Director-Centric Virtual Camera Production Tools for Rogue One

Mike Jutan
Industrial Light & Magic / Lucasfilm

Steve Ellis
Industrial Light & Magic / Lucasfilm

Figure 1: *Rogue One director Gareth Edwards operating a virtual camera, real-time output, and final shot.*

ABSTRACT

For *Rogue One: A Star Wars Story*, executive producer John Knoll wanted the all-CG shots to feel consistent with the signature handheld camera style that director Gareth Edwards captured on set. To achieve this, the Industrial Light & Magic (ILM) R&D team created a director-centric virtual camera system that encourages open set exploration of the all-CG *Star Wars* worlds. We enabled the director to achieve his artistic vision via our low footprint, flexible, iteration-based production toolset.

CCS CONCEPTS

• **Computing methodologies → Motion capture;** Graphics input devices • *Human-centered computing → Interaction techniques*

ADDITIONAL KEYWORDS AND PHRASES

Virtual camera, post-vis, filmmaking

ACM Reference format:
Mike Jutan and Steve Ellis. 2017. Director-Centric Virtual Camera Production Tools for Rogue One. In *Proceedings of SIGGRAPH 2017 Talks, Los Angeles, CA, USA, August 2017*, 2 pages.
DOI: 10.1145/3084363.3085053

1 INTRODUCTION

Gareth Edwards is a hands-on filmmaker, often operating the Arri Alexa camera on set. He does not like to be constrained to the initial sequence planning, opting instead to try alternative angles to find the most interesting shot. Our system provided this freedom within the pure digital environments of *Rogue One*.

Our goal for the virtual camera system was to mimic Edwards' on-set experience when shooting all-CG shots, tailoring the workflow to match his directing style. This strategy of providing a comfortable and familiar shooting environment enabled him to focus on the art rather than new technology. We achieved our goal via a low footprint hardware setup, flexible iteration-based shot workflows, and an automated data processing pipeline. The *Rogue One* virtual camera shoots provided invaluable communication between Edwards and ILM artists; by him "showing rather than telling", we achieved his vision with higher fidelity. Iteration time to shot completion was also reduced.

SIGGRAPH '17 Talks, July 30 - August 03, 2017, Los Angeles, CA, USA
ACM 978-1-4503-5008-2/17/07.
http://dx.doi.org/10.1145/3084363.3085053

2 A NIMBLE PRODUCTION SOLUTION

2.1 Low Footprint Hardware Setup

ILM traditionally uses a VICON optical mocap system on our Motion Capture stages. For *Rogue One*, we tested the concept of an ILM Mobile Studio, emphasizing quick setup and tear down. Our initial shoot used an InterSense motion tracking system, a tethered virtual camera, and required a truss and lengthy setup time. For a lighter-weight solution, we chose the simple, low-cost HTC Vive, which requires less physical space and setup time. Subsequent shoots were run with just one artist acting as support/mocap operator for Edwards. As described by Wooley et. al [2015], our Zeno Virtual Production software makes it possible for a very small crew to run a large-scale production.

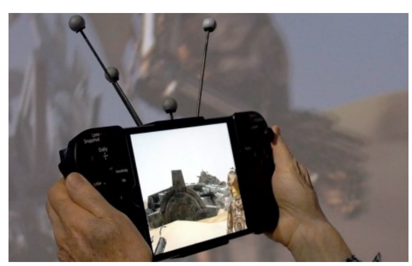

Figure 2: *the ILMvCAM iPad/Gamevice virtual camera*

The ILMvCAM (see Figure 2) is constructed from purely off-the-shelf hardware: an Apple iPad Mini, Gamevice game controller, and a connected mocap system, which tracks position and orientation. Joystick moves and button presses are captured by the ILMvCAM App, and are sent to the host computer (running Zeno). Zeno then interprets these events and performs the appropriate action. For example, "joystick up" may map to a "camera boom up" action, or can be inverted to control "camera boom down". Actions may be remapped at any time to suit director preference. Buttons can start a new take, start/stop timeline playback, or even switch between available lenses.

To display the virtual scene live, we stream video from the host computer back to the ILMvCAM iPad App, taking advantage of NVidia's H.264 hardware encoding and a dedicated wireless network. The ILMvCAM embodies the Zeno camera, allowing the director to control the 3D scene in a natural, tactile way.

We tested ILMvCAM with several directors and found that those who play video games or are camera operators often preferred it to more traditional virtual camera rigs. Edwards used it on nearly every shoot; he found the lightweight, wireless form factor more satisfying for capturing handheld-style shots.

2.2 Flexible Iteration-Based Shot Workflows

During the pressure of a real-time shoot, the mocap operator needs to react as swiftly as possible to any director request. The steps required to achieve a positive result are often quite complex. We leveraged years of production experience with a wide variety of directors, to predict potential requests. Building upon the Zeno Virtual Production platform [Wooley et. al, 2015], we wrote automated solutions for time-consuming tasks.

A director may want to review a take immediately after shooting it, playback a camera move generated in pre-vis, add refinement motion to an existing camera move, or record one type of motion (e.g. pan) in a first-pass and then record a different type of motion (e.g. tilt) as a second-pass. A director may even want to interactively adjust scene lighting or retime pre-vis animation. We built shortcuts for these types of actions.

For Edwards, a major goal was facilitating a freedom of play within a virtual set, mimicking the freedom he favored when shooting on practical sets. We added the ability to walk around large virtual sets with a larger than one-to-one motion scale. The system also supports shooting continuously without cutting, so if a shot didn't work, he could simply discard it without penalty, and a new idea could easily replace it.

2.3 Automated Data Pipeline

We reduced artist burden by further developing our asset optimization pipeline, to auto-generate real-time-ready versions of all assets with no artist intervention. The system is attractive to production as it plugs directly into ILM's pipeline and uses our production assets and camera models. This enables us to push the director's captured camera moves through the pipeline within minutes of selecting a take. ILM artist teams across the globe can then immediately begin working on shot refinement.

3 PRODUCTION SUCCESS

During our initial post-vis shoot, Edwards used this system to compose two of the most iconic shots in the *Rogue One* trailer: the Star Destroyer reveal and the Death Star dish installation. Tweaking the lighting characteristics in real-time helped Edwards visualize the ominous creeping of the Death Star dish shadow across the scene. When the shoot day wrapped in London, the virtual camera data was transferred to the ILM Layout department in San Francisco. Turnaround time was of the utmost importance, so, by leveraging our automated data pipeline, San Francisco refined animation for Edwards to review in London by morning. Merely one week later, the new *Rogue One* trailer was released with the final, high-quality versions of these two iconic shots.

The final shots in the space battle sequence (see Figure 1), are true to Gareth Edwards' artistic vision, as they almost exactly match his real-time virtual camera work. Our flexible system enabled him to capture the all-CG scenes in his signature practical style, adding visual consistency to the film and thereby benefiting the overall aesthetic of *Rogue One*.

REFERENCES

WOOLEY, K., JANG, Y., AND LOCKWOOD, N. 2015. Raptor Wrangling: Real-time Motion Capture for Jurassic World. In *ACM SIGGRAPH 2015 Talks (SIGGRAPH 2015)*, Article 42. ACM, New York, NY. DOI: https://dx.doi.org/10.1145/2775280.2792532