the creative crew to decide on different aspects of production *e.g.* lighting, position of props, animation, camera view, *etc.* onset while having a live (lower quality) preview. Although it doesn't necessarily involve capture and estimation of lighting, however, fine tuning of lighting parameters with live preview can be very effective and much faster to finalize a scene before moving the final quality render in post-production.

In this work we build upon our previous works [2, 4] and introduce a new light capture setup based on a SLAM-tracked tablet PC and an industrial C-mount fisheye camera which can be employed in film/TV studios to facilitate capture of registered light probes significantly. We visually show in an experiment the importance of modelling discrete light sources in indoor scenes versus the traditional HDRI lighting approach.

Our prototype light capture setup consists of a small light probing fisheye camera which is mounted on a rig where a Google Tango prototype tablet is installed on (Figure 1). The offset between the tablet and the fisheye camera is fixed and measured once by imaging a static calibration pattern by both tablet's and probe fisheyes to find the relative extrinsic transformation.

The light probing camera is a See3CAM C-mount 1.2 MP USB 3.0 industrial digital camera with standard USB Video Class (UVC) interface and 1/3in sensor size. The camera is equipped with a Fujinon 1.4mm fisheye lens with manual iris range F1.4-F16 that provides 185° and 144.5° horizontal and vertical field of views, respectively.

Neutral Density (ND) filters with different optical densities (depending on the intensity of the lamps) are added inside the optical system (1/2in ⌀) to attenuate light rays and avoid over exposed images. A number of spacer rings are used to adjust the focus.

An Android app is developed with Tango's Java API and UVCCamera library to record the tracking information alongside the captured light probe images on the local storage. The studio is surveyed and saved as an Area Description File (ADF) beforehand (takes about 2 minutes) and loaded into the app for more robust tracking performance.

In order to take light probes, the user is able to set the desired exposure while having a preview image on the screen. In addition to single exposures, bracketing option is also available for creating the HDR brackets. The option covers 10 stops on our selected camera's API. The user is recommended to use suitable ND filters to avoid over exposed light probes; in the ideal case, the longest exposure image of the brightest lamp should be still not over exposed.

The introduced light capture setup is used to probe a test scene (approx. 4x3m) illuminated with three spot lamps, L1-3, which are operating at different settings. 24 HDR light probes are captured in total so that L1, L2 and L3 are visible in 12, 10 and 10 of them, respectively. The light probing phase takes less than 10 minutes. The captured images are then fed into our algorithm [2] to estimate the unknown parameters of the lamps *i.e.* intensities, 3D positions, dominant directions and beam angles.

To visually compare the importance of discrete light source estimation in the scenes with small extents compared to the traditional HDR image-based lighting, we create a virtual scene with the geometry of our studio *i.e.* modelling the walls, floor and the ceiling with diffuse material. The scene contains an animated droid [3] which is rendered with Quasi Monte Carlo GI method of Cinema 4D Studio.

Figure 2 shows the rendered droid at different locations of the studio, illuminated with the estimated spot lights compared to single HDR image-based lighting. Results show how the droid's shading and shadows change accordingly when it moves in the studio while the renders of HDRI environment map keep almost the same appearance.

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[3] Pariah Studios. Free BB-8 style droid scene file. URL pariahstudios.co.uk/free-bb-8-style-droid-scene-file.

[4] Jonas Trottnow, Kai Götz, Stefan Seibert, Simon Spielmann, Volker Helzle, Farshad Einabadi, Clemens KH Sielaff, and Oliver Grau. Intuitive virtual production tools for set and light editing. In *Proc. CVMP*, pages 6:1–6:8, 2015.