Raptor Wrangling: Real-time Motion Capture for Jurassic World

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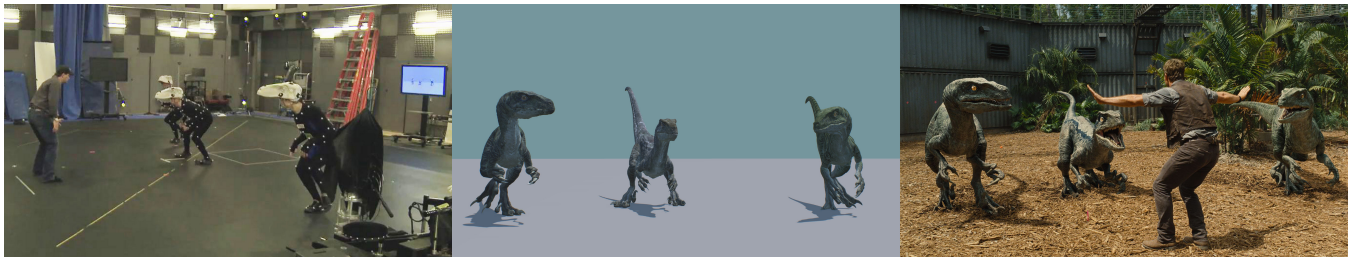

Figure 1: *Raptor Motion Capture: reference video, real-time output, and final frame. ©2015 Universal Pictures*

Abstract

Inspired by the first Jurassic Park, where the velociraptors were animatronic suits worn by performers, Industrial Light & Magic (ILM) used real-time motion capture as the basis for the animation of the raptors and other bipedal dinosaurs in *Jurassic World*.

Using ILM's Zeno application framework, we built a system for real-time retargeting and visualization of hero characters which was tightly integrated into our asset and shot production pipeline.

During motion capture sessions, our system allowed us to visualize the actors' performances on up to four creatures at 24 frames per second, with the same geometric detail and rig complexity which artists work with offline. This gave our animation director the confidence to capture multiple takes and select performances, knowing that the motion would look identical in shot and be a solid foundation for animation to build upon.

1 Rigging and Retargeting

Unlike many real-time applications which use relatively simple character rigs, our system uses the full hero animation rigs in order to leverage the controls built for animators to drive complex behaviors in the creature. A single hero dinosaur rig can contain over 2000 transforms and hundreds of constraints.

Our retargeting system was exteneded to compensate for the difference between human and dinosaur skeletons. The joints in the dinosaur skeleton that map to those of the human are specified in a mapping that can be easily be modified, saved, and re-used. For example, remapping the human leg the control rig of the raptor's dog-like hind leg, produced natural walking motion. Mapping the human head joint to a joint mid-way along the raptor neck resulted in a more natural movement of the neck when the actor turned their head.

Additionally, our system does not require the actor and creature to be in a particular pose, such as a T-pose, during retargeting. Instead, offsets are automatically calculated to map between the actor's and creature's current poses. Additional manual controls allow adjustment of the offsets during live sessions. This enabled the performers to each develop their own "dino pose", to comfortably and expressively perform without exactly reproducing a dinosaur's posture.

2 Optimization

The dinosaurs were rigged in Maya using ILM's procedural rigging system, BlockParty, and then converted to work in our Zeno application framework. Zeno features a highly efficient, multi-threaded scene graph which allows us to evaluate the complex rigs in real-time.

We implemented skinning in a vertex shader as part of our real-time renderer to avoid the cost of computing deformation during evaluation.

Profiling showed that the remaining performance bottleneck was the number of draw calls in each render pass. Each mesh and texture map incurs a draw call, so we developed a model and texture optimization tool to reduce the number of separate meshes and textures. All meshes under a single transform hierarchy are combined while merging geometric properties. A single mesh, particularly a combined mesh, may have many textures which are stitched into a single map.

3 Production Workflow

This system was integrated into ILM's asset and shot production pipeline, which made it possible for a very small crew to run a large scale production. No additional artist time was required to produce special real-time-ready assets. Assets were optimized as the geometry was updated and checked into our asset database.

Retargeting was set up in advance and adjusted live when necessary. In post, the cleaned motion capture data was simply loaded into the scene file from the capture session for verification and then exported back to Maya for additional animation.

The director and actors immediately reviewed each take after capture, allowing them to make informed changes to the performance.

A crew of three artists shot, processed, retargetted, and delivered performances for six creatures in over 240 shots across 13 sequences.

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